Impact of Information Communication Technology on Economic Growth: Evidence from Asian Economies

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(Finance)

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ISLAMABAD

2017

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A research thesis submitted to the Department of Management Sciences,
Capital University of Science and Technology, Islamabad
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT SCIENCES

(Finance)

DEPARTMENT OF MANAGEMENT SCIENCES

CAPITAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Acknowledgement

This thesis includes no material which has been already accepted for the award of any other degree or diploma in any university and confirms that to the best of my knowledge the thesis includes no material previously published or written by another person, except where due reference is made in the text of the thesis.

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Acronyms

ATM	Automated teller machine
BB	Branchless Banking
EXP	ARDL
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GMM	Generalized Method of Moment
ICT	Information Communication Technology
IMP	Import
INT	Internet
INV	Investment
IMF	International Monetary Fund
ITU	International Telecommunication Union
LDCs	Least Developed Countries
MOB	Mobile Subscriptions
MENA	Middle East and North Africa
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
R&D	Research and Development
UNDP	United Nations Development Programme
WB	World Bank

Abstract

Economies around the world extremely differ regarding their rates of economic growth having high growth rates in developed world and slow growth rates for developing countries. This disparity is not a coincidence, but the consequences of several interacting economic and political environment factors. Since investment and use of ICT increases significantly in Asian Countries during the past decade; this study establishes the impact of information and communication technologies (ICT), especially mobile phone rollout, on economic growth in 43 Asian countries for the period 2005 to 2015 using balanced panel data. In estimating the impact of ICT on economic growth (by using GDP as proxy measure), this study uses a wide range of ICT indicators, including mobile phone penetration, ICT Investment and Use of Internet. In order to address any endogeneity issues; this study uses the System Generalized Method of Moment (GMM) estimator for estimating the ICT impact on GDP by using three different regression equations (thereby measuring the specific impact of each selected indicator on the economic growth of selected Asian countries). The results confirm that all the ICT indicators used in this study (including investment in ICT, mobile phone development and use of Internet) significantly contribute to economic growth in Asian countries.

Keywords: ICT, mobile subscriptions, internet, ICT Investment, economic growth, Asian countries

Chapter 1

Introduction

1.1 Theoretical Background

In the widestterm, an economy can be defined as group of consumers demanding various things like food, clothing, shelter, or entertainment. Allocating resources to match production with desired consumption pattern (by effectively utilizing the markets) is the core of economics. In efficient markets, desired consumption guide the production of all the participants i.e. there is no prospect of making one person better off without making another worse off. In developed economies, scarce resources (mainly human and financial capital)can efficiently converted into the things consumers demand; which is one of the greatest challenge currently faced by developing economies.

Economies around the world extremely differ regarding their rates of economic growth having high growth rates in developed world and slow growth rates for developing countries. This disparity is not a coincidence, but the consequences of several interacting economic and political environment factors. The economic situation of a specific country depends on the capabilities of that country to produce valuable products and services efficiently. Theoretically, growth in GDP per capita or increase in economic growth rate is significantly dependent on the increase in productivity growth rate. The rapid increase in this productivity growth rate primarily arises from technological progress and innovation resulting in more productive labour, knowledge and human capital accumulation, R&D activities, learning-by-doing processes, and other spillover effects. The enormous variety of capabilities of Information and Communication Technologies has revolutionized growth opportunities that lower the operation efforts needed for establishing the foundation for sustainable growth and enormously facilitate enhanced productivity improvements afterwards.

ICT infrastructure can be effectively utilized to significantly increase the economic growth rate of developing economies (Estcahe, Perlman, & Trujilo, 2005; W.W.Sharkey, 2000; Gutierez &Berg, 2000). Following the significant increase in ICT infrastructure throughout the world, rapid technological dissemination and innovations along with significant price decline of ICT equipment have also been observed in OECD countries (OECD, 2003). The positive effects of ICTs on economic growth have not only been confirmed by many members of the OECD but also by the European Union (Edquist & Henrekson, 2004; Hanclova, Doucek, Fischer & Vltavska, 2015; Falk & Biag, 2015).

According to Information and Market Signals theory, the correlation between market amalgamation and GDP growth advocate that greater access to Information Communication Technologies can significantly improve the different functions of markets; effectively resulting in drastically improving the life style of poor communities living all over the world. Appropriately designed ICT interventions can provide sustainable way to end deprivation by increasing the earning possibilities through effectively deploying the undecided part of the market as a facilitating hand for the poor people. Figure 1.1demonstrates that ICT can be effectively used to create a "Digital Provide" that can not only increase the individual incomes due to the availability of right information for various economic decisions but also results in making the markets more effective; ultimately leading to economic growth.

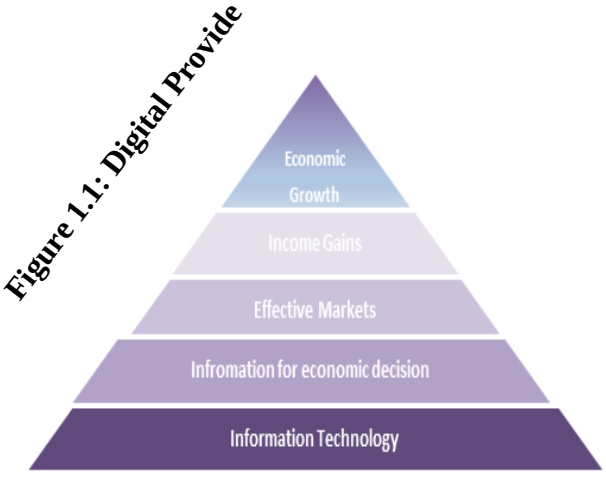


Figure 1.1: Digital Provide

During the start of the 21st century, gross disparities among the social and economic conditions of different nations or inequalities among different statesis one of the prominent issue arises in the world. With the arrival of computers and internet; policy advisors and world development organizations (like World Bank and UNDP) have pointed out a number of opportunities which can be utilized to close the gap between

developed and developing nations. Lack of required ICT infrastructure has also been observed as one of the significant factor that can contribute in widening the gap between the developed and developing countries as shown by world social and economic indicators (published in the annual reports of World Bank and UNDP).

As a result of the accelerated technological progress and perpetual price declines of ICT since the mid-1990s, the last two decades were marked by rapid diffusion of ICT throughout the world. This rapid diffusion of ICT multidimensional capabilities has not only enforced the business world in substituting and changing the conventional capital and labour but also facilitate the business world in bringing extensive innovations in their products and processes. During the last decade, it was also observed that economic and trade processes are heavily influenced by the formation, diffusion, accumulation, processing and application of information due to greater use of ICT.

Considering the "World Summit on the Information Society" organized by United Nation and other global organizations towards Information Communication and Technology based regulations had not only confirmed the importance of ICT infrastructure but had also acknowledged the ICT as a significant economic determinant. After the early over-ambitious believe in ICT as the panacea for economic development and growth, it has been finally realized that ICT can be used as an effective tool for fostering economic growth that can make a significant contribution to more efficient growth processes.

During the pasttwo decades, numerous researches were carried out in developed countries to evaluate the impact of ICT on GDP growth (like Hagsten, 2015, Hanclova et al., 2015, Falk & Biag, 2015, Niebel, 2014, Gottfries, 2013 etc.). All of these studies have confirmed ICT as one of the substantial contributor in increasing the GDP growth; however due to the less availability of required infrastructure, macroeconomic dissimilarities exist in developing countries due to which the information communication technology infrastructure cannot be effectively utilized. Therefore adequate deployment of ICT infrastructure under the prevailing conditions have now emerged as a new prime challenge for the developing nations.This is also

pertinent to mention here that due to the availability of statistical data, greater literacy rate and adequate ICT knowledge of developed economies people; a majority of the research relating to ICT's impact on economic growth have been conducted in developed countries, but nonetheless provided useful conclusion highlighting the magnitude and dynamic effects of ICT on GDP growth. Contrary to above, some studies have also been conducted in developing countries during the last decade for obtaining substantial evidence or measuring the possible impact of ICT on the GDP growth (Wavermen, Msechi &Fus (2005), Jorgenson, 2005, Paitkowski (2004), Paitkowski (2006) and Younghwa Lee, (2003)). Currently, the digital divide within the developing world is escalating due to the fact that emerging economies have been partly succeeded in obtaining benefits from information communication and technologies potential to boost their economic growth.

1.2 Problem Statement

Due to the above mentioned potential and complementary effects on labor and capital (the key foundations of economic growth), ICT has been a center of dispute among various economist investigating growth of economies during the past 2 decades. Since most of the previously conducted research conducted at cross-national level concluded that ICT is correlated with substantial productivity gains for developed economies but not for developing economies (Dewaan & Kreamer, 2000; Pohjola, 2001; Scheryer, 2000) and due to dramatically increase in ICT investment and use of ICT in the previous 2 decades; this study will try to evaluate whether the investment in ICT has started to increase productivity gains leading to overall GDP growth for developing economies or not. Majority of the population (especially rural areas population) in Asian countries will remain 'below the poverty line' and the major issues that was mentioned as causing the poor and vulnerable groups not to effectively utilize their resources to enhance their earning opportunities are; remoteness, inconvenience and greater cost. Both government and the private sector are jointly putting up their efforts to encourage the development of models which can be used to effectively utilize the economic resources thereby leading to economic growth. Information Communication Technology (by using high level of coverage available through mobile phones, internet, ATMs, mobile wallet accounts and other available infrastructure) can be used as a solution to financial inclusion to target this huge population currently not availing the banking services due to high transaction costs and the challenge is to confirm whether ICT can be used as an effective tool for economic growth in Asian countries. Since mobile banking has already been introduced in majority of the Asian countries during last two decades; there is a need to evaluate whether ICT has a positive and significant impact on economic growth or not.

1.3 Research Objectives

The overall purpose of this study is to assess the impact of ICT development(especially focusing on the role of investment in ICT, mobile phone penetration and use of internet in effectively utilizing the economic resources)on the

economic growth of Asian countries. Specifically, this study has following research objectives:

i. To analyze the overall impact of ICT on economic growth in Asian countries.
ii. To analyze the specific impact of mobile phone penetration on economic growth in Asian countries.
iii. To analyze the specific impact of Investment in ICT on economic growth in Asian countries.
iv. To analyze the specific impact of Internet users on economic growth in Asian countries.

1.4 Research Questions

This study has following research questions:

i. Is there any relationship exists between ICT and economic growth for Asian countries?
ii. Can mobile phone penetration leads to economic growth in Asian countries?
iii. Can Investment in ICT leads to economic growth in Asian countries?
iv. Can use of internet leads to economic growth in Asian countries?

1.5 Significance of the Study

The purpose of this study is to add to the existing literature about the impact of ICT on the economic growth of Asian countries; because only a limited number of studies have been conducted for emerging economies in order to determine the macroeconomic and microeconomic impacts of ICT on economic growth. This study analyze how the contribution to GDP growth differs amongst country groups and try to explain what might causing these potential differences with help from previous research. Branchless banking, by using the telecommunication companies infrastructure, has also been emerged as a new channel to reduce the transaction cost of financial intermediaries which includes but not limited to commercial and micro-finance banks; thereby resulting in not only improving the overall profitability of businesses but also results in increasing the flexibility of businesses. Moreover, information asymmetries can be reduced by using a good communication network

that allows better information flows. Based on above mentioned ICT characteristics, this study have validated the alternate hypotheses (thereby rejecting the null hypotheses) concluding that there exists a significant and positive correlation between average real GDP per capita and ICT in Asian countries.

Chapter 2

Literature Review

In the beginning the classical economists like Smith, Ricardo, Ramsey and Schumpeter provided fundamental approaches to the economic growth theory having valuable conclusion that capital cannot sustain growth indefinitely due to the diminishing marginal rate of productivity and its relation to the accumulation of physical and human capital.

During the 1960, Robert Solow and Trevor Swan independently developed a new exogenous growth model (which superseded the Keynesain Harrod Domar model) to measure long term economic growth rate within the framework of neoclassical economics. The major contribution of Solow (1956) and Swan (1956) was a production function assuming constant return on scales, diminishing returns on capital and an exogenous technological explanation for economic growth in the long run. Existing theories stated for a long time that capital, labor and technological development are the main drivers for sustained economic growth. The technology factor is suggested to complement capital and labor in the sense that it brings productivity gains in production by new knowledge and innovations (Solow, 1956; Romer, 1990; Gottfries, 2013).

In this model the technological factor, or Solow residual, is a parameter of great importance. It includes all other factors of production that cannot be explained by capital and labor alone. Since growth is discussed to be influenced by technology, which often is determined by factors such as new innovations, externalities, human capital and investment decisions, there are reasons to believe upon a positive correlation among the Solow residual and the capital variable for ICT (Stiroh, 2002), making the neoclassical model suitable to use in this context. Although Stiroh finds little evidence of the positive relationship, he argues that one should not drop the framework of the neoclassical concept since there are strong reasons to believe GDP growth in the digital era which is in favor of identified technological factors. The production function outlined by Solow includes the three following factors of production:

$$Y=AK_{\alpha}L_{1-\alpha}$$

where Y is output stock, K and L is the stocks of capital and labor respectively. A is the technological parameter affecting the productivity of K and L. In addition, the function represents constant returns to scale, implying that 1 unit increase in both capital and labor will contribute to 1 unit increase in the level of output. The values of α and $(1-\alpha)$ will therefore sum up to one.

In the context of emerging economies or Least Developed Countries (LDCs), gathering information is extremely costly which was not only reported by early observers but also one of the central tenets of the information-theoretic approach. In a debate of least developed economies, Leibenstien (1968) presents a snapshot of these economies as, "obstructed, incomplete and 'relatively dark' economic systems." A comparable statement was also stated by Gertz (1978) that "information is poor, scarce, maldistributed, inefficiently communicated, and intensely valued."

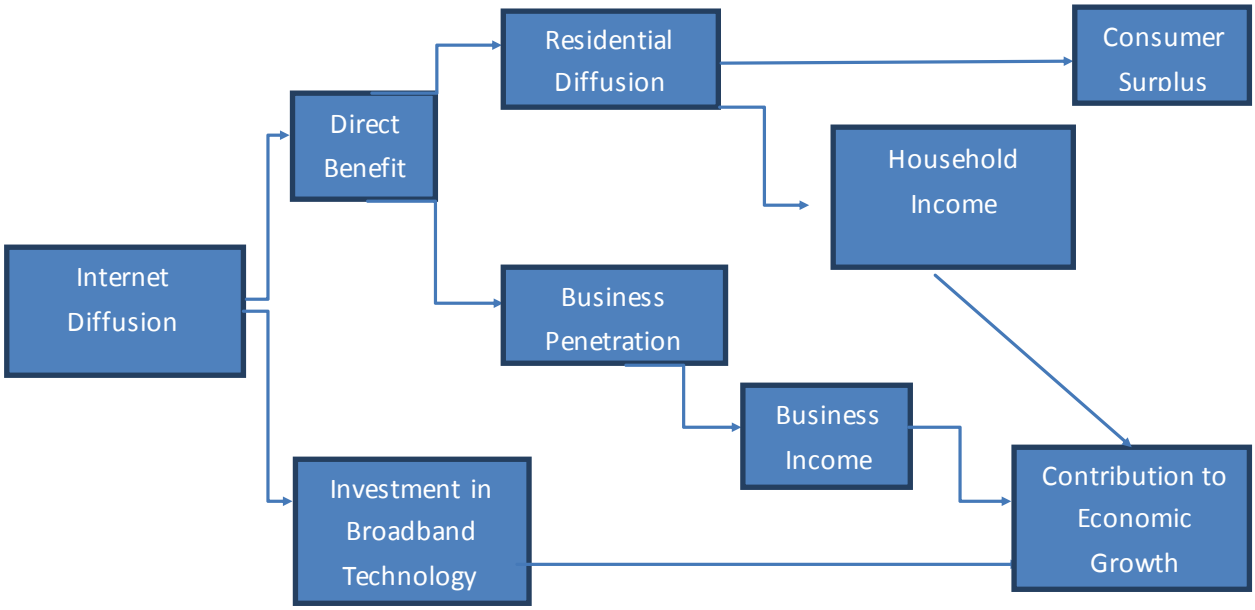
Earlier research provided strong evidence that only developed economies were able to effectively utilize their resources for the development of ICT infrastructure. In fact, previous studies provided evidence of economic growth through network externalities, with a special focus on telecom service and the internet. Keeping in view of above mentioned discussion, Grace, Keny, and Qaing (2003) carried out a study to explain why only developed countries were assumed to benefit from the information communication and technology. According to them, the value of a telephone line goes up exponentially with the number of users connected to the system due to network effects. They were also of the opinion that an extraordinary economic growth is recorded when a minimum threshold of users are crossed. Roler and Wavermen (2001) also presented the same results stating that extraordinary GDP growth is recorded when the diffusion rate reached 40 lines per 100 inhabitants. Based on above we concluded that ICT development is increasingly considered a factor in economic growth rather than a consequence of it which was also validated by Tcheng (2007).

As per the report issued by Katz, 2012; Internet is also a significant contributor to GDP growth at the following levels:

1. Effective positioning and use of broadband technology across business hubs will increase the productivity by using backward and forward vertical integration; thereby adopting effective and efficient business processes for not only customer relationship management but for also supply chain management.
2. Effective use and placement of internet facilities helps in accelerating innovation by presenting innovative users applications and services
3. Effective use and placement of internet facilities also helps the businesses in not only increasing their target market areas but also helps to effectively reduce direct labour and raw material costs by having more efficient labour and better access to raw materials.

There are multiple approaches, which includes but not limited to econometric techniques and qualitative macro and micro level case studies to estimate the economic impact of broadband technologies. Following figure 2.1 shows the contribution to GDP growth by effectively deploying broadband facilities:

Figure 2.1 : Impact of Broadband on GDP



Since there are numerous studies conducted in the past confirming the positive and significant impact of broadband to GDP growth; however this is pertinent to mention here that these studies were mainly focused only on OECD countries (which mainly includes Western Europe and United States of America) as shown by the Table 2.1:

Table 2.1 – Impact of broadband technology on GDP Growth					
Country	**Year**	**Author**	**Publisher**	**Data**	**Results**
United States of America	2007	Crandal et al.	Brooking Organization	48 states of US over a period of 3 years (2003 to 2005)	Insignificant results
	2008	Thompson and Garbaz	Ohio University	46 United States of America for the period 2001 to 2005	10% increase in internet diffusionincreases the system efficiency by 3.6%
Organization for Economic Cooperation and Development (OECD)	2009	Czernich et al.	LMU MUNICH University	25 OECD Countries between 1996 to 2007	10% growth in broadband diffusion increases GDP growth by 1.2%
	2009	Koutroumpis	Imperial College	22 OECD countries during the period 2002 to 2007	10% increase in broadband diffusion produced an additional GDP growth of 0.25%
Developed Economies	2009	Qiang et al.	World Bank	66 developed economies during the period 1980 to 2002	10% increase in broadbanddiffusionproduced an additional GDP growth of 1.21%

Developing Economies	2009	Qiang et al.	World Bank	120 developing economies during the period 1980 to 2002	10% increase in broadband diffusion produced an additional GDP growth of 1.38%

The above mentioned studies were mainly conducted during the period 2007 to 2009 containing balance panel data of more than 120 countries to evaluate the possible correlation among internet dissemination and GDP growth. The results of all of these studies confirms the positive and significant correlation between GDP and broadband penetration.

Many researchers argue that information communication and technology is necessary for the rapid development of developing countries (like Cronin et al., 1993; Dholakia & Harlam, 1994; Jukkia & Pohjola, 2002; Medon, 2000; Pohjola, 2001; Roller & Wavermen, 2001). Contrary to that other researchers were of the opinion that greater attention was given to ICT expansion as a major source for economic growth, while not enough attention is given to human and financial capital, (Bolou, 2006; Feilding, 2002; Kneler, 2005; Lamberton, 2001; Nawgwu, 2005; Von Lubtiz & Wickramsinghe, 2006). Isaksson (2010) concluded in his research paper that telecom can be used as an important input in order to increase the total factor productivity of the traditional inputs of labor, capital, and land. Nandi (2002) concluded that markets will be more efficient and there will be few or no idle resources, when telecom infrastructure is in equilibrium (e.g. capital and transactions costs of production can be reduced by using effective and efficient financial market).

Following are the two different school of thoughts that are also used to explain the possible correlation between ICT and economic growth:

- Technophiles: According to technophiles; productivity, innovations, employment opportunities and product quality will be increased by using ICT infrastructure (Camrody, 2012; Castels, 1998; Castels, Fernadezet al. 2007; Mansel 1998).
- Technophobes: According to technophobes; ICT Infrastructure is widening the gap between the rich and poor, urban and rural, and literate and illiterate segments. They have a strong believe that due to scarce resources; human and physical capital investments required for ICT development may utilize the resources allocated for other activities that can create a greater impact on the economic growth (Mansel, 1999; Van Dijik, 1999).

Furthermore, some studies have not only recognized that ICT have significant impact on GDP growth; but they have also concluded that well deployed ICT infrastructure can have the following significant positive spillover effects on the various aspects of social life:

- ICT infrastructure can be used to increase e-learning (Aduwa Ogiegbean& Iymau, 2005; Kankanranta, 2005)
- ICT infrastructure can be used for providing better health care services (Branko, Lovel, & Basilakis, 2003; Von Lubtiz & Wickramsinghe, 2006)
- ICT infrastructure can be used to capture tacit knowledge (Jian, 2006), and
- ICT infrastructure can also be used for maintain good governance (Meso, Data, & Mbarika, 2005).

Datta and Agarwal (2004) were also of the same opinion that well deployed ICT infrastructure can be used to obtain the following dual economic benefits (i.e. direct and indirect benefits):

Table 2.2 –ICT Direct and Indirect Economic Benefits	
Direct	**Indirect**
From supply side: ▪ Increase national productivity ▪ Jobs creation ▪ Increase in revenues streams resulting in additional government revenues	From ICT use: ▪ Surplus capital accumulation ▪ Increase organization's productivity ▪ Provide better and greater access to target markets ▪ Development of remote areas by using ICT infrastructure ▪ Reduce Transaction Cost

Keeping in view of the conclusions of the above mentioned studies; world development agencies (like IMF, World Bank and UNDP) and International Telecommunication Associations are pushing developing economies to develop effective and efficient ICT infrastructure in order to obtain substantial social and economic benefits.

Hardy (1980) established the correlation between GDP per capita, telephone users per capita and number of radios using the data of 15 industrial and 45 developing economies for period 1960 to 1973 using path analysis and cross lagged correlation method. Hardy concluded that telephone lines per capita had positive and significant impact on GDP growth, however contrary to that number of radios have no correlation with GDP growth. Following the research work of Hardy (1980), Norton (1992) concluded that investment in telecommunication is a significant predictor of GDP growth and telecommunication can be considered both as a "cause" and "effect" of GDP growth.

Majority of the studies carried out by different researchers using various proxy measures of ICT concluded that ICT is significantly impacting economic growth; however there are some studies like Grace, Kenny, and Qiang (2003) and Heeks (1999) which concluded that insignificant correlation exists between ICT and GDP growth. These researchers were of the opinion that adverse impacts may arise due to

the opportunity costs of investments and expenses in ICT that can be used for the development of education and health sector.

In addition to that, ICT can also be used to increase increases Foreign Direct Investment (FDI); effectively resulting in bridging the deficit caused by greater imports and fever exports. It has also been observed that international organizations are more willing to invest in those economies having well established information communication and technology infrastructure because of the following reasons:

- ICT increases organizations output using flexible organization structures
- ICT provides easy access to market and sale organization products in global and international markets (Grace, Kenny, and Qiang (2003))
- ICT infrastructure attract diversified portfolio and venture capital
- Increases market efficiency and effectiveness (i.e. improves market functioning and increases trade)
- Availability of information at low cost due to well distribution of market information

Khuong M.Vu (2011)by using Generalized Method of Moment (GMM) regression method concluded that although mobile phones and personal computers have significant impacts on GDP growth; however the effect of internet penetration on economic growth is greater than other indicators used in this study. His study was based on the panel data of 102 countries for the period 1996 to 2005 to establish the possible correlation between ICT indicators (Broadband Penetration, Mobile phone subscribers and Computers) and GDP growth.

GSM Association has recently hired the services of Deloitte to estimate the possible impact of mobile phones on GDP growth and they had published a report in 2016 concluding that 10% increase in mobile phone penetration would result in increasing annual GDP per capita growth rate by 0.65 percent, as earlier reported by Waverman, Meschi, and Fuss (2005). Qaing, Rosotto, and Kimura (2009) also supported the

above mentioned results concluding that if the mobile phone subscription increases, than GDP per capita grew by 0.6% for developed economies and 0.8 percent for developing economies which is in consistent with the results reported by Mishra (2013) and Lam (2010).

Sasi &Goiaed (2013) carried out a study for MENA countries to find the impact of financial development and ICT on GDP growth using dynamic panel model with system GMM estimators. They concluded that although financial development have negative impact and ICT have positive impact on GDP growth; the interaction between ICT diffusion and financial development was found positive and significant in the regression equation. They concluded that financial development benefits relating to economic growth can only obtained subject to the availability of minimum required ICT infrastructure.

Ishida, 2014, using autoregressive distributed lag (ARDL) bounds testing approach for period 1980 to 2010, recently provided evidence that ICT has not only long term relationship with economic growth but also significantly impact the energy demand function in Japan. Das, 2015 also recently examined the effect of information and communication technology (ICT) on the GDP growth of Indian economy for the period 1996 to 2005. Despite of the fact that ICT spillover effects have not been evenly distributed across the board due to the less availability of required ICT infrastructure, the study results advocate an increasing role of ICT investment in driving aggregate economic growth in India.

Hagsten, 2015 recently explored the correlation between information and communication technology (ICT) intensity in firms (using internet/broadband as proxy measure) and labour productivity across 14 European countries for the period 2001 to 2010. Using pooled OLS estimation based on approximately 400,000 observations in harmonized and representative data; the researcher concluded that there is a significant and positive correlation between the proportion of broadband internet-enabled employees and labour productivity in firms.

To summarize, ICT can be effectively used to increase GDP by using the different channels like providing right information at the right time to make right decisions, creating fresh employment opportunities, increasing revenue streams by bringing innovations in existing products and reducing costs by using efficient processes (with a special focus on intermediations costs) and providing greater access to markets. By using the branchless banking network, ICT can be effectively used to target remote areas in order to bring more and more people in the financial regulatory framework resulting in achieving financial inclusion targets. Based on the above literature review; following hypotheses are developed which will be tested by applying the appropriate research methodology:

- H1: There is positive and significant impact of ICT on economic growth for Asian countries.
- H2: There is positive and significant impact of investment in ICT on economic growth in Asian countries.
- H3: There is positive and significant impact of mobile phone penetration on economic growth in Asian countries.
- H4: There is positive and significant impact of internet users on economic growth in Asian countries.

Chapter 3

Data and Methodology

3.1 Data Description

Secondary annual data of the Asian countries has been collected and analyzed by using econometric techniques in order to measure the impact of ICT on economic growth. In order to increase the degrees of freedom, create greater variability and to correct the problem of omitted variables; we had used panel data which also allows the analysis of dynamic adjustments even with a short time series dimension attributes that cross-sectional or short time series data do not share. Currently there are 50 countries in the Asian pacific region out of which there are 7 seven countries whose secondary data was not available due to which this study have used the data of the following 43 countries:

Table: 3.1- Name of Selected Asian Countries

Afghanistan	Israel	Philippines
Armenia	Japan	Qatar
Azerbaijan	Jordan	Russia
Bahrain	Kazakhstan	Saudi Arabia
Bangladesh	Kuwait	Singapore
Bhutan	Kyrgyzstan	Sri Lanka
Brunei	Laos	Tajikistan
Cambodia	Lebanon	Thailand
China	Malaysia	Timor-Leste
Cyprus	Maldives	Turkey
Georgia	Mongolia	Uzbekistan
India	Myanmar (Burma)	Vietnam
Indonesia	Nepal	Yemen
Iran	Oman	
Iraq	Pakistan	

Note: Since the secondary data for some of the required indicators was not available in case of Syria, North Korea, South Korea, UAE, Palestine and Taiwan; so that's why this study have excluded these countries from the total population.

Since deployment of mobile phones schemes in majority of the Asian countries really began in the last decade, therefore this study period comprised from the year 2005 to 2015. Data was collected using the following sources:

- IMF data portal,
- World Bank data portal,
- ITU database
- Country Telecommunication Regulatory Authorities (like in case of Pakistan we will obtain the required data from PTA website)
- Country Central Bank database
- Other Publications

3.2 Variables

Based on literature review and secondary data analysis, the study is based on the following variables:

Table: 3.2 –Types of Variable and their proxy measures

Sr.	Type of Variable	Name of Variable	Proxy Measure
1	Dependent Variable	Economic Growth	Gross Domestic Product (GDP)
2	Independent Variable	Information Communication Technology (ICT)	ICT Investment Mobile Subscribers Internet Subscribers
3	Control Variables	Imports, Exports, Foreign Direct Investment (FDI)	

3.2.1 Information Communication Technology (Independent Variable)

Most of the empirical studies usestwo ways i.e. nonmonetary and monetary to represent the level of ICT development. Following those studies; teledensity (the number telephone subscribers and internet broadband subscribers per capita) was used to measure the ICT growth as a nonmonetary variable, and ICT investment per capita was used to measure the ICT growth as a monetary variable.

3.2.2 Economic Growth (Dependent Variable)

This study uses GDP per capita to measure the economic growth which is one of the most effective way to investigate the economic growth of a country validated by above literature review.

3.3 Methodology

Following the guidelines of Neo-classical Solow model discussed in literature review, the empirical model in this study is based on the research model used in the IMF working paper (2011).This study will try to establish the correlation between ICT and economic growth using a dynamic growth model(common effect) with GDP growth as dependent variable and ICT as independent variable. As mentioned above, this study uses panel data of 43 cross sections over a period of 11 years for determining the possible impact of ICT on economic growth.

The general regression equation can be written as follows:

$Y_{i,t} = \beta_o + \beta_1 * X + €_{i,t}$ ..... (1)

Generalized Method of Moments (GMM) estimator, developed by Arelano and Bover (1995) and Blundel and Bond (1998), is used in this study for measuring the impact of ICT on economic growth. The main reason for using GMM estimator for regression analysis is its superiority on other estimators (like first-difference GMM estimator) and due to its lower bais and higher efficiency on a small sample data (Soto, 2009). Based on above discussion, GMM estimator is suitable for estimating Equation (1) due to the following desired characteristics:

1. GMM estimatoris used for panel data analysis with ‘‘large N’’ and ‘‘small T’’, in which the relationship among the lagged explained variable and the error term may be significant. This characteristic of GMM is suitable for this exercise having the panel data of 43 countries for a period of 11 years (i.e. from 2005 to 2015).
2. With other fixed-effect panel estimators, GMM estimator consider the presence of country fixed effects, which is important for avoiding the omitted variable bias.

3. Error term ($€_{i,t}$) may have individual specific patterns of heteroscedasticity and serial correlation.

Based on above, the regression model equation (1) can be re-written as follows:

$$y_{i,t} = \beta_o + \beta_1 * y_{i,t-1} + \beta_2 * ICT_{i,t} + \beta_3 * X_{i,t} + €_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where as

- $Y_{i,t}$ is the growth in GDP per capita,
- $ICT_{i,t}$ will be measured by using growth per capita of three different proxy indicators i.e. mobile phone penetration, internet and Investment in ICT,
- $X_{i,t}$ is a vector of other independent variables which includes Imports, Exports, Foreign Direct Investment,
- € is error term,
- i and t represent country and time period respectively.

This study will start estimation with a set of variables determining economic growth i.e. the initial level of real GDP per capita, Imports, Exports, Foreign Direct Investment and other control variables such as national income per capita, inflation, government consumption, and institutional development.

Since we are using three different proxies to measure ICT, so following three different regression equations will be used for our detail analysis:

3.3.1 Measuring the effect of ICT on economic growth by using ICT Investment as proxy measure:

In order to measure the effect of ICT on economic growth by using ICT Investment as proxy measure, equation (2) can be written as follows:

$$y_{i,t} = \beta o + \beta_1 * y_{i,t-1} + \beta_2 * Investment_{i,t} + \beta_3 * X_{i,t} + \eta_i + €_{i,t}$$

$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$

Where as

- $Y_{i,t}$ is the growth in GDP per capita,
- $Investment_{i,t}$ is the growth in ICT investment per capita

- $X_{i,t}$ is a set of control variables comprising of exports and imports
- € is error term,
- i and t represent country and time period respectively.

3.3.2 Measuring the effect of ICT on economic growth by using mobile banking as proxy measure:

In order to measure the effect of ICT on economic growth by using mobile banking as proxy measure, equation (2) can be written as follows:

$$y_{i,t} = \beta o + \beta_1 * y_{i,t-1} + \beta_2 * \text{Mobile}_{i,t} + \beta_3 * X_{i,t} + \eta_i + €_{i,t} \quad \text{.....(4)}$$

Where as

- $Y_{i,t}$ is the growth in GDP per capita,
- $\text{Mobile}_{i,t}$ is the growth in mobile subscribers per capita
- $X_{i,t}$ is a set of control variables comprising of exports, imports and FDI
- € is error term,
- i and t represent country and time period respectively.

3.3.3 Measuring the effect of ICT on economic growth by using Internet as proxy measure:

In order to measure the effect of ICT on economic growth by using Internet as proxy measure, equation (2) can be written as follows:

$$y_{i,t} = \beta o + \beta_1 * y_{i,t-1} + \beta_2 * \text{Internet}_{i,t} + \beta_3 * X_{i,t} + \eta_i + €_{i,t}$$

.....(5)

Where as

- $Y_{i,t}$ is the growth in GDP per capita,
- $\text{Internet}_{i,t}$ is the growth in internet users per capita
- $X_{i,t}$ is a set of control variables comprising of exports and FDI
- € is error term,
- i and t represent country and time period respectively.

Chapter 4

Results and Discussion

4.1 Descriptive Statistics

Table 4.1 exhibits the descriptive statistical manners of the data for the period of 2005-2015. In the below mentioned table, GDP represents Gross Domestic Product per capita, FDI represents Foreign Direct Investment per capita, EXP represents Exports per capita, IMP represents imports per capita, MOB represents Mobile Subscriptions per capita, INT represents internet per capita and INVEST represents investment in ICT per capita.

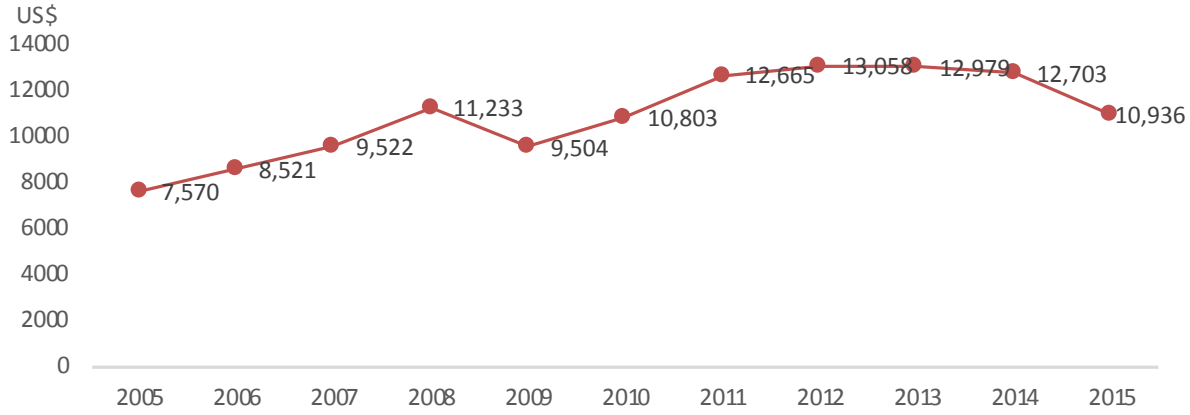
Table 4.1 – Descriptive Statistics

Variable	Observations	Mean	Median	Std Dev	Minimum	Maximum
GDP	472	10,862.90	3,725.37	16,316.23	239.81	94,944.09
FDI	473	611.46	101.66	2,637.88	39.80	43,921.40
EXP	438	8,166.37	1,768.01	18,506.83	46.41	121,292.11
IMP	438	5,543.02	1,624.11	13,094.94	40.32	96,258.83
MOB	473	0.85	0.84	0.45	0.003	2.13
INT	471	29.16	20.10	24.91	0.07	93.48
INVEST	238	19.35	12.45	20.67	0.12	130.17

The above mentioned table suggests that the average GDP for all the Asian countries between 2005 and 2015 was US$ 10,863 per capita. As illustrated by the following graph, there is a constant rise in the GDP between the years 2005 to 2008 before the economic recession of 2008 took place. The effect of the recession can also be seen in the year 2008 to 2009 when the GDP fell from US$ 11,233 to US$ 9,503 per capita before starting to rise again from the year 2009 to 2010. The standard

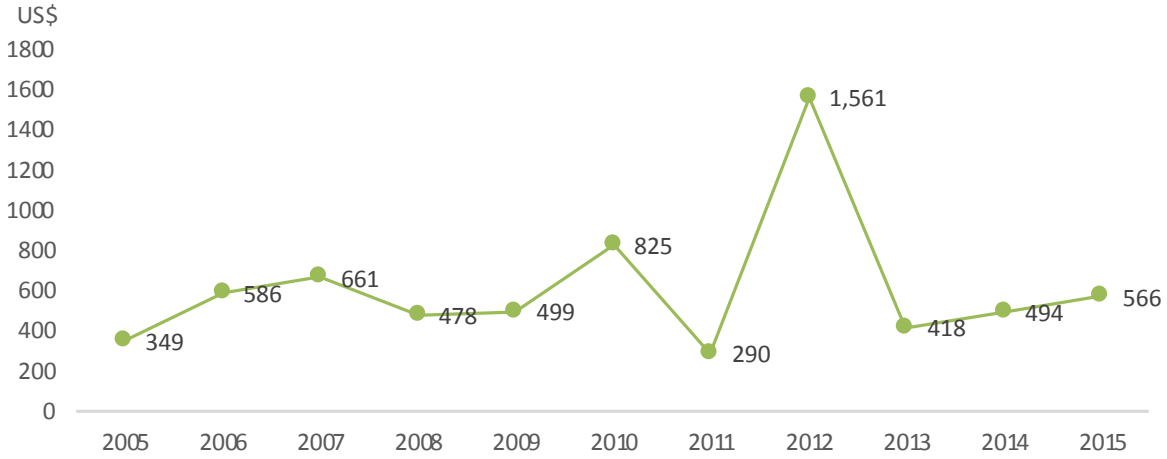
deviation/variation in the GDP between the periods 2005 to 2016 was US$ 16,316 per capita. In addition to that, this is also pertinent to mention here that the minimum GDP in the study period was of Myanmar (Burma) recorded at US$ 240 per capita while the highest was that of Qatar which was recorded at US$ 94,944 per capita.

Figure 4.1 - Average GDP per capita



Similarly average foreign direct investment for all the Asian countries between 2005 and 2015 is US$ 611.4 per capita. There is a general rise in the foreign direct investment between 2005 and 2015 with standard deviation in FDIof approximately US$ 2637.87 per capita. In addition to that, minimum foreign direct investment in this period was recorded of Yemen which had a negative FDI of US$ 10,675 per capita while the highest FDI was also recorded by Cyprus in the year 2012 when it had an FDI of US$ 4,241

Figure 4.2 - Average FDI per capita

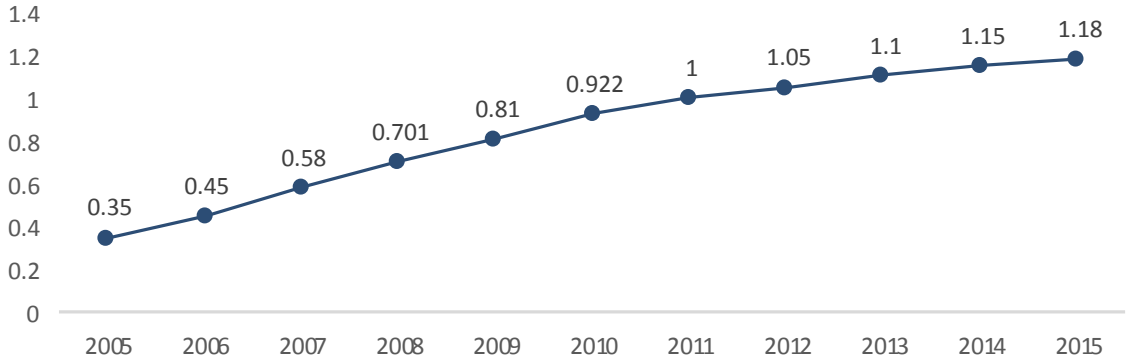


As far as export and imports are concerned, the average exports and imports for all the Asian countries between the years 2005 to 2015 remained at US$ 8,166 and 5,543 per capita. The export numbers show a constant growth from 2005 till 2012 where exports were at their peak at US$ 10357, thereafter exports fell continuously till 2015. The minimum export recorded was US$ 46.40 per capita by Afghanistan and the maximum export was of US$ 121,292per capita by Singapore. On the other hand, Imports grew on a constant basis from 2005-2014 where they peaked at US$ 6671.5 per capita before falling to US$ 5861 per capita in the year 2015.

Figure 4.3 - Average Exports and Imports per capita

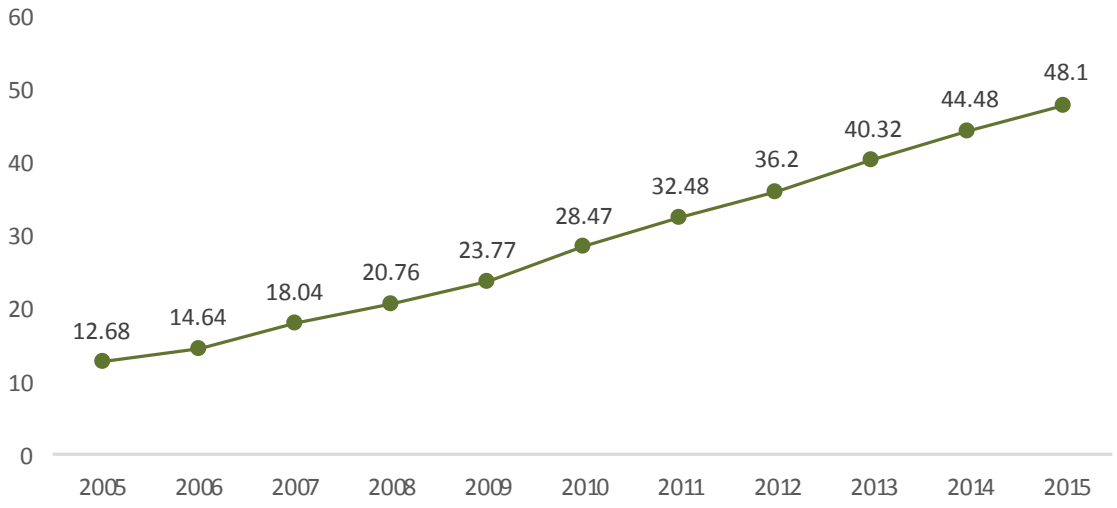
The number of mobile subscriptions showed a constant and significant growth in the period 2005 to 2015 rising from 0.35 to 1.18 mobile per user which was fueled by improved technology and lower costs as shown by the figure 4.4:

Figure 4.4 - Average Mobile Subscriptions per capita



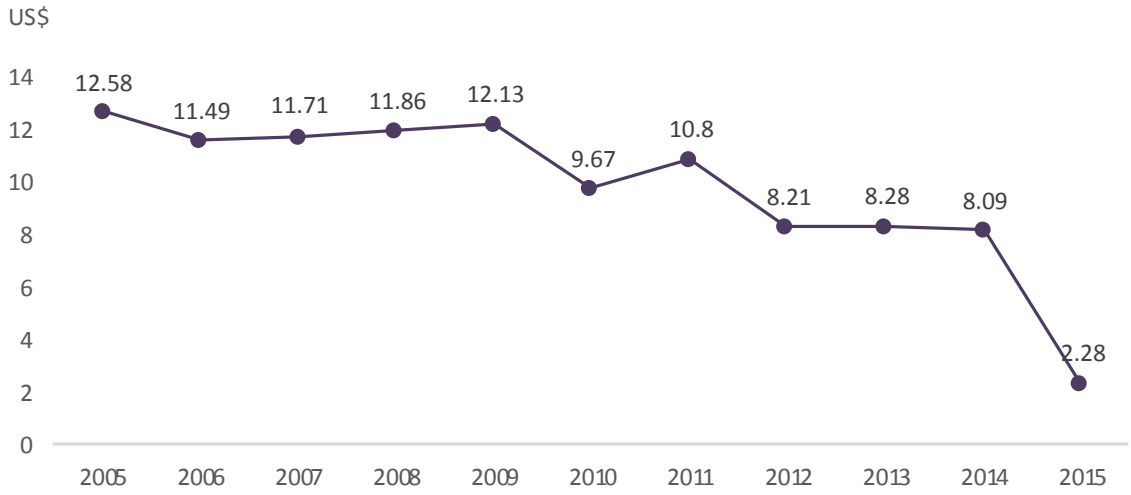
The number of Internet connections in the Asian countries during the year 2005 to 2015 witnessed a constant and a significant increase from 12.68% in 2005 to 48.1% in 2015 as shown by the figure 4.5. This can be attributed to evolving technology and significant reduction in internet costs during the decade.

Figure 4.5 - Average Internet users as % of total population



Investment in Telecom witnessed a constant decrease throughout the decade from 2005 to 2015. The average investment in telecom during these years was US$ 19.3 per capita having a standard deviation of US$ 20.6 per capita as shown by figure 4.6:

Figure 4.6 - Average ICT Investment per capita



4.2 Correlation Analysis

In order to check the relationship between dependent and independent variables, we had performed the following correlation analysis:

Table 4.3 – Correlation Analysis

	GDP	FDI	IMP	EXP	MOB	INT	INV
GDP	1.000000						
FDI	0.119168	1.000000					
IMP	0.714824	0.096019	1.000000				
EXP	0.776650	0.097179	0.725299	1.000000			
MOB	0.317968	0.017340	0.288213	0.274074	1.000000		
INT	0.073061	-0.047679	0.054052	0.130064	0.176217	1.000000	
INV	0.091547	0.009533	0.170522	0.027161	0.219776	-0.052772	1.000000

As shown by the above mentioned table, there exists overall weak positive correlation between our variables of interest/independent variables and the dependent variable. Mobile subscriptions is positively correlated with GDP having a coefficient of 0.3180 which means that GPD will increase when mobile subscribers increases. Similarly Use of ATM, Use of Internet and ICT Investment is positively correlated with GDP with coefficients of only 0.0487, 0.0731 and 0.0915 which means that they are not significantly correlated with our dependent variable. In addition to that, this is also pertinent to mention here that control variables (i.e. Exports, National Income, Imports and Foreign Direct Investment) have significant positive correlation with GDP; however the significant positive correlation of control variables is due to fact that these are the variables which effectively constitutes GDP.

4.3 Regression Analysis

In order to validate/confirm the hypothesis build through detailed literature review, we have performed the regression analysis (a statistical technique) for estimating the correlation between dependent and independent variables. Before starting our

regression analysis, we have to ensure that following necessary conditions of regression must be satisfied:

- The data must be stationary by applying the Unit Root Test
- Variables should not be correlated which can be checked by applying the Multi Collinearity Test
- There should be no relationship between error term and lag error term i.e. Auto correlation does not exits which can analyzed through Durbin Watson test value.

4.3.1 Unit Root Test:

Before doing anything, first of all we can check the stationary status of all variables by using Unit Root Test. By applying that test, we conclude that all the variables are stationary as shown by the table4.2:

Table 4.2– Unit Root Test Results

Variable Name	Statistics	Prob.
GDP	-5.40613	0.0000
FDI	-10.5321	0.0000
EXP	-16.6247	0.0000
IMP	-10.4982	0.0000
NI	-6.69389	0.0000
MOB	-9.61609	0.0000
ATM	-10.7889	0.0000
INT	-29.9825	0.0000
INVEST	-74.0188	0.0000

4.3.2 Auto Correlation:

Since the value of Durbin-Watson stat is 2.06 by applying the regression analysis as shown by the table 4.4, we conclude that problem of Auto-Correlation does not exists i.e.there is no relationship between error term and lag error term.

Since we are using three different proxies to measure ICT as shown by the equation 3 to 5, we can apply the regression separately in order to validate the hypothesis.

4.3.3 Regression Model 1 (Impact of ICT on GDP by using ICT investment as proxy measure of ICT)

In order to measure the effect of ICT on economic growth by using ICT Investment as proxy measure, we have used the above mentioned equation (3) to apply regression in order to determine the possible relationship between GDP and Investment in ICT. By incorporating the control variables, equation (3) can be re-written as follows:

$$GDP_{i,t} = \beta_o + \beta_1 * GDP_{i,t-1} + \beta_2 * Investment_{i,t} + \beta_3 * EXP_{i,t} + \beta_4 * IMP_{i,t} + €_{i,t} \quad \text{.....(6)}$$

Table 4.4shows the regression results which shows that Adjusted R^2 is 0.73 which means that 73% variation in dependent variables was explained by the variable of interest and the control variables.

Table 4.4 - Results of Regression Model 1				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024789	0.007319	3.386964	0.0009
GDP(-1)	0.113723	0.041760	2.723241	0.0071
INV	0.004120	0.001073	3.840930	0.0002
EXP	0.419461	0.040555	10.34307	0.0000
IMP	0.212891	0.044334	4.802026	0.0000
R-squared	0.731981	Mean dependent var		0.081576
Adjusted R-squared	0.725992	S.D. dependent var		0.141503
S.E. of regression	0.074071	Sum squared resid		0.982087
Durbin-Watson stat	2.064892	J-statistic		1.324334
Instrument rank	8	Prob(J-statistic)		0.723363

The above results shows that all the above mentioned variables have positive significant impact on the GDP growth in Asian countries; specifically our variable of interest i.e. ICT Investment is significant, which means that increase in investment in ICT will result in the growth of GDP in Asian countries. The ICT Investment coefficient value is 0.004 having t-statistics of 3.84 means that increase in the ICT Investment will result in the increase of GDP growth by 0.004 which is in consistent with the results reported by earlier studies such as (Das, 2015), (Hazuki Ishida, 2014), (Jason Dedrick, 2011), (Vecchi, 2005) and (Hwan-Joo Seo, 2009). Although the recent study conducted Mr. Das in India concluded that ICT spillover effects have not been evenly distributed across the board due to the less availability of required ICT infrastructure recommending an increasing role of ICT investment in driving aggregate economic growth; however another study conducted by Hazuki Ishida in Japan provided strong evidence that ICT has not only long term relationship with economic growth but also significantly impact the energy demand function in Japan. Similarly a recent study reported by Personal Computing Industry Center (PCIC) once again supported our hypothesis that developing countries have achieved significant productivity gains from ICT investment in the more recent period as they have increased their IT capital stocks and gained experience with the use of ICT. Vecchi, 2005 studied the industry data of USA and UK using a dynamic panel data estimation

method yielded a positive and significant effect of ICT Investment on output growth. As far as control variables which includes Imports and Exports are concerned, all the control variables are significantly impacting the GDP growth having positive coefficients.

Based on the above regression results, equation (8) can be re-written as follows:

$GDP_{i,t} = \beta o + 0.11 * GDPi_{,t-1} + 0.004 * Investment_{i,t} + 0.42 * EXP_{i,t} + 0.21 * IMP + €_{i,t}$ .....(7)

4.3.4 Regression Model 2 (Impact of ICT on GDP by using mobile subscribers as proxy measure of ICT)

In order to measure the effect of ICT on economic growth by using mobile banking as proxy measure, we have used the above mentioned equation (4) to apply regression in order to determine the possible relationship between GDP and Mobile Subscriptions. By incorporating the control variables, equation (4) can be re-written as follows:

$GDP_{i,t} = \beta o + \beta_1 * GDPi_{,t-1} + \beta_2 * Mobile_{i,t} + \beta_3 * EXP_{i,t} + \beta_4 * IMP_{i,t} + \beta_5 * FDI_{i,t} + €_{i,t}$ .....(8)

Table 4.5 shows the regression results which shows that Adjusted R^2 is .56 which means that 56% variation in dependent variables was explained by the variable of interest and the control variables.

Table 4.5 - Results of Regression Model 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.026537	0.006828	3.886795	0.0001
GDP (-1)	0.159436	0.039092	4.078467	0.0001
MOB	0.029899	0.017452	1.713237	0.0875
EXP	0.296868	0.033303	8.914064	0.0000
IMP	0.173098	0.036875	4.694164	0.0000
FDI	0.001374	0.000477	2.881783	0.0042
R-squared	0.563477	Mean dependent var		0.075112
Adjusted R-squared	0.557276	S.D. dependent var		0.144786

S.E. of regression	0.096337	Sum squared resid	3.266831
Durbin-Watson stat	1.873296	J-statistic	7.692708
Instrument rank	10	Prob (J-statistic)	0.103506

The above results shows that all the above mentioned variables have positive significant impact on the GDP growth in Asian countries; specifically our variable of interest i.e. mobile subscription is significant, which means that increase in number of mobile usage will result in the growth of GDP in Asian countries. The mobile subscription coefficient value is 0.03 having t-statistics of 1.71 means that increase in the mobile subscription will result in the increase of GDP growth by 0.03 which is in consistent with the results reported by earlier studies such as (IMF, 2011), (Khuong M.Vu, 2011) and (Yiheyis, 2014). Yiheyis by using panel data of 36 African countries finds evidence that supports our hypothesis that increased mobile penetration contributes to the growth rate of real gross domestic product (GDP). Similarly the recent working papers issued by International Monetary Fund (IMF) clearly established a link between ICT penetration and economic growth by using GMM method on a panel data of 44 African countries which effectively concluded that that ICT penetration has positive effects on economic growth. As far as control variables which includes Foreign Direct Investment, Imports and Exports are concerned, all the control variables are significantly impacting the GDP growth having positive coefficients which is is consistent with the previous studies.

Based on the above regression results, equation (7) can be re-written as follows:

$GDP_{i,t} = \beta o + 0.16 * GDPi_{,t-1} + 0.03 * Mobile_{i,t} + .30 * EXP_{i,t} + 0.17 * IMP_{i,t} + 0.001 * FDI_{i,t} + €_{i,t}$ .....(9)

4.3.5 Regression Model 3 (Impact of ICT on GDP by using Internet as proxy measure of ICT)

In order to measure the effect of ICT on economic growth by using Internet as proxy measure, we have used the above mentioned equation (5) to apply regression in order

to determine the possible relationship between GDP and Internet. By incorporating the control variables, equation (5) can be re-written as follows:

$$GDP_{i,t} = \beta o + \beta_1 * GDPi_{,t-1} + \beta_2 * Internet_{i,t} + \beta_3 * EXP_{i,t} + \beta_4 * FDI_{i,t} + \epsilon_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

Table 4.6 shows the regression results which shows that Adjusted R^2 is 0.52 which means that 52% variation in dependent variables was explained by the variable of interest and the control variables.

Table 4.6 - Results of Regression Model 3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.027638	0.007249	3.812520	0.0002
GDPG(-1)	0.216043	0.039387	5.485157	0.0000
INTG	0.016972	0.010580	1.604078	0.1096
FDIG	0.001475	0.000494	2.986748	0.0030
EXPG	0.400466	0.022881	17.50228	0.0000
R-squared	0.524248	Mean dependent var		0.075900
Adjusted R-squared	0.518902	S.D. dependent var		0.144723
S.E. of regression	0.100382	Sum squared resid		3.587233
Durbin-Watson stat	1.942000	J-statistic		4.03E-29

The above results shows that all the above mentioned variables have positive significant impact on the GDP growth in Asian countries; specifically our variable of interest i.e. Internet is significant, which means that increase in internet user will result in the growth of GDP in Asian countries. The Internet coefficient value is 0.02 having t-statistics of 1.60 means that increase in the internet users will result in the increase of GDP growth by 0.02 which is in consistent with other studies like (Hagsten, 2015), (Katz, 2012), (Khuong M.Vu, 2011) and (Koutroumpis, 2009). The most recent study conducted by Eva Hagsten to determine the relationship between ICT intensity in firms and labour productivity across 14 European countries for the period 2001 to 2010 concluded that there is a significant and positive relationship between the proportion of broadband internet-enabled employees and labour productivity in firms. Another study conducted by (Koutroumpis, 2009)to investigate

broadband penetration affects on economic growth using a macroeconomic production function with a micro-model for broadband investment on the data of 22 OECD countries indicate a significant causal positive link especially when a critical mass of infrastructure is present. As far as control variables which includes Foreign Direct Investment and Exports are concerned, all the control variables are significantly impacting the GDP growth having positive coefficients.

Based on the above regression results, equation (10) can be re-written as follows:

$$GDP_{i,t} = \beta o + 0.22 * GDPi_{,t-1} + 0.02 * Internet_{i,t} + 0.40 * EXP_{i,t} + 0.001 * FDI_{i,t} + €_{i,t} \quad \text{.....(11)}$$

Chapter 5

Conclusion and Recommendations

During the early 1990s, ICT revolution has rapidly penetrated across nations and change the way people communicate, work, and live by achieving rapid quantum progress in the speed, scope, intensity, quality of access to information, knowledge dissemination and communications. Since these powerful impacts of ICT are substantially impact the economic growth in numerous way; this study investigated the impact of ICT development on economic growth, considering Asian countries for the period 2005 to 2015. Focusing on the role of mobile phone development, use of internet and investment in ICT; this study provided empirical evidence that Information Communication Technology (ICT) is positively and significantly impacting economic growth in Asian Countries.

Using a standard System GMM estimator to address endogeneity issues, the results of the estimations reveal that ICT development (using the penetration rates of mobile subscribers, internet users and investment in ICT as proxy measures) significantly contribute to economic growth in Asian Countries; thereby confirming/validating the hypothesis build during literature review. Though the branchless banking is recently started in a majority of Asian countries, it was observed that the combined impact of financial inclusion and mobile phone penetration on economic growth is strongerin countries where such financial services are available. This is also pertinent to mention here that since most of relevant research from both macroeconomic and microeconomic perspective has been conducted only in developed nations; this study had added the impact of ICT on economic growth for developing countries in the existing literature.

Based on the above mentioned detailed analysis in Chapter 4, we concluded that increase in the mobile subscription will result in the increase of GDP growth by 0.03

which is in consistent with the results reported by earlier studies such as (IMF, 2011), (Khuong M.Vu, 2011) and (Yiheyis, 2014).The findings of this study underline the importance of ICT development, in particular mobile phone rollout, for Asian countries as a source of growth, and the potential of ICT to improve financial inclusion, which itself benefits growth. Following the significant increase in ICT infrastructure throughout the world, rapid technological dissemination and innovations along with significant price decline of ICT equipment have also been observed in OECD countries (OECD, 2003). The positive effects of ICTs on economic growth have not only been confirmed by many members of the OECD but also by the European Union (Edquist & Henrekson, 2004; Hanclova, Doucek, Fischer & Vltavska, 2015; Falk & Biag, 2015). Our hypothesis was also supported by the study carried out by Ding and Haynes in 2004 to investigate the role of telecommunication infrastructure on long run economic growth in China for a sample of 29 regions for the period from 1986-2002. They had also find positive and significant impact of teledensity and the percentage of telecom sector investment in GDP on economic growth which is consistent with the results reported by this study.

In addition to that we have also concluded that increase in the ICT Investment (having coefficient value of 0.004 and t-statistics of 3.84) will result in the increase of GDP growth by 0.004 which is in consistent with the results reported by earlier studies such as (Das, 2015), (Hazuki Ishida, 2014), (Jason Dedrick, 2011), (Vecchi, 2005) and (Hwan-Joo Seo, 2009).However this is also pertinent to mention here that developing countries only began to realize measurable payoffs from ICT investment when they have some critical level of IT capital stock or some minimum level of accumulated experience (human capital) required for such gains to become evident (Triplett and Bosworth, 2002). We have also concluded that increase in the internet users will result in the increase of GDP growth by 0.02 which is in consistent with other studies like (Hagsten, 2015), (Katz, 2012), (Khuong M.Vu, 2011) and (Koutroumpis, 2009).

Based on above mentioned finding, conclusion and as suggested by Kiski and Pohjoola (2001) and Dewan et al (2010); Asian countries should consider policies and

strategies to create "clusters" of interconnected ICT technologies for creating significant impact in places such as universities, colleges, libraries or community centers rather than just endorsing a single technology. Also; in order to improve the ICT infrastructure to obtain significant economic gains, ICT equipment's (like computers, laptops, internet devices) should be subsidized and specific training institutes for providing the required training to effectively use and operate ICT equipment should be created under public private partnerships.

References

Africa, I. i.-C. (2006). Chowdhury, Shyamal. Journal of International Development, Vol. 18.

Andrianaivo, M., & Kpodar, K. (2011). ICT, financial inclusion, and growth: Evidence from African countries. IMF Working Paper, WP/11/73.

Aportela, Francisco. 1999. "Effects of Financial Access on Savings by Low-Income People." Working paper, MIT, Cambridge, MA.

Bångens L and Söderberg, B. (2008), Mobile Banking –Financial Services for the Unbanked?, ISBN: 978-91-85991-01-3, http://www.spidercenter.org/files/m-banking_study.pdf accessed on 02/01/201.1.

Barro, Robert J., (1991), ―Economic Growth in a Cross Section of Countries, The Quarterly Journal of Economics, 106(2), pp. 407–43.

Bagozzi, R.P. (2007): "The legacy of the technology acceptance model and a proposal for a paradigm shift." Journal of the Association for Information Systems

Beck, Thorsten, Asli Demirguc-Kunt, and Maria Soledad Martinez Peria, (2007), ―Reaching Out: Access to and Use of Banking Services Across Countries,‖ Journal of Financial Economics, 85(1), pp. 234–66.

Beck, T, and Laeven, L. (2008) Resolution of Failed Banks by Deposit Insurers: Cross-Country Evidence. In: Demirguc-Kunt, A., Kane, E. and Laeven, L. (eds), Deposit Insurance around the World, Issues of Design and Implementation, Cambridge, MA: MIT Press.

Berg, L. G. (2000). Telecommunications liberalization and regulatory governance: lessons from Latin America. *Telecommunications Policy*, vol. 24, issue 10-11, 865-884.

Best Ogawara, Jason and Pete (2002) Mobile Commerce', Journal of Internet Commerce, 1: 3, 29 -41.

Bollou, F. (2006). ICT infrastructure expansion in sub-Saharan Africa: An analysis of six West African countries from 1995 to 2002. Electronic Journal on Information Systems in Developing Countries, 26, 1–16.

Brown, I., Z. Cajee,, D. Davies and S. Stroebel, (2003), Cell phone banking: Predictors of adoption in South Africa—An exploratory study. International Journal of Information Management, 23(5), 381-394. doi: 10.1016/S0268-4012(03)00065-3.

CGAP. (2006). Mobile Phone Banking and Low-Income Customers Evidence from South Africa. Retrieved from: http://www.globalproblems-globalsolutionsfiles.org/unf_website/PDF.

BASA (2003). Financial Sector Charter. Retrieved from: http://www.banking.org.za/our_industry/financial_sector_charter/financial_sector_charter.asp.

Chuttur, M.Y. (2009), Overview of the Technology Acceptance Model: Origins, Developments and Future Directions: Indiana University, USA,

Cheney, Julia S. (2008), An Examination of Mobile Banking and Mobile Payments: Building Adoption as Experience Goods? Discussion paper, the Federal Reserve System, USA http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1266809 accessed on 25/12/2010.

Cronin, F. J., Parker, E. B., Colleran, E. K., & Gold,M. A. (1993). Telecommunications infrastructure investment and economic development. Telecommunications Policy, 17, 415–430.

Das, A. A. (2015). Information and communication technology and economic growth in India. Telecommunications Policy.

Davis, F. D. (1989): "Perceived usefulness, perceived ease of use, and user acceptance of information technology": MIS Quarterly

Degryse, Hans and Steven Ongena. 2005. "Distance, Lending Relationships, and Competition". The Journal of Finance, Vol. 60, No. 1 Page 231 of 231-266.

Demirgüç-Kunt, A., and Kane, E. (2002) Deposit insurance around the globe: Where does it work? Journal of Economic Literature 60, 175-95.

Dholakia, R. R., & Harlam, B. (1994). Telecommunications and economic development. Telecommunications Policy, 18, 470–477.

Djankov, Simeon, Pedro Miranda, Enrique Seira and Sharma Siddharth. 2008. "Who Are the Unbanked?" World Bank Policy Research Working Paper 4647.

Donne and Telleze, (2008), Mobile banking and economic development: Linking adoption, impact, and use, Asian Journal of Communication Vol. 18, No. 4, December 2008, 318-332.

Falk, M. &. (2015). Empirical Studies on the Impacts of ICT Usage in Europe. Institute for Prospective Technological Studies Digital Economy Working Paper , 14.

Fielding, D. (2002). Health and wealth: A structural model of social and economic development. Review of Development Economics, 6(3), 393–414.

Hagsten, E. (2015). Broadband connected employees and labour productivity: a comparative analysis of 14 European countries based on distributed Microdata access. Economics of Innovation and New Technology.

Hazuki Ishida, K. H.-i.-d. (2014). The effect of ICT development on economic growth and energy. Telematics and Informatics.

Henrekson, H. E. (2004). Swedish Lessons: How Important are ICT and. Research Institute of Industrial Economics.

Hwan-Joo Seo, Y. S. (2009). Does ICT investment widen the growth gap? Telecommunications Policy.

IMF. (2011). ICT, Financial Inclusion, and Growth: Evidence from African Countries. IMF Working Paper.

Jason Dedrick, K. L. (2011). IT and Productivity in Developed and Developing Countries. Personal Computing Industry Center (PCIC).

Jana Hanclova, P. D. (2015). Does ICT capital affect economic growth in the EU-15 and EU-12 countries? Journal of Business Economics and Management, Vol. 16, issue 2, 387-406.

Jensen. (2007). The digital provide: Information (technology), market performance, and welfare in the South Indian fisheries sector. Quarterly Journal of Economics, 122.

Jukka, J., & Pohjola, M. (2002). Economic growth in the new economy: Evidence from advanced economies. Information Economics and Policy, 14, 189–210.

Jorgenson, K. V. (2005). Information Technology and the World Economy. Journal of Economics.

Katz, D. R. (2012). Impact of broadband on the economy. International Telecommunication Union (ITU).

Khuong M.Vu, S. (2011). ICT as a source of economic growth in the information age: Empirical evidence from the 1996–2005 period. Telecommunications Policy, 35.

Kneller, R. (2005). Frontier technology, absorptive capacity and distance. Oxford Bulletin of Economics and Statistics, 67(1), 1–23.

Kraemer, S. D. (2000). Information Technology and Productivity: Evidence from Country-Level Data. Management Science.

Koutroumpis, P. (2009). The economic impact of broadband on growth: A simultaneous approach. Telecommunications Policy.

Lamberton, D. M. (2001). An information infrastructure for development. Prometheus, 19, 223–230.

Lee, K.S., H.S. Lee and S.Y. Kim(2007), Factors influencing the adoption behaviour of mobile banking: a South Korean perspective. Journal of Internet Banking and Commerce, 12(2).

Madon, S. (2000). The Internet and socio-economic development: Exploring the interaction. Information Technology and People, 13(2), 85–101.

Mansell, R. (1999). Information and communication technologies for development: Assessing the potential and risk. Telecommunications Policy, 23(1), 35–50.

Naidoo, S. (2011), No frills, no action, big headache. Financial Mail. Retrieved May 29, 2011 from http://www.fm.co.za/Article.aspx?id=132000.

Niebel, T. (2014). ICT and Economic Growth - Comparing Developing, Emerging and Developed Countries. IARIW 33rd General Conference. Rotterdam, the Netherlands.

Nwagwu, W. (2005). Deficits in the visibility of African scientists: Implications for developing information and communication technology (ICT) capacity. World Review of Science, Technology and Sustainable Development, 2, 244–260.

Petersen, Mitchell A. and Raghuram G. Rajan. 2002. "Does Distance Still Matter? The Information Revolution in Small Business Lending". Journal of Finance, Vol. 57, No. 6 (Dec., 2002), pp. 2533-2570.

Pohjola, M. (2001). Information technology, productivity, and economic growth: International evidence and implications for economic development. London: Oxford University Press.

Piatkowski, B. v. (2004). Productivity, innovation and ICT in Old and New Europe. International Economics and Economics Policy.

Roller L.H.,&Waverman, L. (2001). Telecommunications infrastructure and economic development: a simultaneous approach. American Economic Review, 91, 909–923.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, Vol. 70, No. 1, pp. 65-94.

Stiroh, K. J. (2002). Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say? AMERICAN ECONOMIC REVIEW, VOL. 92, NO. 5, pp. 1559-1576.

Swan, T. W. (1956). Economic growth and capital accumulation. Economics Records.

Tait, G. a. (2003). The future of open and distance learning. Proceedings of the 10th International Conference on Open and Distance. England.

Thorsten Beck, A. D.-K. (2007). Barriers to Bank Access and Use Around the World. World Bank.

Tiwari, and Buse, (2007), The mobile Commerce prospects: A strategic Analysis of Opportunities in the Banking Sector, Hamburger University Press. (E-Book) pp.73-74.

Vecchi, M. O. (2005). Quantifying the Impact of ICT Capital on Output. Economica.
Venkatesh, V. (2000), "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model", Information systems research.

Waverman, L.-H. R. (2001). Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. AMERICAN ECONOMIC REVIEW, VOL. 91, NO. 4, pp. 909-923.

Walker, M.R. (2004), Factors affecting the adoption of mobile banking service in retail banking South Africa. (Unpublished master's thesis). Pretoria: University of Pretoria (GIBS).

Waverman, M. a. (2005). The impact of telecoms on economic growth in developing countries. The Vodafone Policy Paper.W.W.Sharkey, F. J. (2000). Competition, universal service and telecommunications policy in developing countries. Information Economics and Policy.

Younghwa Lee, K. A. (2003). The Technology Acceptance Model: Past, Present, and Future. Communications of the Association for Information Systems.
Yiheyis, E. C. (2014). Mobile Telephony and Economic Growth. Wiley Online Library.

Annexure

Table 3.3 – Variables Definition and Source		
Variables	**Definition**	**Source**
Gross Domestic Product (GDP)	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank Data Portal, World Development Indicators, IMF Database and International Financial Statistics
Foreign direct investment (FDI)	Foreign direct investment refers to direct investment equity flows in the reporting economy. It is the sum of equity capital, reinvestment of earnings, and other capital. Direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. Ownership of 10 percent or more of the ordinary shares of voting	World Bank Data Portal, World Development Indicators and International Financial Statistics

	stock is the criterion for determining the existence of a direct investment relationship.	
Exports of goods, services and primary income	Exports of goods, services and primary income is the sum of goods exports, service exports and primary income receipts.	World Bank Data Portal, World Development Indicators and International Financial Statistics
Imports of goods and services	Imports of goods and services comprise all transactions between residents of a country and the rest of the world involving a change of ownership from non-residents to residents of general merchandise, nonmonetary gold, and services.	
Net national income per capita	National income is gross national income minus consumption of fixed capital and natural resources depletion.	World Bank Data Portal
Population	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.	World Bank Data Portal
Investment in telecoms with	Investment in telecom projects with private participation covers	International Telecommunication Union, IMF Database,

private participation	infrastructure projects in telecommunications that have reached financial closure and directly or indirectly serve the public. The types of projects included are operations and management contracts, operations and management contracts with major capital expenditure, greenfield projects (in which a private entity or a public-private joint venture builds and operates a new facility), and divestitures.	World Bank Data Portal and Country Telecommunication Regulatory Authorities
ATM	Automated teller machines are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place.	World Bank Data Portal, World Development Indicators and IMF Database
Mobile cellular subscriptions	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the Public Switched Telephone Network (PSTN) using cellular technology. The indicator	International Telecommunication Union and Country Telecommunication Regulatory Authorities

	includes the number of post-paid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services.	
Internet	Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.	World Bank Data Portal, International Telecommunication Union and IMF Database
GDP per capita	GDP divided by total population	
Mobile subscribers per head	Mobile telephone subscribers divided by total population	
ATMs per head	The ratio of ATMS subscribers to total population	

Internet per head	Internet users divided by total population
ICT Investment per head	ICT Investment divided by total population