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# Microfinance, Financial Inclusion and ICT: Implications for Poverty and Inequality

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## Abstract

This study assesses the role of Information and Communication Technologies (ICT) in poverty & inequality reduction by fostering financial inclusion, using panel dataset of sixty-two countries between 2001 and 2012. It mainly focuses on two different dimensions of financial inclusion e.g., inclusion by commercial banks and by microfinance institutions (MFIs). As the formal financial institutions deal with wealthy and well-off clients, whereas the MFIs claim to be the bankers of poor. A large number of poor people are still un-banked in low income countries; however, research in development finance suggests that accessible and timely finance has the potential to bring poor out of poverty. The importance of MFIs in providing credit and other financial services at the doorstep of financially excluded households is globally acknowledged. Thus, it is inevitable to investigate the determinants of (MFIs)/financial inclusion particularly in developing countries. In the first step of data analysis, we find positive association of ICT diffusion with financial inclusion and a negative relationship with poverty & inequality. Furthermore, the results of the study indicate poverty reducing effects of financial inclusion measured either way. It was also observed that the ICT dimensions when used as instruments for financial inclusion accelerate economic growth and reduce poverty & inequality. Therefore, policies to promote information and communication infrastructure could stimulate financial inclusion by promoting digital finance. Moreover, better collaboration between ICT and financial sector will likely to advance digital financial inclusion that could help to bridge the financial infrastructure gap.

*Keywords:* ICT, Financial Inclusion, Microfinance, Poverty & Inequality

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## 1. Introduction

The intellectual debate over the contribution of financial sector in overall economic growth continued extensively; particularly for economists and policymakers' investigating this underlying relationship endures preeminent for many years but still indecisive with antagonistic opinions. [58] argued that the banker and entrepreneur can swiftly augment the economic growth and industrial development. Well-functioned financial sector has various benefits and contributions towards overall growth of an economy. As financial intermediation plays its role by transferring and allocation of scarce resources [42, 10]. Moreover, developed financial system is perceived as the most important component of market in transition economies due to its role in allocation of scarce resources [25, 13]. On the other hand, adversaries have the opinion that financial institutions are neither sufficient nor

necessary for economic growth.<sup>1</sup>

Another stream of research outlined the scenario which lies between these two polar extremes and showed bidirectional relationship. In addition to finance-growth and poverty nexus, this study considers the role of information and communication technologies (henceforth ICT) diffusion that is thought to promote financial inclusion and beneficial for poverty reduction.<sup>2</sup> It is generally believed that (ICT) penetration through mobile telephony rollout has greater benefits. Mobile rollout is considered the most important factor in ICT diffusion, it improves the availability of financial products (supply side) and boosts demand for these products (demand side). Further, the increased ICT penetration helps promote the overall economic growth as well by advancing financial inclusion which stimulates financial sector development. Moreover, ICT penetration facilitates information flows and the analysis of credit worthiness in efficient way by maintaining the comprehensive database of clients. As a result, economies witness the escalation in private investment and eventually rise in economic growth (see, for instance [39]). They further argued that the ICT have a positive significant impact on rural development; enable better connectivity to stay in touch with dear ones that reduces psychological disorders; provide rapid market information to farmers that improves their bargaining power and eliminates the middleman. Furthermore, increased ICT penetration promotes various non-agricultural economic activities in rural areas like ecolodges and women owned micro enterprises. They also highlighted that increased information and knowledge enable micro entrepreneurs to apprehend and manage business in improved fashion. Micro and small enterprises will get faster and cheaper market information than print media. Additionally, service delivery and mobile banking would be efficient as a result of less cost, improved infrastructure and information. Similarly, [19] consider technology diffusion as a key channel through which productivity growth is achieved.

Furthermore, [21] described direct impact of ICT through rise in employment opportunities and demand, while they explain indirect economic benefits through social returns. The debate of direct and indirect benefits of ICT goes on and turns to Latin America and Africa (see, for instance, [43]). ICT diffusion plays a positive role in the advancement of community through numerous channels. It contributes to education sector by increasing Internet access, facilitates virtual education through electronic and print media. The association between ICT and health is also very important; it aids dissemination of rapid medical information and permits online operation facility in rural areas.

In addition, some researchers conceive that economic growth leads ICT penetration which eventually enables (in particular) under-served groups of the society to access financial markets. In turn, this increased access for the lower end of society would help to reduce financial infrastructure gap in low and middle income countries (see, for instance [39]). On the other hand, studies indeed described finance led technology development (see, also, [20]). They anticipated that the financial markets contribute significantly in the process of technological advancement. The authors further demonstrated that the financial sector development contributes and facilitates the essential process of experimentation for the initial commercialization of technologies. A large number of financial market operations are managed from computer and Internet related technologies; trading of securities in capital markets and future forward contracts among others.

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<sup>1</sup>This statement's context is that the financial institutions have played a significant role in capitalistic economies but it is neither sufficient nor necessary, see Pyka and Andersen (2013) "Long Term Economic Development". p.434.

<sup>2</sup>ICT stands for Information and Communication Technologies. We used ICT in plural form throughout this paper.

Banking transactions have become more efficient and secure; e-banking has changed the entire banking system. With the increasing spread of mobile phone and Internet related technologies, digital banking is progressing at rapid pace. When it comes to the adoption and implementation of new technologies, the Microfinance Institutions (MFIs) also not fall short. These institutions typically deal with less educated, (rural) poor and unbanked individuals, their ICT based solutions are largely customer oriented. [14] revealed that MFIs are switching from labor-intensive and costly social networks to ICT-based solutions. Microfinance sector has tremendous contribution in the success of Millennium Development Goals (MDGs). Recently, policy makers have turned their attention to explore the role of ICTs in sustainable development and urban goals. Research on ICT and financial services is promising which thereby provides incentive to explore into more rigorous analysis.

The other side of story sheds light on negative effects of improved ICT penetration on poor household. They might spend greater portion of their earnings on mobiles, sim cards and recharge of pre-paid connections. It increases the share of household or personal budget on mobile and Internet based technologies that could have been utilized for other household basic needs, such as food, health and education. Eventually, the limited budget of household gets disturbed and the economic situation of poor would worsen. Empirical studies point out that the household spending on mobile phone related technologies is rising more than proportionally in developing countries compared to advanced world. The share of income devoted to mobile services could have been used for food, health, education or on other productive purposes or needs. For example, [27] indicated negative impacts of opportunity costs from the utilization of financial resources in ICTs rather than in health and education. Besides, [63] suggested that the increasing use of mobile phone and Internet related technologies leads towards anxiety, depression and sleep disorders. The use of social media at workplace is also a burning issue, as it reduces the productivity. Even mismanagement of time by the general public in using mobile and Internet is a growing concern. Furthermore, less educated Internet users are exposed to online scams, frauds, malware and viruses. Sometimes they trap themselves in serious situations unintentionally.

In addition to the negative effects of ICTs at household level, some authors also show its impact at aggregate level as well. [24] suggest that a threshold effect of ICT could lead countries to a poverty trap. As the required threshold level is achieved ICT development would no longer generate favorable outcomes for low income countries. On the one hand, rapid diffusion of ICTs in an economy increases employment opportunities. While on the other, it also becomes the reason of labor downsizing because of the introduction of less labor intensive technologies. [45] argued that the advent of new technology can create unemployment for the operative, laborer and lower skilled workers but it would increase high professional and technical jobs. Machines are taking over human jobs, revolution in robotic technology could also leave many workers without work. Further, the introduction of technology in financial markets has made financial products and services more complex. The ever increasing sophistication in the financial markets has made it mandatory to understand the basic economic and financial concepts [53]. The technology entrants in financial provision industry could result in defaults and the transformation for incumbents will also increase the cost.

Although research is laden with the positive impact of financial development in developed economies nevertheless recorded with lower tendency. In developing world the impact of financial development is paradoxical where the estimated tendency is higher as well. Therefore, it is indispensable to delve into analyze this relationship for developing economies to accomplish this

conundrum sharply. In addition, the financial inclusion channel caters lower attention in the present literature. While the role of ICTs and financial inclusion on poverty and inequality is also rare due to data limitations. This study devotes an effort to combine a unique dataset to explore the underlying interactions. The aim of this study is to examine simultaneously two different dimensions of financial inclusion i.e., inclusion by commercial banks and by microfinance institutions (MFIs). As the formal financial institutions deal with wealthy and well off clients, whereas the MFIs claim to be the bankers of poor. Many poor people particularly from African and Asian countries are still un-banked; however, research in development finance suggests that accessible and timely finance has the potential to bring poor out of poverty. The importance of MFIs in providing credit and other services at the doorstep of financially excluded households is globally acknowledged. This study explores the impact of financial inclusion by MFIs and by commercial banks on poverty and inequality. Most notably, it examines how ICTs boost financial inclusion and help poverty reduction. This study is an attempt to spell out the possible effects of ICT diffusion to enhance different types of financial inclusion and poverty alleviation. And finally, in this study we attempts to determine whether the ICT provide favorable environment in the expansion of digital financial services.

## 2. Literature Review

The literature related to this study is organized in the following manner. The first section describes a comprehensive review of research conducted to examine the impact of financial development on poverty. In addition, this section presents the role of microfinance institution in poverty reduction at aggregate level. Second section discusses the stream of research devoted to explore the impact of financial access and household welfare (at household level). Section three analyzes studies about the linkages among ICT, financial access and poverty. Finally, section four gives an overview of research related to the role of new technology in promotion of digital financial services.

### *2.1. Finance, Microfinance and poverty: broader perspective*

Microfinance has now gained a reputation to pull households out of poverty by reaching out to unbanked end of the community. Microfinance Institutions (MFIs) frequently conduct impact assessment surveys of their credit schemes. These reports are often loaded with positive impact of small amounts of loans on poor. Usually, MFIs organize longitudinal or follow up surveys in order to study socio-economic conditions of their clients. Some studies also present comparative analysis of clients (active borrowers of MFIs) with non-clients (Potential borrowers, not yet borrowed). These institutional research reports are not free from bias in impact assessment. Moreover, research aimed at the impact of MFIs on aggregate poverty & inequality is relatively scarce due to the lack of continuous time series data of latter indicators. On the other hand, inadequate and short time series data about MFIs performance and outreach might be the potential reasons that hinder researchers to investigate this compelling facet. Some notable exceptions are discussed here.

Several influential studies demonstrated that developed financial markets contribute to poverty reduction and lowering inequality. The argument that access to finance reduces poverty becomes more strong with the support of these studies. For example, [9] find that access to finance reduces poverty, they further illustrate that the households with a bank account or using plastic money instruments are more likely to be rich, wealthy and highly educated in countries with higher foreign bank presence compared to those who don't. Similarly, [16] analyze possible impact of asses to finance on poverty using labor market channel. This study also argues that access to finance has

potential to reduce poverty, increase employment and income in low income regions. In a recent IMF working paper, [4] present that socio-economic growth can be achieved by enhancing financial inclusion. [30] and [5] emphasize on the importance of quality of governance and institutions for financial sector particularly for lower income countries. In a series of research papers about financial Inclusion, the World bank has focused on different key aspects and schemes aimed at improving financial inclusion. [6] suggest that the post offices can help increase financial inclusion by offering account opening services to the financially excluded folks.

A striking theoretical model developed by [1], argued that micro-credit typically reduces long-run inequality and poverty however it might alter long-run GDP. Meanwhile, one of the fundamental empirical studies by [33], measured impact on poverty at aggregate level using cross-country and panel data. They relied on two period cross sections (2003 & 2007) of 61 countries. To estimate this relationship they use gross loan portfolio per capita (GLPPC) adjusted for write-offs and inflation as a proxy for MFIs activities in a given economy.<sup>3</sup> They present negative and statistically significant impact of MFIs activities on poverty. More specifically, a country *ceteris paribus* with larger microfinance network likely to experience lower poverty. Similarly, the impact of MFIs on income inequality was studied by [36], where they indicated equalizing effects of MFIs for inequality. In addition, they concluded that MFIs substantially reduce inequality and contribute to overall economic growth. [34] indicate the process of distribution of money to poor communities as *financial permeation*. They expand their empirical analysis to 90 countries from 1998-2008 and found that financial permeation significantly reduces poverty. In contrast, it is argued that, microfinance alone cannot reduce poverty. Despite greater penetration of microfinance in Bangladesh and Bolivia and Indonesia compared with other developing nations, poverty is still a gigantic issue for these countries.<sup>4</sup> In addition to these studies more recent survey of literature related to financial development, inequalities and leverage provided by [8]. They highlight reverse causality and the significant role of inequalities in the dynamics of financial development and financial crises.

These days microfinance sector is more connected to the formal financial markets. This sector also adopt the best practices from their traditional counterparts. [60] provide that microcredit could be used as a mechanism to extend the reach of formal economy. They emphasized that the large and strong commercial banks may lend to microcredit borrowers who desire to “Graduate” and demand for the bigger amount of credit than microloans. Main thesis we infer from this particular study is that the formal financial sector of the economy also matters for the MFIs and its borrower. Likewise, [62] considers microfinance as an instrument for developing financial markets rather a development tool to alleviate poverty. In this view one can deduce that MF does have the potential to affect macroeconomic growth via different channels such as sectoral development, employment opportunities, pulling out the poor from vulnerabilities and promoting micro enterprises. Following studies explored direct link of microfinance with aggregate growth along with the indirect effect by illustrating contribution of microfinance sector in traditional financial system. The study of [44] makes an attempt to address the lacuna of research on the interaction of microfinance sector with broader real economy and commercial banks. Data ranging from 1996-2009 of 1433 MFIs from 102 countries have been utilized by taking time averages. Their findings report that the intermediation

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<sup>3</sup>Lack of time series data about poverty and microfinance constrained authors to make cross sections for 2007 and panel data by combining two or one observation per country for 2003 and 2007. Gross Loan Portfolio of microfinance institutions to total population in a country serves as the microfinance penetration proxy.

<sup>4</sup>Aneel Karnani, “Microfinance Misses Its Mark”, Stanford Social Innovation Review Summer 2007.

of microfinance sector could potentially contribute to financial sector and real economy.

Relying on market failure hypothesis, [65] depict that MFIs outreach is higher in countries where access to finance is very low as well as it serves financially excluded in well developed financial systems. On the basis of these studies, it might be possible to say that for the development of microfinance sector overall financial system of a country is essential element. MFIs do have an impact on standard of living, commercial banking and economy through different mechanisms. However, their success also depends on formal financial sector, macroeconomic and business environment among many others. One of the groundbreaking empirical studies about the success of MFIs on country specific macroeconomic factors published by [2]. Their analysis emphasized the role of stable economy for MFIs of the country in which they operate. [26] observed that in a developed financial system individuals are more likely to commence new businesses that creates a competitive environment and increased growth of firms. They also highlighted that local financial development could advance regional economic performance.

## *2.2. Microfinance and Poverty: household survey approach*

We have reviewed the microfinance impact assessment literature and find that the evidence of microfinance impact at aggregate level (macroeconomic) is relatively scarce and at early stage. In this study, we explored whether MFIs reduce poverty and inequality at aggregate level. It also measures the impact of financial inclusion through commercial banks and MFIs simultaneously. Microfinance is considered one the most effective and significant tools to fight poverty especially in developing countries. It has gained a reputé to have an effect on social and economic conditions of the borrower. Microfinance initially came up with the small amount of credit to poor people who were previously neglected by the formal financial sector. Later, various MFIs entered in the field including NGOs, societies, and some full fledge microfinance banks. Its new mechanism to serve the poor community without or little collateral got promising response from all around the globe. These institutions also claim to enhance women empowerment in rural and relatively less literate communities. Nowadays, MFIs are providing value added services to their clients by organizing different types of trainings, health and education facilities and energy provision along with banking services including savings, deposits, loans and mobile banking.

It is perceived that access to finance has the potential to reduce poverty while MFIs exclusively target the poor. They charge higher interest rates from their poor clients; small amount of loans are given after initial screening of the potential borrower. The amount of next loan is higher than the previous depending on the track record of borrower and the cash flows of microenterprise. Opponents of the microfinance believed that small amount of loans do not have the positive impacts on poverty, instead of pulling them out of poverty they push them into the state of helplessness by arguing the case of Bangladesh, Bolivia and Indonesia. Despite comparatively larger microfinance market share, these countries still witness higher poverty levels.<sup>4</sup> Empirical research based on the impact assessment demonstrates that MFIs have a positive impact on standard of living of the borrower alongside indirect effect through the development of financial sector and economy. There is very little empirical and theoretical evidence about the impact of microfinance at aggregate level. In contrast, a sufficient amount of research is existent on the impact assessment of microcredit at household and individual levels. For instance, existing literature suggests that household welfare could be increased through affordable and accessible finance (see, for instance, [31, 32, 23]).

In an early study about microfinance, [55] stated that it has been proved that the provision of credit to poor is a powerful tool in development. The author further described that the quality

of life of poor can be improved by bringing them into banking system. [31] measure the impact of microfinance on household income, consumption and women body mass index. Their findings conclude that the purpose of loan is a significant predictor in the success of microloans, overall they show positive impact on income and food consumptions. Moreover, they argue that small loans increase household consumption on food items which facilitates in reduction of poverty headcount ratio. In addition, [48] notice modest improvements in dwellings of MF borrowers. [32] concentrate on household access to microfinance and its potential to reduce poverty. By utilizing national household data from India they applied treatment effect model, findings confirm positive and significant effects of productive microfinance loans on multidimensional welfare indicators.

Examining the impact of MFIs on aggregate economy, poverty & inequality is relatively a new field. Studies which investigated this underlying relationship could be distinguished on the basis of methodology adapted, sample size, indicator selection and time duration. In earliest literature, researchers have investigated the impact of microcredit on poor using direct surveys of clients and impact assessment by MFIs. Moreover, various researchers compared the clients with non-clients. As microfinance industry grows with the attraction of more clients, it caters the attention of academician and international organizations. Critics argue that, does microfinance alone have a potential to reduce poverty in an economy? Does microfinance become a main element of country's financial sector? Whether microfinance industry has become mature enough that can affect overall growth of an economy with small amount of loans with a tiny share in the market? Despite favorable household level evidence of microfinance, these questions still largely remain unanswered.

### *2.3. ICT, Financial Inclusion and Poverty*

Over the last 10 years, a growing literature in the area of ICT and growth indicates the significance of the role of ICT in social and economic uplifting. Similarly, evidence suggests that the better access to finance can reduce poverty and improve household welfare. [37] state that developed countries are characterized by higher access to finance than developing economies and microfinance plays a considerable role to expand financial inclusion. Similarly, ICTs can help in reaching out the poor in a number of ways, by e-banking, mobile-banking and mobile ATMs, it also helps access to timely and cheap information and better connectivity with micro loan officers. [49] observe that mobile technology is an excellent tool to accelerate financial inclusion particularly in far remote areas. Similar findings learned by [39] for a sample of African countries, they confirm positive contribution of ICT in economic growth through financial inclusion channel. In like a manner, [66] concludes that the underprivileged and rural populations are the foremost beneficiary of technological development. [15] suggest higher social and economic benefits of mobile telephony in rural areas and project poverty reducing effects of mobile phone. [56] report positive association between level of human development and financial inclusion. They also exhibit positive role of information and communication technologies and related infrastructure to boost financial inclusion. [46] review the literature of ICT and progress towards measurement of its impact. They concluded that much of the focus of researchers remain on macro level ICT linkages before 2002 while less attention paid to its role in poverty reduction at micro level.

Furthermore, [20] point out that greater banking originated financial depth facilitates faster technology diffusion particularly for higher capital intensive technologies. Moreover, they present that developed financial markets facilitate and foster technology diffusion. In a similar manner, [47] suggest that mobile banking improves the economic conditions of the poor in Kenya. In addition, following authors also report beneficial implications of ICTs for poor and financial development,



evidence from rural India [18], using panel data [59] and from MENA and Asian countries [57] and [51] respectively. Empirical evidence that demonstrates the impact of ICT on poor is limited to African countries, (see, for instance [39]) there is a dire need to explore that important link in other regions of the world. It is also imperative to place emphasize on to study the role of ICTs in expanding financial inclusion (including Microfinance) and digital financial inclusion. [18] reveal that ICT could play a positive role to improve access to information, education, health, government and financial services particularly for poor. [59] finds positive association between ICT penetration and financial development. She describes that the increased mobile phone penetration and Internet potentially enhance financial depth which eventually boost overall economic growth.

#### 2.4. Summary of the literature and gaps

As noted from the literature several researchers examined the effects of financial sector development on real economy. Though, studies with respect to developing economies are sparse. Whereas, researchers argued that the financial development in developing countries has greater impact on economic growth compared with developed economies. Finance-growth nexus gets renewed attention with the incorporation of new econometrics approaches, financial reforms, new polices and continuously striding financial market systems. This study considers the recent inventions such as mobile phone and cellular Internet, personal computer and broadband to uncover the direct and indirect impact of these technologies on households at aggregate level. Secondly, it exploits the financial inclusion channel to explore whether the advent of these technologies helps expansion of financial services in the lower and middle income countries.

More recent strand of literature on financial inclusion concentrates on the use of mobile phone for financial transactions and to promote financial inclusion. As the researchers suggest that information and communication infrastructure could stimulate financial inclusion by promoting digital finance. In their paper, [39] identify following paths depicted in figure 1, that show how ICT development can accelerate economic growth. They however didn't consider the implications of ICT for poverty & inequality. In addition, they focused only on formal financial inclusion (commercial banks) and their sample was limited to African countries. In this study, we also considered financial inclusion through microfinance institutions.

We based our analysis on the hypothesis that ICT development improves financial markets, increases access to finance, reduces credit constraints and eventually helps poverty alleviation. Figure 1 shows three blocks that explain this mechanism, we adhere to two constituents of ICT i.e., Telephone (mobile or fixed) and Internet.<sup>5</sup> Central and bottom blocks represent financial markets and poverty respectively. The central block shows the financial inclusion which is composed of conventional financial institutions (e.g., commercial banks) and microfinance sector (including MF banks, NGOs, etc.). Finally, in the bottom the main dependent variable of this study i.e., poverty & inequality are shown. In short, we may describe this figure as ICT-Finance-Poverty respectively, that exhibits the role of new technologies in promotion of financial inclusion (through different channels listed between blocks) and eventually the impact of financial inclusion for poverty, inequality and overall economic growth.

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<sup>5</sup>Note: L<sup>A</sup>T<sub>E</sub>X codes written by Charles-Axel Dein as Porter model, can be found at: [Texample](#), we modified those codes to serve our purpose.

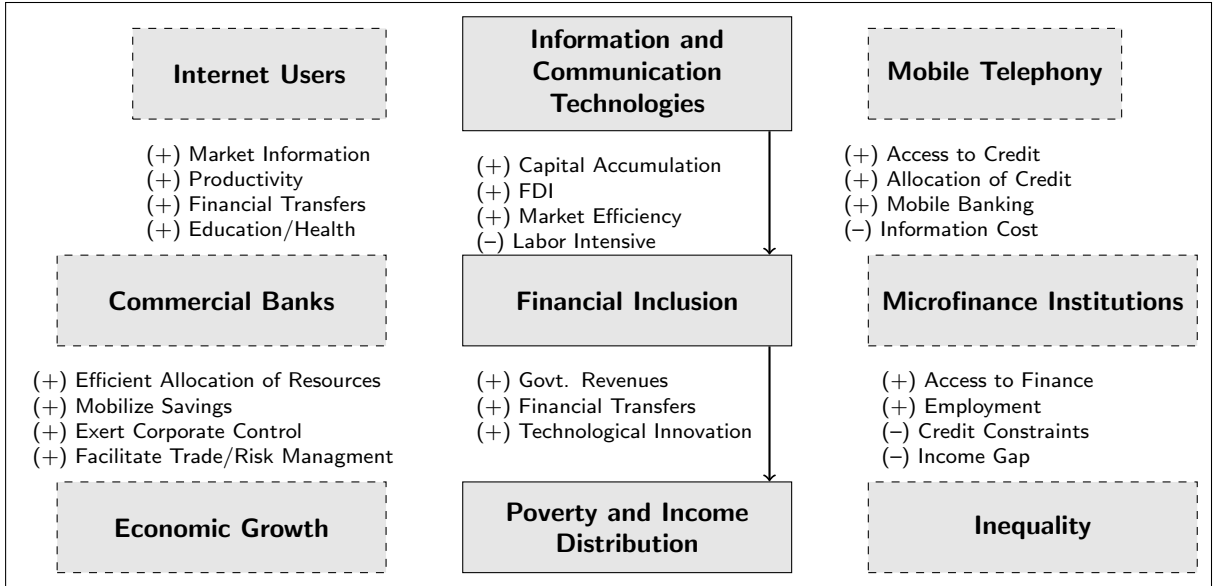


Figure 1: Theoretical Framework

### 3. Data and Methods

This study is conducted with an objective to examine what role ICTs can play in poverty reduction through financial markets. In addition to that we investigate the equalizing and poverty reducing effects of microfinance at aggregate level. Time frame of this study was based on the data during 2001-2012. However, lack of continuous time series data on Poverty & inequality forced us to take three year averages from 2001-2012. Resultantly, the dataset we are able to obtain for the analysis could be divided into four non-overlapping cross sections i.e., 2001-2003, 2004-2006, 2007-2009, 2010-2012. Our method is in line with the recommendations of [42, 39, 33, 4]. They further suggested that this method renders robust results, avoids potential endogeneity and ensures sufficient number of observations to run a panel data analysis. In addition, this method smooths out any short term fluctuations in the data series. It is also worth noting that our panel largely consists of developing and emerging economies and these economies usually exhibit shorter business cycles (see, for example, [54]). We only retain those countries having at least two observations of poverty during the period under study. As a result we are left with 62 countries for our analysis. Table 11 presents the list of countries along with regions and income levels.

#### 3.1. Data description and sources

Data are collected through various sources. The first set of variables consists of the indicators related to Microfinance Institution (MFIs) which is collected from Microfinance Information Exchange (MIX), whereas the second set of variables contains macroeconomic and poverty indicators from the World Bank (WDI), third set involves variables related to Information and Communication Technologies (ICT) which is taken from the International Telecommunication Union (ITU) database 2015.

##### 3.1.1. Poverty & Inequality

We use most recent indicator of poverty which measures poverty headcount ratio at \$ 2 a day as main response variable. This variable is broadly used as a proxy of aggregate poverty in an

economy, that refers to the percentage of population living below \$ 2 a day. The other outcome variables of poverty in this study are Gini coefficient, which measures the income inequality and poverty gap and its squared, that reflects the depth of poverty and its incidence, see [33].

### 3.1.2. *Microfinance Inclusion/Intensity*

We measure microfinance financial inclusion as the ratio of gross loan portfolio to GDP, and number of borrowers divided by total population in a country. Higher loan portfolio and the number of borrower represent greater expansion of MFIs activities and improved financial inclusion. These indicators expected to have negative impact on both poverty headcount and Inequality. Rise in the scale of MFIs activities may ease credit constraints for unbanked and eventually decreases poverty (see, for instance, [33, 34]).

### 3.1.3. *Mainstream Financial Inclusion*

Next we move forward to measure formal financial inclusion. It is challenging to approximate financial inclusion because of a few number of financial inclusion variables and non-availability of standard measure. We held two indicators of financial inclusion, e.g., commercial bank deposits and borrowers per head. In addition, access to financial institutions is also taken from the newly developed index by [61], we also use alternative indicators for financial inclusion such as loans per head and Credit/GDP ratio.<sup>6</sup> We added population density in financial inclusion regression following [39] and expect positive coefficient; banks' overhead cost and the number of bank branches per  $km^2$  were also added to account for efficiency of financial intermediaries and geographical coverage of bank branches respectively.

### 3.1.4. *ICT Indicators*

Information and communication technologies (ICT) diffusion is measured through, Mobile cellular subscriptions, Internet users, Fixed telephone lines (all per head), price of 3-minute local mobile call and ICT imports. Better ICT infrastructure supposed to favor financial markets, economic growth and hence poverty reduction (see, e.g., [39, 4]). ICT favor financial inclusion while increased access to finance helps poverty reduction.

### 3.1.5. *Control Variables*

The number of potential control variables is huge but we stick to these indicators following empirical literature. We include trade openness as one of the control variables which is measured as (imports+exports/GDP). Consistent with the neoclassical theory we expect negative association of openness with poverty and inequality and positive with economic growth. Following finance-growth nexus literature, this study has taken real GDP per capita (RGDP) and the ratio of (Credit/GDP) to approximate economic growth and financial development in a given economy. These two indicators play positive role in poverty reduction and household welfare. We expect higher level of per capita income is related to lower poverty headcount ratio and greater financial development (see, e.g., [42, 11]). In addition we use final government consumption as percentage of GDP to account for size of the government, a negative coefficient on poverty and inequality is expected as it captures the benefits of public spending. Share of arable land is also used as control variable; negative sign

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<sup>6</sup>We included most commonly used indicator of financial deepening as a broader measure of financial inclusion, considering the fact its higher correlation with all other financial inclusion proxies [61, 39].

of the coefficient is expected because a large share of arable land is supposed to be favorable in fight against poverty & inequality (See for example, [7]).

In addition, to capture the quality of legal environment we introduced political rights as well as index of civil liberties [38]. Both indices are retrieved from freedom in the world database see, for instance [35]. The freedom house variables move between 1 (most free) and 7 (least free).<sup>7</sup> Similarly, to approximate quality of institutions in a country this study incorporates cost of contract enforcement from doing business. As the higher enforcement cost dampens economic activities and supposed to have a negative impact on financial inclusion and positive link with poverty.

### 3.2. Model

In order to examine the hypothesized relationship, we followed a standard model of [11], [33] and [36]. Where we introduced ICT penetration and build on the standard model to measure the effects of microfinance and mainstream formal financial inclusion on poor, following baseline regression is estimated for panel data.

$$Pov_{i,t} = \gamma_0 + \gamma_1 mfi_{i,t} + \gamma_2 fi_{i,t} + \gamma_3 ict_{i,t} + \gamma_4 macr_{i,t} + \gamma_5 inst_{i,t} + \epsilon_{i,t} \quad (1)$$

where “*MFI*” denotes financial inclusion by Microfinance institutions, “*Fi*” represents financial inclusion by commercial banks whereas, “*ICT*” is the level of Information and communication technologies, in addition to these the control variables are “*MACR*”, macroeconomic indicators such as GDP per capita and “*INST*” denotes institutional and freedom indicators. In the first step of data analysis we performed pooled OLS with cluster-robust standard errors. For a given individual country the error  $\epsilon_{i,t}$  is likely to be correlated over time, with the application of cluster-robust standard errors we get unbiased and consistent coefficients [22]. Whereas default standard errors assume that the residuals follow (i.i.d) pattern. These standard errors are adjusted for individual clusters and are slightly larger than the simple estimation, also see, [52, 16]. Next we used fixed and random effects model to quantify the impact of financial inclusion and ICT on poverty & inequality. This is done by extending the standard model formulated above to control for cross country differences. One can differentiate the fixed and random effects model as the former allows variations in the intercept parameter for each entity while the latter treats heterogeneity across entities as a random component. [39] assert that the random effect estimator performs better in case of small T in a panel framework. Following equation can be formulated as follows:

$$Pov_{i,t} = \beta_0 + \beta_1 MFI_{i,t} + \beta_2 Fi_{i,t} + \beta_3 ICT_{i,t} + \Gamma_4 X_{i,t} + \delta_i + \epsilon_{i,t} \quad (2)$$

where  $X_{i,t}$  is a set of other macroeconomic and institutional control variables discussed above,  $\delta_i$  deals with specific effects at individual country level and  $\epsilon_{i,t}$  is the disturbance term.

#### 3.2.1. Instrument Variables

Instrument variable (IV) regression is useful when some variables are being determined within the system termed as endogenous. Generally one or two explanatory variables are treated as endogenous in regression model in a situation where unexpected shocks affect both the explanatory and explained

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<sup>7</sup>We reversed these variables to make it more descriptive, after reversal 1 becomes least free and 7 most free. For more detail see, <https://freedomhouse.org/report/freedom-world-2016/table-scores>

variables simultaneously. Instrument variable regression is also used to avoid endogeneity bias, one may assume that the number and growth of microfinance institutions is high in countries with higher number of poor. Hence, instrument variable regression (IV) is the best alternate to obtain the coefficients when one or more explanatory variables are endogenous. We used instrument variables determined by the finance growth literature such as a dummy of country’s legal origin and absolute value (scaled 0-1) of the latitude as instruments of financial development (see, for instance, [11]). To select an instrument for microfinance inclusion, we use 3 year lag value of average Gross Loan Portfolio (GLP) divided by the number of microfinance institutions in a country and the cost of contract enforcement in line with [33]. Lag (first and second to avoid from autocorrelation) values of the endogenous variables and indicators of fractionalization (religion, language and ethnic) are also used as instruments (see, for example, [11, 13]). Since our dataset is panel we need to assume the instruments  $z_{i,t}$  that are correlated with the endogenous regressors  $x_{i,t}$  and are uncorrelated with  $\varepsilon_{i,t}$ .

IV model follows two stage approach and derives the reduced form equation. If we place the instrument of microfinance inclusion instead of the actual indicator, the reduced form equation is as follows which determines the suitability and presence of endogeneity in selected instruments, see, [33].

$$MFI_{i,t} = \pi_0 + \pi_1 enf_{i,t} + \pi_2 lagglp_{i,t} + \pi_3 X_{i,t} + \pi_4 X_{i,t} + v_{i,t} \quad (3)$$

where ”enf” is the cost of contract enforcement, ”lagglp” is an indicator of microfinance inclusion (defined above) in a country,  $X_{i,t}$  is the set of other explanatory variables used in standard OLS model,  $v_{i,t}$  is an i.i.d error term. It is worth mentioning that validity and suitability of instruments are crucial in the IV models, several post estimation techniques are used to assess the validity of instrument regressors. We used diagnostic tests suggested by [33] for the same purpose. The first diagnostic test deals with the null that variables are exogenous; if we fail to reject its null we can not proceed further. The next step is to test the first stage regression which shows the correlation between additional instruments (x) and an endogenous regressor (y). Various criterion are used to do that task, such as  $R^2$  and adjusted  $R^2$ , F-statistics and Minimum eigenvalue statistic for 2sls bias and finally test of over identification restrictions. Test of over identification restriction is the most concerned and widely used diagnostic test for IV regressions, it tests two different things at the same time; first, the nonexistence of correlation between instruments and error term, second the equation is misspecified and that the one or more excluded exogenous variables should be included in structural form equation. In the next step we confirmed our results obtained through above mentioned econometrics techniques with robust and quintile regression. In addition to that we performed winsorizing at 1% and 99% to reduce the effects of potential outliers.

### 3.3. ICT penetration: A determinant of Financial Inclusion

In this study we are interested to explore the financial inclusion channel through which ICT development influences poverty and inequality. Three measures of ICT penetration have been used to investigate this hypothesized link, however in order to avoid redundant tables we report the results by using mobile phone penetration as an indicator of ICT development. Mobile phone penetration has higher correlation with the other two variables of ICT, i.e., fixed line telephone and Internet subscribers. Figure 2 (a) presents the trends in mobile versus Internet subscribers, both show increasing trends but mobile phone subscribers are growing at higher rates around

the world. Figure 2 also illustrates positive correlation between finance and growth and mobile phone subscribers with economic growth and financial development. Furthermore, mobile phone penetration seems to show positive linear relationship with microfinance intensity measured as gross loan portfolio and microfinance intensity reveals positive relationship with economic growth and negative with poverty headcount ratio. Each colored point represents region, where it can be observed that the African region under performs in capitalizing gains of ICTs as compared to the others.

After getting a general overview about the correlation among underlying variables we then move a step further. We followed [37, 39] to build a finer model to measure the possible impact of mobile phone on financial inclusion. Measurement of financial inclusion is yet a point of focus in ongoing research. [39] consider financial inclusion at aggregate level, however we included financial inclusion through microfinance as well as a newly developed index by [61]. Following, [39] the model for the determinants of financial inclusion can be specified as follows:

$$FI_{i,t} = \zeta_0 + \zeta_1 mob_{i,t} + \zeta_2 y_{i,t} + \zeta_3 pden_{i,t} + \sum_{j=1}^n X_{i,t}^j + \varepsilon_{i,t} \quad (4)$$

Where  $FI$  stands for financial inclusion and used as a dependent variable (as explained earlier two measures of financial inclusions are used here).  $mob$  is approximated by the per head mobile phone users in a country;  $y$  and  $pden$ , GDP per capita and population density are the main control variables respectively in this regression;  $X$  contains other explanatory variables, we include bank overhead cost to account for banks' efficiency; whereas commercial bank branches per 1000  $km^2$  is used to represent geographic coverage and outreach of commercial banks. Finally,  $\varepsilon_{i,t}$  represents the disturbance term.

#### 4. Results and Discussion

We begin by examining the descriptive statistics of selected variables in table 1. It lists the number of observations utilized for the main analysis, mean, median, standard deviation, minimum and maximum values for each of the selected variable.

[Table 1 about here]

In addition, figure 2 exhibits international comparisons and associations of financial access and poverty. We show both types of financial access (i.e., Microfinance and commercial banking). We notice crippling kickoff phase of the microfinance sector during early 2000, but afterwards the outreach has increased significantly in terms of borrowers, depositors and the number of bank branches. All of the outreach indicators show increasing trends across regions from 2000 onwards. It might be possible to infer that the microfinance sector is booming and getting bigger in terms of outreach and profitability after its deadening outset. This figure also suggests a significant differences in microfinance outreach before during and after global financial crises. Which indicates the integration of microfinance sector with conventional financial markets. Moreover, notice an increase in the number of ATMs in all regions over the selected period, and higher poverty and poverty gap in SSA as compared to other regions. Furthermore, we plot poverty headcount ratio and mobile cellular subscriptions for all countries. Figure 3 exhibits the geographical visualization of mobile penetration and poverty headcount ratio. Mobile cellular subscriptions (per 100 people) are for the period of 2014, whereas we took the most recent value of PHCR at \$1.90 a day.

[Figures 3 about here]

This clearly indicates the diminishing trends of poverty around the world, however central Africa still struggling in poverty reduction. On the other hand, mobile penetration is rising rapidly but most of the African nations are lacking behind as compared to the other regions. It can also be observed that the deeper intensity of mobile phones in first image corresponds to the lower poverty value in second image of the poverty headcount ratio.

#### 4.1. *Microfinance Inclusion-Informal*

We start off the analysis with pooled ordinary least square regression (POLS) followed by fixed and random effects estimation. Furthermore, to account for outliers lead us to apply robust and quintile regression. In addition, we use instrument variable regression to overcome endogeneity issue. Tables 2-4 present the results of these five different models. We tested poverty headcount and Gini coefficients keeping same set of regressors in equations. Results of these tables confirm poverty & inequality reducing impacts of financial inclusion (MFIs and formal), the results remain significant even if we control for other indicators such as economic growth, arable land, government consumption and trade openness.

Table 2 reports the effects of microfinance inclusion on poverty & inequality. As can be observed in table 2 that the coefficient of loan portfolio stays in negative regime in most of the specification, hausman test indicates towards fixed effects model when poverty headcount ratio is dependent variable and random effects in case of Gini coefficient. Since, we have four observations per country, [39] suggest that random effects estimation technique is preferred in limited time dimensional data. They further argued that the large number of observations along with small time dimension increases the possibility of bias in fixed effects estimation. To test the quality and validity of instruments, we performed test for weak identification, endogeneity and over identification. All diagnostic tests substantiate the selection of instrument variables, as we can reject the null of exogeneity whereas fail to reject the null of no correlation between instruments and residuals in both IV regressions, meaning that our instruments are appropriate and models are correctly specified. In addition, median regression also supports the findings of OLS and IV however the coefficient for inequality is negative but insignificant. The rest of control variables, for example arable land, trade openness, government consumption show expected coefficients signs in OLS and IV regressions.

[Table 2 about here]

Table 3 provides the results of microfinance inclusion on poverty & inequality.<sup>8</sup> This variable indicates the intensity and depth of microfinance institutions. Keeping the same set of regressors we find alike results. Again, the coefficients in random effects model are highly significant and according to the predictions, IV regression also shows significant and negative impact of microfinance inclusion on both poverty & inequality. This suggests that microfinance institutions promote financial inclusion by bringing unbanked poor into banking system and equip them to start small level businesses and other income generating activities. These findings are consistent with [28] and [33], they support poverty and inequality reducing effects of microfinance intensity.

[Table 3 about here]

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<sup>8</sup>In this table we use the alternate proxy of microfinance inclusion that is total number of borrower divided by total population.

#### 4.2. Mainstream Financial Inclusion-Formal

Table 4 presents the results when we added a broad indicator of financial inclusion. The coefficient of formal financial inclusion is negative and highly significant in all models. As can be observed in Columns 1-10, deposits per head indicator remains negative and significant across table, which implies that greater financial inclusion corresponds to lower poverty & inequality. Additional tests for the instruments also validate the findings of selected IV models. Access to finance in low income countries remains a paramount task, whereas economists suggest that timely and accessible finance can reduce poverty and income inequality. Our results indicate favorable benefits of financial inclusion for poverty & inequality in sampled countries. [50] provide similar results in Asia, they construct an indicator of financial inclusion and suggest that higher financial access significantly reduces poverty and income inequality. [17] also show poverty reducing effects of financial inclusion through the expansion of state-led banks in India. [29] constructs an index of financial inclusion and reports that better access to finance reduces poverty. Further, [13] present similar findings.

[Table 4 about here]

#### 4.3. ICT and Poverty

In the next step we used indicators of poverty & inequality as dependent variables and test whether ICTs reduce poverty & inequality by fostering financial inclusion, results are presented in tables 5 and 6. Our main indicators of ICTs such as mobile cellular subscriptions, fixed lines subscribers and Internet users show negative significant impact on poverty even in the presence of controlled variables such as level of economic development, inflation, government consumption and trade openness. This result implies that ICT related technologies significantly reduce poverty & inequality. The coefficient of personal computer is insignificant yet it shows a negative sign and the effect of the price of a 3-minute mobile local call is positive insignificant for poverty however it becomes significant for inequality. [39] find positive insignificant coefficient of personal computer and negative significant for price of a 3-minute mobile local call on economic growth. We take mobile penetration as an indicator of ICT diffusion in further analysis, where negative significant coefficient of mobile penetration on poverty & inequality can be noticed in IV regression. Meaning that, after controlling for endogeneity and using instruments of mobile penetration results hold as they were reported in pooled OLS. This confirms favorable role of ICTs diffusion in fight against poverty. As discussed earlier, only a few studies elaborated the ICTs and poverty relationship, however there is considerable evidence about the role of ICTs and economic growth (see, for instance, [46]). [64] notes positive supply side ICT expansion effects for rural human capital in Madhya Pradesh, India. [15] also report a multidimensional-level impact of mobile telephony on sustainable poverty reduction.

[Tables 5 and 6 about here]

Table 7 summarizes findings of the impact of ICTs on poverty & inequality with respect to an interaction term of the different forms of ICTs and income level of the countries. Columns 1-4 provide the results of interaction terms of different set of ICT indicators such as mobile and telephone, mobile and GDP or Internet and GDP. It also quantifies the effects of ICT with consideration to the income levels of countries. Columns 5 and 6 present the results of the interaction of ICT indicator with a dummy variable of low middle and upper income countries. Columns 1-4 contain the interaction effect of two continuous variables, whereas columns 5 and 6 present the interaction of one



continuous and one categorical variable.<sup>9</sup> In this situation we have got mobile phone penetration which is a continuous and income levels are categorical variables. An interaction of a categorical and continuous variable suggests that the slope of a continuous variable is different for at least one or more levels of the categorical variable. A categorical variable is usually coded as zero/one. We include three groups i.e. low, middle and upper-income countries. By doing so we would be able to shape the differential effects of financial inclusion and ICT in three income groups.<sup>10</sup>

Columns 1-4 provide the nonlinear relationship between ICT and poverty. Column 1, displays the results on interaction term of mobile and fixed phones to show whether they are compliments or substitutes. It shows negative and significant coefficient which implies that the mobile phones are substitutes for fixed telephones in sampled developing economies. [39] and [41] presented similar finding in Africa. [41] suggested that, holding all other variables fixed, the marginal (partial) effect of mobile phone penetration on poverty can be computed as follows:

$$\frac{\partial \text{Poverty headcount ratio}}{\partial \text{Mobile per head}} = 0.118 - 0.208 \times \text{Fixedtelephone}$$

A negative value of the interaction term ( $\text{Mobile} \times \text{Fixedtelephone}$ ) also suggests that the marginal impact of mobile penetration is smaller for countries with higher fixed telephones outreach and the other way around. Marginal impact is stronger for a country with less developed fixed telephone infrastructure. This confirms the notion that mobile penetration is higher in developing economies because of poor fixed lines outreach while the impact of mobile penetration on poverty reduction is also significant in these countries. As [67] indicate that the poor infrastructure of fixed telephones lines in developing countries leads towards rapid mobile phone penetration. Furthermore, in columns (3) and (4) we introduced two interaction terms in each of the equations separately such as: ( $\text{Mobile} \times \text{GDPpercapita}$ ) and ( $\text{Internet} \times \text{GDPpercapita}$ ). Consistent with [39, 67, 41], both interaction terms endorse the fact that the impact of ICTs related technologies is much stronger in low income countries.

[Table 7 about here]

Column 5 and 6 provide the results of an interaction of ICT indicator (Mobile penetration) with a dummy variable of low and middle income. We divided selected countries into three groups described earlier on the basis of World bank rankings. If dummies of low and mid equal zero, then the coefficient of *Mobile* on poverty explains variations in the dependent variable for upper income countries. Similarly, ( $\text{Mobile} + \text{Mobile} \times \text{low}$ ) shows the effect of mobile penetration in low-income countries, whereas the expression ( $\text{Mobile} + \text{Mobile} \times \text{mid}$ ) presents the impact of mobile penetration in countries categorized as middle-income (for an interaction term of ICT and financial development see, [57]). The results of these interactions reveal that the impact of mobile penetration varies according to income group of the country. As observed in column (5) of table 7, the effect

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<sup>9</sup>We compute slope of the poverty head count ratio (dependent variable) on mobile phone penetration (independent variable) when fixed telephone (moderator variable) is held constant at different levels such as low to high.

<sup>10</sup>Following equations can be formulated; (i)  $y_{i,t} = \gamma_0 + \gamma_1 \text{lngdp}_{i,t} + \gamma_2 \text{op}_{i,t} + \gamma_3 \text{gouv}_{i,t} + \gamma_4 \text{inf}_{i,t} + \gamma_5 \text{Mobile}_{i,t} + \gamma_6 \text{Telephone}_{i,t} + \gamma_7 \text{Mobile}_{i,t} \times \gamma_8 \text{Telephone}_{i,t} + \varepsilon_{i,t}$ . (ii)  $y_{i,t} = \gamma_0 + \gamma_1 \text{lngdp}_{i,t} + \gamma_2 \text{op}_{i,t} + \gamma_3 \text{gouv}_{i,t} + \gamma_4 \text{inf}_{i,t} + \gamma_5 \text{Mobile}_{i,t} + D_{\text{low}} + \gamma_6 \text{Mobile}_{i,t} \times D_{\text{low}} + D_{\text{mid}} + \gamma_7 \text{Mobile}_{i,t} \times D_{\text{mid}} + \varepsilon_{i,t}$ , where  $D_{\text{low}}$  and  $D_{\text{mid}}$  represent lower and middle income group countries respectively. More on interaction term for level of income see, [13], for mobile and fixed phone [41, 39].

of mobile penetration in upper income countries is negative and significant by  $(0.218)^{11}$  percentage points; while its effect in low income countries is  $(0.051)$   $(-0.218 + 0.269 = 0.051)$ .<sup>12</sup> This result indicates that the ICTs (mobile penetration) affect poverty differently according to the country's income level.

#### 4.4. ICT and Financial Inclusion-Both Formal & Informal

Next we turn our attention to investigate whether mobile penetration affects financial inclusion. Table 8 suggests strong evidence of the positive significant impact of mobile penetration on financial inclusion measured either way by commercial banking or microfinance. Columns (1-2) depict positive impact of mobile penetration at 10-15% level of significance even in the presence of controlled variables; however coefficient is highly significant when a broad measure of financial inclusion is used as dependent variable. Columns (5) and (6) also confirm positive correlation of mobile penetration with access to finance, this measure is taken from [61], he constructs a broad financial development index by including a range of financial access and depth indicators. Finally, Columns (7) and (8) report the impact of mobile phone diffusion on microfinance inclusion.

It can be observed that the coefficient of mobile phone is very high in both columns at (1%) significance level. This findings conclude that the higher value of mobile penetration improves financial inclusion through formal and informal financial institutions. Moreover, income per capita and population density also increase financial inclusion as both show positive and significant coefficient for overall financial inclusion, whereas they behave differently for financial access and micro finance intensity. Banks overhead cost shows expected sign however remain insignificant in some equations, similarly quality of legal environment depicts positive coefficient in all models but only significant in column (2). Bank branches proxy takes positive significant coefficient on financial access, however continue to be insignificant but maintained expected sign in most of the equations. The main variable of interest mobile penetration does show significant positive coefficient in all columns. Our this findings also show greater resemblance with those of [37, 39, 12], where they suggest positive effects of mobile phone penetration to expand financial access.

[Table 8 about here]

To further refine our analysis and to strengthen the estimation that ICT transmit beneficial effects to poor and foster economic growth through promoting financial inclusion. We used ICT indicators as instrumental variables for financial inclusion. The idea behind using ICT indicators as instruments is to determine how cross-border differences presented in the exogenous component of financial inclusion explain economic growth & poverty across countries [10] and [59]. By so doing we seek to examine the channel through which the impact of ICT passes on to poor. We use GMM estimation following [59], and select a vector of instrumental variables, assuming zero mean of error term. [59] introduced ICT variables as instruments for financial development to examine their impact on GDP. We improve on [59] by analyzing the fresh data and considered more dimensions of the financial inclusion. In addition, we focused on poverty related indicators and added microfinance intensity indicator that was not considered previously.

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<sup>11</sup>The value of the slope of poverty headcount ratio (dependent variable) on mobile (independent variable) is  $(-218)$ , when dummy for low income countries equals zero, while the value of the slope when dummy equals 1 can easily be determined by adding both these coefficients.

<sup>12</sup>This calculation is based on the following formula:  $(Mobile + Mobile \times low)$ .

[Table 9 about here]

Table 9 presents the results of GMM analysis in which we attempt to predict financial inclusion through its exogenous components. Four measures of financial inclusions have been used in this analysis, all indicators are negative and significant at 5 and 10% respectively. This result suggests poverty reducing impact of ICT through financial inclusion. That also confirms the prediction of financial inclusion through its cross country exogenous components. Furthermore, this result also supports that the ICT affect poverty through promotion of financial inclusion; due to its correlation with both of the indicators i.e. endogenous and dependent in this equation. In addition, we proceed by taking a broad measure of financial inclusion defined above in column (6-9), which presents negative and significant impact on inequality, poverty gap and poverty severity index while positive significant on economic growth. In all cases j-statistics confirms that the data do not reject the condition of orthogonality and the models are properly specified. The signs of all controlled variables used here are according to the expectations and as per theoretical predictions.

## 5. Conclusion

This study examined the impact of ICT diffusion on financial inclusion and poverty reduction. A number of existing studies investigated the impact of microfinance on household welfare and economic situation. However, its impact on poverty & inequality at aggregate level is relatively a new subject. As the direct link of ICTs and poverty is somewhat hard to determine however, we focus on the effects of ICTs on poverty through financial inclusion. This could be the potential channel through which ICTs affect poverty & inequality. We test whether ICTs reduce poverty by fostering financial inclusion. Several researchers concluded negative coefficient for finance on poverty. Nevertheless, the effect of financial inclusion is undetected enthusiastically in existing literature, while the role of ICTs diffusion in promotion of financial inclusion and access to finance also remains an interesting subject in digital age.

The findings of present study highlight the significance of financial inclusion and ICT development; particularly mobile phone penetration can promote financial inclusion in lower and middle income countries. Using the panel dataset of sixty-two countries over the period 2001-2012, we first examine the impact of two different forms of financial inclusion i.e., (i) broad or formal and (ii) microfinance. We observe poverty & inequality reducing effects of financial inclusion measured either way. Most noticeably, our results suggest negative association between microfinance intensity and poverty headcount ratio. Results remain unchanged when poverty headcount is replaced by Gini coefficient. These findings indicate that microfinance intensity not only reduces poverty but also its depth and severity measured as poverty gap and squared poverty gap. Our study depicted a negative relationship between ICT diffusion and poverty. Further, the results suggest that most ICT indicators can help reduce poverty and income inequality by fostering financial inclusion. More importantly, mobile phone diffusion exhibits positive association with financial inclusion measured either from microfinance intensity or from formal financial sector. Results of the study persist to be robust in case of GMM regression when ICT dimensions plugged in as instruments for financial inclusion.

In conclusion, policies to promote information and communication infrastructure could stimulate financial inclusion by promoting e-finance. Moreover, better collaboration between ICT and financial sector will likely to improve digital/mobile banking. Finally, the role of regulators is imperative in order to harness the beneficial and sustainable gains from the increased tech (Fintech,

digital-only or neobanks) entrants with an objective to provide financial services. Further research could be done to explore the risks associated to Fintech and its impact on the provision of financial services to the unbanked segment of society and finally it could be interesting to examine its impact on the transmission of monetary policy. In developing countries, most of the people are unbanked or underbanked. Whereas, initiatives are being taken to increment outreach and to make sure that everybody has equal opportunity to borrow from financial institutions. To reduce the financial inclusion it is imperative to build an effective and efficient microfinance infrastructure that would truly operate for the poor. Secondly, promotion of digital banking should also be the priority agenda for the policy makers. Thirdly, developing and designing a regulatory framework and consumer protection mechanism for the changing landscape of financial markets. Fourthly, improving the financial capability among the population and awareness about the digital banking are also equally important tasks.

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## 6. Appendices

Table 1: Summary statistics

Variable	Obs.	Mean	SD	Median	Min	Max
Poverty headcount	197	2.724	2.724	3.034	-2.163	4.533
Poverty gap	196	1.597	1.597	1.915	-4.200	4.070
Gini coefficient	196	3.699	3.699	3.695	3.187	4.175
Microfinance loans/GDP	248	1.547	1.547	0.488	0	14.34
Borrowers/total population	248	1.849	1.849	0.774	0	12.36
Deposits per head	131	0.762	0.762	0.614	0.006	3.906
Loans per head	101	0.227	0.227	0.176	0.001	0.803
Access to Finance	244	0.204	0.204	0.128	0.006	0.949
Domestic Credit	243	3.203	3.203	3.251	0.908	4.988
Mobile per head	247	3.231	3.231	3.659	-1.796	5.017
Internet per head	248	1.702	1.702	1.914	-1.934	3.981
Fixed lines per head	248	1.585	1.585	2.142	-1.483	3.497
Personal computers	132	4.162	4.162	2.275	0.122	22.52
Price of 3-min local mobile call	53	0.697	0.697	0.685	0.141	1.351
Price of 3-min local fixed call	71	0.163	0.163	0.134	0	0.621
GDP per head	248	7.247	7.247	7.360	5.302	9.108
Government consumption	247	2.513	2.513	2.493	1.674	3.113
Openness index	248	4.247	4.247	4.254	3.276	5.058
Arable lands	248	2.550	2.550	2.572	0.361	4.150
Inflation rate	230	7.553	7.553	6.145	1.268	33.03
Bank overhead cost	245	5.144	5.144	4.546	0.918	19.46
Population density	248	4.228	4.228	4.282	1.764	7.001
Cost of contract enforcement	188	3.544	3.544	3.461	2.407	5.007
Index of civil liberties	248	4.251	4.251	4	2	7

Table 2: Impact of Microfinance Intensity/ Inclusion on Poverty and Inequality

VARIABLES	Poverty Headcount Ratio					Gini coefficient				
	OLS (1)	FE (2)	RE (3)	QR (4)	IV (5)	OLS (6)	FE (7)	RE (8)	QR (9)	IV (10)
Log GDP per capita	-1.040*** (0.099)	-2.349*** (0.282)	-1.193*** (0.113)	-0.920*** (0.067)	-1.191*** (0.118)	0.034 (0.022)	-0.009 (0.040)	0.018 (0.021)	0.045** (0.020)	-0.003 (0.025)
Loan Portfolio /GDP	-0.057** (0.027)	-0.002 (0.024)	-0.054*** (0.020)	-0.041* (0.024)	-0.183** (0.070)	-0.004 (0.007)	-0.008** (0.003)	-0.008*** (0.003)	-0.011 (0.007)	-0.042*** (0.015)
Arable lands	-0.381*** (0.143)	0.990* (0.530)	-0.308** (0.132)	-0.193*** (0.070)	-0.506*** (0.114)	-0.100*** (0.025)	0.016 (0.075)	-0.075*** (0.026)	-0.108*** (0.021)	-0.118*** (0.025)
Trade openness	-0.801*** (0.249)	-0.333 (0.290)	-0.559** (0.219)	-0.558*** (0.155)	-0.916*** (0.272)	-0.102* (0.059)	-0.023 (0.040)	-0.045 (0.034)	-0.093** (0.047)	-0.063 (0.059)
Government Consumption	-0.967*** (0.351)	-0.441 (0.384)	-0.618** (0.275)	-0.710*** (0.190)	-0.934*** (0.326)	0.019 (0.069)	0.016 (0.053)	0.021 (0.044)	-0.029 (0.057)	-0.000 (0.070)
Constant	17.337*** (1.877)	20.157*** (2.718)	16.361*** (1.359)	14.408*** (0.886)	19.433*** (1.517)	4.100*** (0.311)	3.794*** (0.380)	3.908*** (0.232)	4.141*** (0.266)	4.374*** (0.328)
R-squared	0.619	0.461	0.603		0.539	0.251	0.065	0.239		
Hausman			26.11 (0.000)					3.95 (0.556)		
Theta			0.70					0.80		
Pseudo R2				0.447					0.180	13.747
Weak Identification					13.65					
Endogeneity										
Durbin (score)					7.86					15.04
$\chi^2(1)$					0.005					0.000
Hansen stat (OIR)					0.74					0.073
Observations	196	196	196	196	123	195	195	195	195	123

Notes: Results of this table are derived from following baseline equation;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 loan_{i,t} + \gamma_3 arable_{i,t} + \gamma_4 op_{i,t} + \gamma_5 gov_{i,t} + \varepsilon_{i,t}$  OLS estimation with robust standard errors in parentheses. The dependent variables are i) poverty headcount ratio and ii) Gini coefficient. Gross Loan Portfolio /GDP, it shows the financial inclusion (MFI) in a given economy. OLS, FE, RE, QR and IV represent Pooled OLS, Fixed and Random Effects, Quintile and Instrumental Variable regression respectively. \*\*\*, \*\* and \* represent significance at 1%, 5% and 10%, respectively. The lower part of the table provides diagnostics and stability tests for applied models.

Table 3: Impact of Microfinance Intensity/ Inclusion on Poverty and Inequality

VARIABLES	Poverty Headcount Ratio					Gini coefficient				
	OLS (1)	FE (2)	RE (3)	QR (4)	IV (5)	OLS (6)	FE (7)	RE (8)	QR (9)	IV (10)
Log GDP per capita	-1.017*** (0.100)	-2.303*** (0.287)	-1.179*** (0.114)	-0.879*** (0.066)	-1.090*** (0.103)	0.036 (0.022)	-0.004 (0.040)	0.018 (0.021)	0.046** (0.020)	0.022 (0.022)
Borrower /Population	-0.056 (0.034)	-0.011 (0.031)	-0.068*** (0.024)	-0.054** (0.025)	-0.176** (0.073)	0.003 (0.007)	-0.010** (0.004)	-0.009*** (0.003)	0.001 (0.008)	-0.035** (0.016)
Arable lands	-0.379** (0.143)	0.970* (0.532)	-0.306** (0.132)	-0.235*** (0.070)	-0.495*** (0.114)	-0.097*** (0.024)	-0.004 (0.073)	-0.077*** (0.026)	-0.102*** (0.022)	-0.113*** (0.025)
Trade openness	-0.847*** (0.240)	-0.309 (0.297)	-0.529** (0.220)	-0.649*** (0.152)	-1.166*** (0.260)	-0.108* (0.057)	-0.005 (0.041)	-0.038 (0.034)	-0.122** (0.048)	-0.119** (0.056)
Government Consumption	-1.048*** (0.375)	-0.439 (0.383)	-0.703** (0.276)	-0.826*** (0.196)	-1.246*** (0.367)	0.028 (0.074)	0.013 (0.053)	0.011 (0.044)	-0.024 (0.061)	-0.059 (0.079)
Constant	17.574*** (1.904)	19.772*** (2.760)	16.381*** (1.355)	14.934*** (0.899)	20.546*** (1.748)	4.065*** (0.320)	3.749*** (0.383)	3.907*** (0.234)	4.214*** (0.280)	4.559*** (0.377)
R-squared	0.619	0.462	0.388		0.546	0.250	0.070	0.055		
Hausman			25.34 (0.000)					2.94 (0.567)		
Theta		0.707						0.809		
Pseudo R2				0.447					0.173	12.986
Weak Identification					13.07					
Endogeneity										
Durbin (score)					6.718					13.76
$\chi^2(1)$					0.009					0.000
Hansen stat (OIR)					0.400					0.015
Observations	196	196	196	196	123	195	195	195	195	123

Notes: Results of this table are derived from following baseline equation;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 bor_{i,t} + \gamma_3 arable_{i,t} + \gamma_4 op_{i,t} + \gamma_5 gov_{i,t} + \varepsilon_{i,t}$ . Borrowers /Population measured as the number of active borrowers/total population, it shows the financial inclusion (MFIs) in a given economy. (all notes are same as in table 2).

Table 4: Impact of Financial Inclusion on Poverty and Inequality

VARIABLES	Poverty Headcount Ratio					Gini coefficient				
	OLS (1)	FE (2)	RE (3)	QR (4)	IV (5)	OLS (6)	FE (7)	RE (8)	QR (9)	IV (10)
Log GDP per capita	-0.534*** (0.182)	-1.094*** (0.379)	-0.764*** (0.144)	-0.551*** (0.108)	-0.201 (0.269)	0.089*** (0.032)	-0.091 (0.070)	0.048* (0.029)	0.101*** (0.027)	0.144** (0.060)
Deposits per head	-0.832*** (0.286)	-0.582*** (0.170)	-0.634*** (0.131)	-0.800*** (0.132)	-1.195*** (0.270)	-0.087** (0.037)	-0.053* (0.030)	-0.077*** (0.024)	-0.099*** (0.033)	-0.134** (0.061)
Arable lands	-0.070 (0.143)	-0.467 (0.636)	-0.204 (0.138)	0.002 (0.088)	0.222 (0.190)	-0.055* (0.031)	-0.071 (0.108)	-0.067** (0.028)	-0.086*** (0.022)	-0.032 (0.044)
Trade openness	-0.812*** (0.272)	0.533 (0.332)	-0.155 (0.234)	-0.486*** (0.183)	-0.808* (0.420)	-0.062 (0.064)	0.069 (0.058)	0.031 (0.044)	-0.016 (0.046)	-0.039 (0.094)
Government Consumption	-0.665 (0.464)	-0.508 (0.384)	-0.646** (0.287)	-0.326 (0.251)	-0.658 (0.493)	0.081 (0.079)	-0.005 (0.068)	0.018 (0.055)	0.074 (0.062)	0.157 (0.107)
Constant	12.745*** (2.901)	11.567*** (3.588)	11.772*** (1.707)	10.447*** (1.327)	9.973*** (3.227)	3.338*** (0.479)	4.353*** (0.630)	3.429*** (0.334)	3.164*** (0.332)	2.602*** (0.726)
R-squared	0.700	0.541	0.486		0.761	0.331	0.204	0.119		0.434
Hausman			18.67 (0.000)					10.13 (0.0716)		
Theta			0.779					0.814		
Pseudo R2				0.532					0.269	
Weak Identification					21.66					22.28
Endogeneity										
Durbin (score)					7.468					6.520
$\chi^2(1)$					0.006					0.010
Hansen stat (OIR)					0.151					0.103
Observations	107	107	107	107	29	107	107	107	107	29

Notes: Results of this table are derived from following baseline equation;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 dep_{i,t} + \gamma_3 variable_{i,t} + \gamma_4 opi_{i,t} + \gamma_5 gov_{i,t} + \varepsilon_{i,t}$ . Deposits per head, total number of deposits divided by total population, it shows the financial inclusion (formal) in a given economy. (all notes are same as in table 2).

Table 5: Effects of ICTs on Poverty and Income Inequality

VARIABLES	Poverty Headcount Ratio						Gini coefficient					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log GDP per capita	-0.915*** (0.114)	-0.730*** (0.197)	-0.686*** (0.186)	-0.833*** (0.132)	-0.781*** (0.138)	-0.497*** (0.146)	0.053* (0.028)	0.118*** (0.036)	0.117*** (0.035)	0.056 (0.035)	0.059 (0.037)	0.041 (0.063)
Trade openness	-0.827*** (0.257)	-0.733*** (0.256)	-0.716*** (0.252)	-0.810*** (0.262)	-0.704** (0.293)	0.112 (0.406)	-0.100 (0.064)	-0.068 (0.064)	-0.070 (0.062)	-0.102 (0.065)	-0.115 (0.071)	-0.062 (0.166)
Government Consumption	-0.780** (0.363)	-0.680* (0.358)	-0.685* (0.355)	-0.737* (0.378)	-0.617* (0.336)	0.122 (0.235)	0.072 (0.080)	0.104 (0.081)	0.100 (0.079)	0.075 (0.082)	0.091 (0.089)	0.147 (0.107)
Inflation	-0.138 (0.149)	-0.140 (0.149)	-0.114 (0.141)	-0.149 (0.155)	-0.077 (0.142)	0.280** (0.130)	-0.018 (0.029)	-0.015 (0.028)	-0.011 (0.027)	-0.020 (0.029)	-0.002 (0.035)	0.122* (0.058)
Mobile	-0.116** (0.055)						-0.021** (0.010)					
Fixed Telephone		-0.265* (0.135)						-0.078*** (0.023)				
Total (Telephone+ Mobile)			-0.175** (0.074)						-0.044*** (0.011)	-0.019 (0.017)		
Internet												
Personal computers					-0.039 (0.032)						-0.006 (0.008)	
Price of 3-minute local call						0.698 (0.466)						0.342* (0.176)
Constant	15.655*** (1.860)	13.733*** (2.212)	13.726*** (2.015)	14.833*** (2.062)	13.501*** (1.979)	5.471*** (1.577)	3.655*** (0.390)	3.022*** (0.448)	3.133*** (0.419)	3.605*** (0.455)	3.575*** (0.466)	2.906*** (0.605)
Observations	190	190	190	190	102	27	189	189	189	189	102	26
R-squared	0.565	0.580	0.582	0.571	0.545	0.666	0.099	0.174	0.157	0.096	0.100	0.390

Notes: Results of this table are derived from following baseline equation;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 op_{i,t} + \gamma_3 gov_{i,t} + \gamma_4 inf_{i,t} + \gamma_5 ICT_{i,t} + \varepsilon_{i,t}$  Five indicators of ICTs are used in separate specifications. Mobile per head, Fixed lines per head Internet users Personal computers per head and Price of 3-minute mobile local call. (all notes are same as in table 2).

Table 6: Effects of ICTs/ Mobile Penetration on Poverty and Inequality

VARIABLES	Poverty Headcount Ratio				Gini coefficient			
	(FE) (1)	(RE) (2)	(QR) (3)	(IV) (4)	(FE) (5)	(RE) (6)	(QR) (7)	(IV) (8)
Log GDP per capita	-2.302*** (0.412)	-1.023*** (0.135)	-0.792*** (0.087)	1.136 (1.255)	0.008 (0.057)	0.045* (0.025)	0.077** (0.030)	0.286* (0.164)
Trade openness	-0.329 (0.314)	-0.550** (0.229)	-0.653*** (0.158)	0.133 (0.564)	-0.022 (0.043)	-0.043 (0.036)	-0.136** (0.056)	0.118 (0.075)
Government Consumption	-0.342 (0.440)	-0.509* (0.298)	-0.343* (0.197)	0.221 (0.737)	0.042 (0.060)	0.052 (0.048)	-0.003 (0.070)	0.086 (0.091)
Inflation	0.005 (0.099)	-0.045 (0.090)	-0.028 (0.106)	0.022 (0.162)	0.002 (0.013)	0.002 (0.013)	-0.019 (0.037)	0.004 (0.021)
Mobile	-0.004 (0.058)	-0.130*** (0.040)	-0.121* (0.064)	-0.581** (0.264)	-0.012 (0.008)	-0.016*** (0.006)	-0.024 (0.023)	-0.070** (0.034)
Constant	22.058***	14.461***	12.888***		3.659***	3.469***	3.854***	
Observations	(3.343) 190	(1.406) 190	(1.001) 190	131	(0.462) 189	(0.244) 189	(0.352) 189	132
R-squared	0.443	0.091	0.065	0.065	0.044	0.591		-0.264
Number of Countries	62	62	49	49	62	62		50
Country FE	YES				YES			
Hausman		0.028				0.835		
Theta		0.815				0.721		
Pseudo R2			0.425				0.09	
Weak identification test (Cragg-Donald Wald F-stat)			6.553					6.360
Underidentification test (pvalue of the Anderson's stat)			0.000					0.000
overidentification test (pvalue of the Sargan's stat)			0.616					0.332

Notes: The dependent variables are i) poverty headcount ratio and ii) Gini coefficient. FE, RE, QR and IV represent, Fixed and Random Effects, Quintile and Instrumental Variable regression respectively. Robust standard errors are reported in parenthesis. \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10%, respectively. The lower part of table provides diagnostics and stability tests for applied models.

Table 7: ICT-Poverty: Testing Country income level interaction

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Log GDP per capita	-0.915*** (0.114)	-0.567*** (0.203)	0.342 (0.226)	0.108 (0.206)	-1.014*** (0.178)	-0.730** (0.357)
Trade openness	-0.827*** (0.257)	-0.742*** (0.250)	-0.703*** (0.249)	-0.733*** (0.255)	-0.883*** (0.268)	-0.862*** (0.273)
Govt Consumption	-0.780** (0.363)	-0.551 (0.338)	-0.600* (0.347)	-0.559* (0.329)	-0.744** (0.357)	-0.698* (0.399)
Inflation	-0.138 (0.149)	-0.099 (0.132)	-0.118 (0.133)	-0.071 (0.136)	-0.123 (0.147)	-0.153 (0.137)
Mobile	-0.116** (0.055)	0.118** (0.054)	1.574*** (0.403)	-0.264** (0.120)	-0.218*** (0.079)	-0.408** (0.161)
Telephone		0.368** (0.142)	-0.312** (0.127)	-0.425*** (0.150)		
Mobile×Telephone		-0.208*** (0.037)				
Mobile×GDP per capita			-0.256*** (0.060)			
Internet				2.143*** (0.506)		
Internet×GDP per capita				-0.290*** (0.065)		
low					-1.230*** (0.366)	-1.125 (1.080)
Mobile×low					0.269*** (0.086)	0.432** (0.165)
mid						-0.302 (0.883)
Mobile×mid						0.215 (0.211)
Constant	15.655*** (1.860)	12.091*** (2.075)	6.816*** (1.825)	8.595*** (1.881)	16.958*** (2.222)	15.120*** (4.156)
Observations	190	190	190	190	190	190
R-squared	0.565	0.637	0.627	0.643	0.584	0.595

Note: This table reports the results of following baseline equation;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 op_{i,t} + \gamma_3 govt_{i,t} + \gamma_4 inf_{i,t} + \gamma_5 Mobile_{i,t} + \gamma_6 Telephone_{i,t} + \gamma_7 Mobile_{i,t} \times \gamma_8 Telephone_{i,t} + \varepsilon_{i,t}$  This table provides the results of interaction terms of different set of ICT indicators such as mobile and telephone, mobile and GDP or Internet and GDP. Column 5 and 6 present the results of the interaction of the ICT indicator with a dummy variable of low middle and upper income countries. This equation can be specified as;  $y_{i,t} = \gamma_0 + \gamma_1 \ln gdp_{i,t} + \gamma_2 op_{i,t} + \gamma_3 govt_{i,t} + \gamma_4 inf_{i,t} + \gamma_5 Mobile_{i,t} + D_{low} + \gamma_6 Mobile_{i,t} \times D_{low} + D_{mid} + \gamma_7 Mobile_{i,t} \times D_{mid} + \varepsilon_{i,t}$ , where  $D_{low}$  and  $D_{mid}$  represent lower and middle income group countries respectively.

Table 8: Mobile Phone Penetration and Financial Inclusion

VARIABLES	Overall Financial Inclusion				Overall Access to Finance		Microfinance	
	Deposits per head	Domestic credit	Access to Financial Ins.	Glp/GDP	Bor/Pop			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobile Phone per head	0.168 † (0.105)	0.183 † (0.127)	0.145*** (0.039)	0.221*** (0.077)	0.021*** (0.007)	0.025** (0.012)	0.962*** (0.218)	0.665*** (0.146)
Log GDP per capita	0.365*** (0.084)	0.224* (0.115)	0.322*** (0.080)	0.172 (0.110)	0.125*** (0.016)	0.100*** (0.015)	-1.198** (0.382)	-0.659* (0.309)
Population density	0.174*** (0.057)	0.203* (0.118)	0.216** (0.084)	0.074 (0.088)	-0.000 (0.015)	-0.048** (0.022)	-0.455 (0.356)	0.205 (0.482)
Overhead cost		-0.022 (0.020)		-0.064** (0.027)		0.004 (0.006)	-0.051 (0.055)	-0.041 (0.056)
Institutions		0.234** (0.099)		0.143 (0.088)		0.011 (0.013)	0.053 (0.188)	0.096 (0.184)
Bank branches		-0.002 (0.012)		0.002 (0.007)		0.007*** (0.002)		
Constant	-3.299*** (0.553)	-3.348*** (0.822)	-0.511 (0.685)	0.575 (0.748)	-0.772*** (0.098)	-0.523*** (0.158)	9.095** (3.457)	3.25 (2.714)
Observations	131	126	242	171	243	172	244	244
R-squared	0.397	0.488	0.361	0.456	0.563	0.698	0.201	0.100

Note: This table reports the results of following baseline equation;  $FI_{i,t} = \zeta_0 + \zeta_1 mob_{i,t} + \zeta_2 y_{i,t} + \zeta_3 pden_{i,t} + \sum_{j=1}^n X_{i,t}^j + \varepsilon_{i,t}$ . This table provides the results of the effects of ICT indicator measured as mobile subscribers per head on financial inclusion. Robust standard errors are reported in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 and † p<0.15. The dependent variable  $FI$  is financial inclusion, measured as the number of deposits divided by adult population of the respective country in column (1) and (2); A broad measure of financial inclusion (CREDIT) in column (3) and (4); Access to financial institutions index is taken from [61], column (5) and (6) present the impact of mobile penetration on access to finance. model (7) and (8) give the results when we use MFI borrower per capita and ration of borrowers to GDP to approximate financial inclusion.  $y$  and  $pden$ , GDP per capita and population density are the main control variable respectively in this regression (see methodology section for the explanation of all variables used here). This model is applied following [39].



Table 9: Impact of ICT on Poverty and Inequality

VARIABLES	Instrumental Variables: GMM Estimation								
	HCR (1)	HCR (2)	HCR (3)	HCR (4)	HCR (5)	GINI (6)	PGAP (7)	PGAP2 (8)	GDPPC (9)
Log GDP per capita	-0.914*** (0.141)	-1.089*** (0.093)	-1.071*** (0.094)	-0.107 (0.468)	-0.767*** (0.202)	0.079** (0.039)	-1.003*** (0.212)	-2.006*** (0.425)	-0.239
Arable lands	-0.316** (0.129)	-0.362*** (0.124)	-0.369*** (0.126)	0.249 (0.314)	-0.277** (0.133)	-0.090*** (0.026)	-0.424*** (0.147)	-0.848*** (0.295)	(0.147)
Trade openness	-0.744*** (0.278)	-0.767*** (0.253)	-0.798*** (0.244)	-0.439 (0.377)	-0.980*** (0.289)	-0.065 (0.068)	-0.845** (0.379)	-1.689** (0.758)	(0.315)
Government Consumption	-0.912*** (0.347)	-1.057*** (0.312)	-1.189*** (0.312)	-0.078 (0.687)	-0.595 (0.424)	0.023 (0.077)	-0.917** (0.409)	-1.834** (0.818)	0.028 (0.411)
Financial Inclusion-1	-0.349* (0.198)								1.620*** (0.231)
Financial Inclusion-2		-0.071* (0.041)							
Financial Inclusion-3			-0.075* (0.046)						
Financial Inclusion-4				-1.699** (0.826)					
A2F					-2.100* (1.203)				
Constant	16.915*** (2.055)	17.727*** (1.758)	18.102*** (1.718)	6.452 (6.198)	15.255*** (2.674)	3.946*** (0.364)	17.985*** (2.383)	35.970*** (4.765)	2.656* (1.488)
Observations	193	196	196	107	194	192	192	192	241
R-squared	0.580	0.617	0.615	0.577	0.618	0.007	0.544	0.544	
Hansen's J-stat	0.92	1.969	2.233	4.439	2.255	0.889	0.866	0.866	0.001
P-value	0.631	0.373	0.327	0.108	0.323	0.345	0.351	0.351	0.966

Notes: The dependent variables are i) poverty headcount ratio and ii) Gini coefficient, iii) Poverty Gap iv) squared poverty gap and Per capita Gross domestic product. Financial Inclusion-1 is measured through the log of (CREDIT), Financial Inclusion-2 is the ratio of gross loan portfolio of MFIs to GDP, Financial Inclusion-3 is microfinance borrower per capita, Financial Inclusion-4 is deposits per head and A2F is the access to financial institutions in a given economy. Instruments are ICT indicators (Mobile subscriptions per head, Internet users and fixed telephone lines per head) in addition to the included regressors except Financial Inclusion. weighting matrix: white covariance; clustered at country level; Robust standard errors are reported in parenthesis. \*\*\*, \*\*, \* and \* represent significance at the 1%, 5% and 10%, respectively.

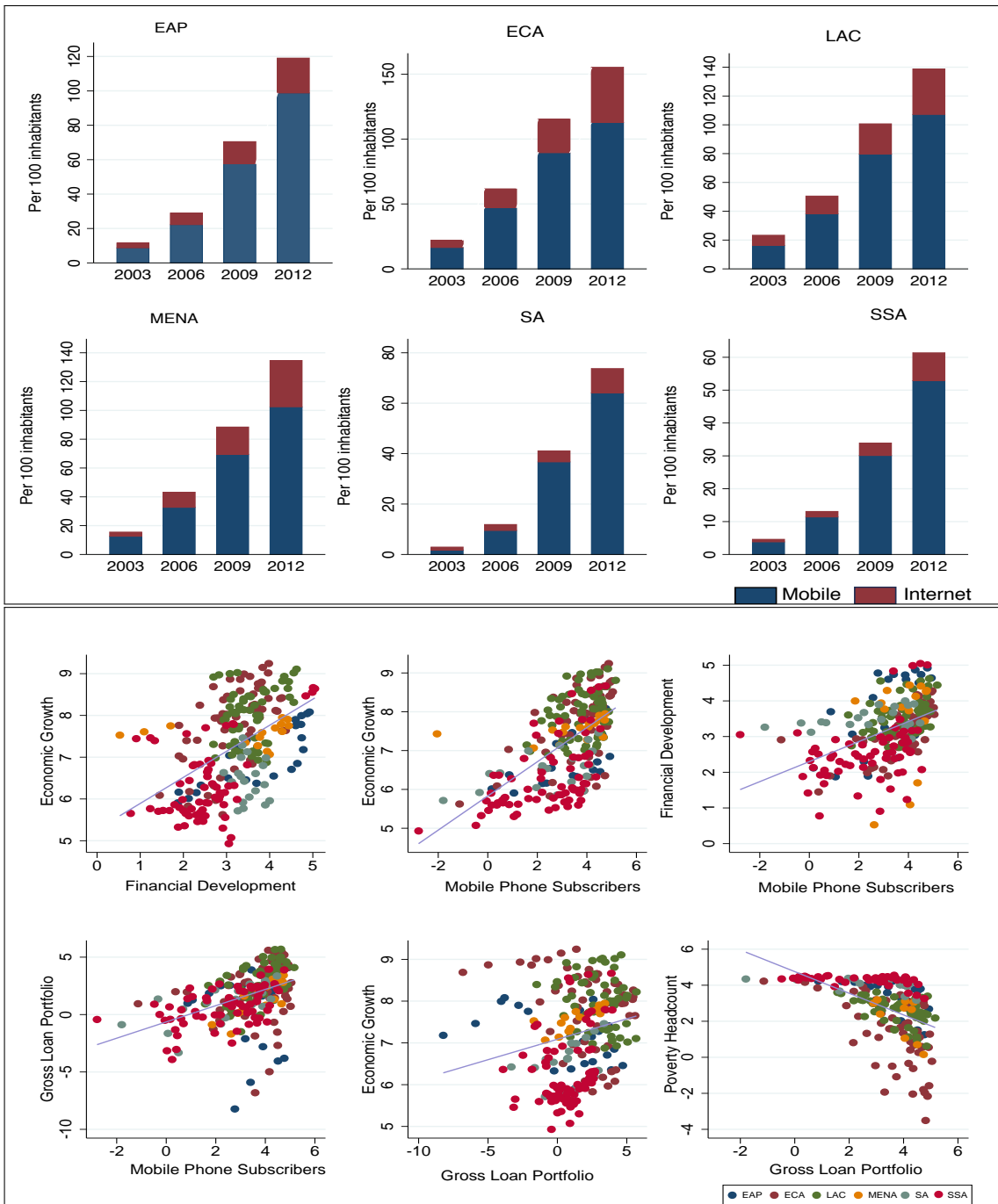


Figure 2: Trends and Correlations

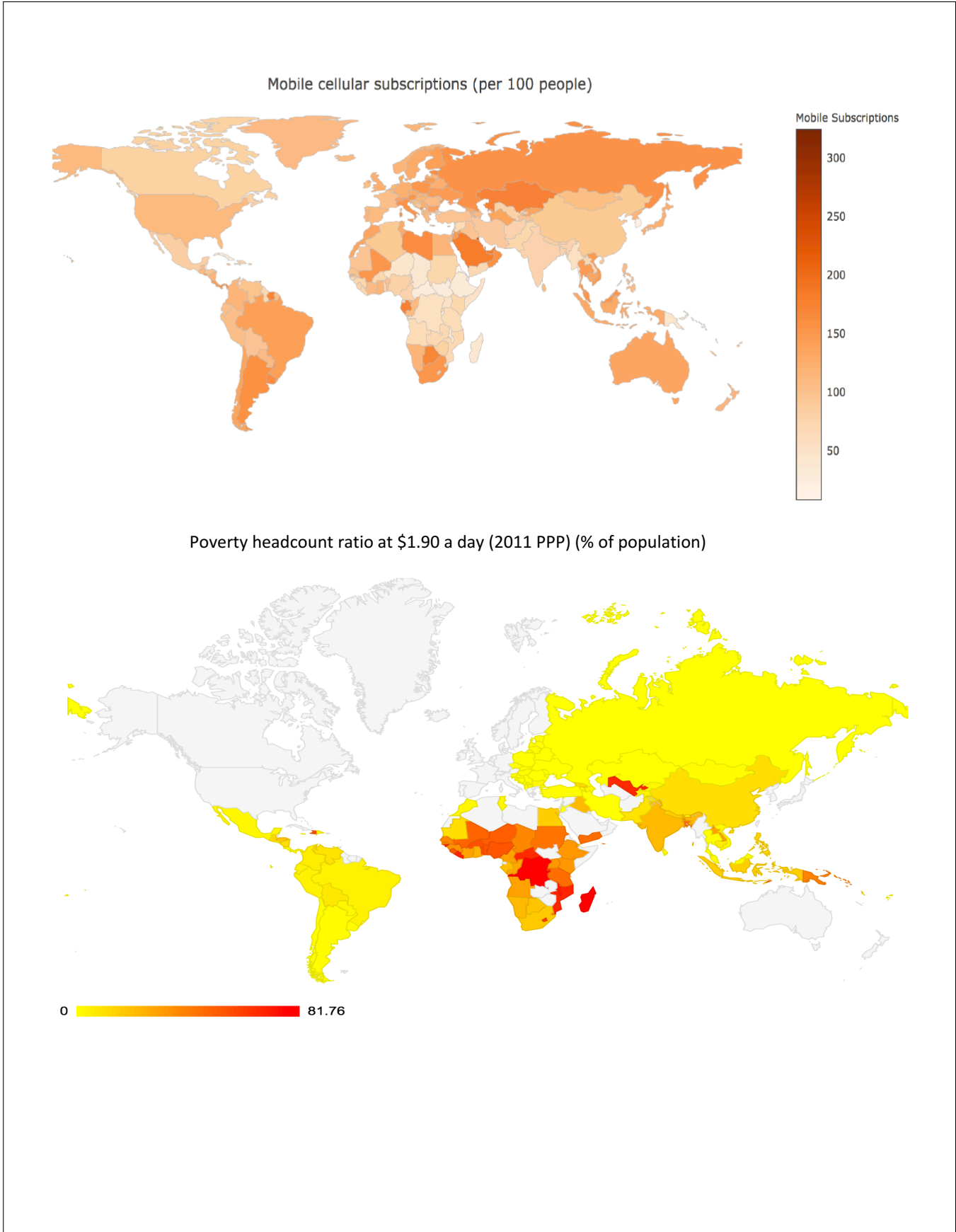


Figure 3: Geographical Visualization of Poverty and Mobile Penetration

Table 10: Variables, Measurement and Source

Variables	Definition	Source
<b>Control</b>		
Gross Domestic Product	Log of Gross Domestic Product Per Capita GDP	WDI
Inflation	Consumer Price Index	WDI
Trade Openness	Ratio of imports plus exports to GDP	WDI
Government Consumption	General government final consumption expenditure (% of GDP)	
Arable lands	Share of arable land/total land (% of GDP)	WDI
Population density	Population density (people per sq. km of land area)	WDI
Foreign Direct Investment	Foreign direct investment, net inflows to GDP	WDI
<b>Poverty &amp; Inequality</b>		
Poverty	Measured as Poverty Headcount ratio at \$ 2 a day	WDI
Poverty Gap	Poverty gap at \$2 a day (PPP) (%)	WDI
Gini coefficient	Income Inequality, natural log of GINI coefficient	WDI
<b>ICT</b>		
Mobile	Mobile cellular subscriptions divided by total population	ITU
Internet	Number of people with access to the worldwide network divided by total population	ITU
Telephone	Fixed Telephone users divided by total population	ITU
Price of 3-minute call	Price of 3-minute local mobile call (peak -rate - US\$)	
<b>Financial Inclusion (Informal)</b>		
Gross Loan Portfolio	Gross Loan Portfolio divided by GDP	MIX
Borrower per capita	Total number of borrowers divided by total Population	MIX
<b>Financial Inclusion (Formal)</b>		
Domestic Credit	Domestic credit to private sector (% of GDP)	GFDD
Access to Finance	Depositors with commercial banks (per 1,000 adults)	IMF-FAS
Deposits per head	Number of Commercial Bank deposits divided by total population	IMF-FAS
<b>Institutional Indicators</b>		
Contract Enforcement	Cost of contract enforcement	Doing Business
Political Rights Index	Political Stability index, range 1-7	Freedom House
Index of Civil Liberties	Civil Liberties index, range 1-7	Freedom House
<b>Other</b>		
Latitude	Absolute value of the latitude of the capital city, range 0-1	[40]
Legal Origin	Dummy variable for legal origin of the country, 0/1	[40]
Religion	Measure of religious fractionalization	[3]
Language	Measure of linguistic fractionalization	[3]
Ethnic	Measure of ethnic fractionalization	[3]

Note: \* The Global Financial Development Database. †The World Bank, World Development Indicators (WDI). ITU, International Telecommunication Union. MIX, Microfinance Information Exchange. IMF-FAS, International Monetary Fund, Financial Access Survey. WGI, World Governance Indicators.

Table 11: List of Countries, Regions and Income group

Country	Region	Group	Country	Region	Group
Albania	ECA	UMI	Lao PDR	EAP	LMI
Armenia	ECA	LMI	Macedonia, FYR	ECA	UMI
Azerbaijan	ECA	UMI	Madagascar	SSA	LI
Bangladesh	SA	LI	Malawi	SSA	LI
Benin	SSA	LI	Mexico	LAC	UMI
Bolivia	LAC	LMI	Moldova	ECA	LMI
Bosnia and Herzegovina	ECA	UMI	Morocco	MENA	LMI
Brazil	LAC	UMI	Mozambique	SSA	LI
Bulgaria	ECA	UMI	Nepal	SA	LI
Burkina Faso	SSA	LI	Nicaragua	LAC	LMI
Cambodia	EAP	LI	Nigeria	SSA	LMI
Cameroon	SSA	LMI	Pakistan	SA	LMI
Chile	LAC	HI	Panama	LAC	UMI
China	EAP	UMI	Paraguay	LAC	LMI
Colombia	LAC	UMI	Peru	LAC	UMI
Congo, Rep.	SSA	LMI	Poland	ECA	HI
Costa Rica	LAC	UMI	Romania	ECA	UMI
Dominican Republic	LAC	UMI	Russian Federation	ECA	HI
Ecuador	LAC	UMI	Rwanda	SSA	LI
Egypt, Arab Rep.	MENA	LMI	Sierra Leone	SSA	LI
El Salvador	LAC	LMI	South Africa	SSA	UMI
Ethiopia	SSA	LI	Sri Lanka	SA	LMI
Guatemala	LAC	LMI	Swaziland	SSA	LMI
Guinea	SSA	LI	Tajikistan	ECA	LI
Honduras	LAC	LMI	Tanzania	SSA	LI
India	SA	LMI	Thailand	EAP	UMI
Indonesia	EAP	LMI	Turkey	ECA	UMI
Iraq	MENA	UMI	Uganda	SSA	LI
Jordan	MENA	UMI	Ukraine	ECA	LMI
Kazakhstan	ECA	UMI	Vietnam	EAP	LMI
Kyrgyz Republic	ECA	LMI	Zambia	SSA	LMI

Notes: Regions and Income groups are classified as per the World Bank classifications. Where, ECA: Europe and Central Asia, SA: South Asia, SSA: Sub-Saharan Africa, LAC: Latin America & the Caribbean EAP: East Asia and Pacific, and MENA: Middle East and North Africa. The income groups are UMI: Upper-middle-income, LMI: Lower-middle-income, LI: Low-income and HI: High-income economies.