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Degree of Master of International Studies
(International Area Studies)

**Contribution of ICT to Economic Growth: Focusing
on Financial Services in Rwanda from 2011 to 2015**

August 2018

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Contribution of ICT to Economic Growth: Focusing on Financial Services in Rwanda from 2011 to 2015

A thesis presented

By

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Seoul National University

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ABSTRACT

Contribution of ICT to Economic Growth: Focusing on Financial Services in Rwanda from 2011 to 2015

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This dissertation examines the contribution of ICT through financial deepening to Rwanda's economic growth. The Ordinary Least Squares (OLS) regression and distributed lag models were used to test the hypothesis. A researcher used the GDP per capita growth as a proxy of economic growth; the value of ATM transactions and mobile banking are a proxy of ICT in financial services.

This study found a significant relationship between ICT use in financial services and financial deepening. Although the evidences indicated the emergence of ICT penetration in financial services, the result of this study did not approve the significant contribution of ICT to Rwanda's economic growth. Analysis showed

that ICT in financial services is mostly directed to consumption rather than productivity and investment.

The major implication of this study is the potential benefit that Rwanda would grasp in terms of economic growth, if more attention is given to ICT in financial services policy reform. The study recommended some policies to encourage the use of ICT in more productive activities. Those policies will link ICT to financial deepening and economic growth.

Key Words: Rwanda's economic growth, ICT, financial deepening.

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ABBREVIATIONS AND ACRONYMS

| | |
|------------------|--------------------------------------------------------|
| AFR | : Access to Finance Rwanda |
| ATM | : Automated Teller Machine |
| BNR | : National Bank of Rwanda |
| EDPRS | : Economic Development and Poverty Reduction Strategy |
| FDIP | : Financial and Digital Inclusion Project |
| Frw | : Rwandan Francs |
| GoR | : Government of Rwanda |
| ICT | : Information and Communication Technology |
| IMF | : International Monetary Fund |
| ITU | : International Telecommunication Union |
| MDGs | : Millennium Development Goals |
| MINECOFIN | : Ministry of Economic Planning and Finance |
| MYICT | : Ministry of Youth and ICT |
| NICI: | : National Information Communication Infrastructure |
| NISR | : National Institute of Statistics of Rwanda |
| OECD | : Organization of Economic Cooperation and Development |
| WDI | : World Development Indicators |

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CHAPTER ONE: GENERAL INTRODUCTION

1.1. Background of the study

Evidences have shown that the level of accessing to financial services is low in developing countries. For example, the World Bank reported that “a half of the adult population in the world does not own an account at a formal financial institution” (World Bank, 2014). Challenges in developing countries are about building a more inclusive financial sector that can stimulate economic growth. Some of them are barriers to account-opening, costs, distance to and from financial service provider, long process of services and the way the supply of such services is organized. However, based on best practices of developed countries, those barriers can be removed by introducing the ICT in financial services.

In tackling barriers that exclude people in using financial services, ICT and digitizing financial services can play a big role. By enabling innovative business models, digital technologies can help to connect more people to financial services

at lower costs including those living in rural and remote areas, by helping them to manage their financial lives and ultimately, getting a pathway out of poverty.

On demand side, ICT cuts the costs of financial transaction especially those of accessing to physical banking system. For instance, “the expansion of mobile telephone may generate the easier access to financial services to previously underserved individuals in developing countries” (Andrianaivo & Kpodar, 2011). In this way, the introduction of mobile payment in developing countries can boost branchless financial services. On the supply side, the adoption of ICT in banks can lead to improvement in service delivery, more efficient and competitive market.

1.2. Statement of the problem

In Rwanda, a big number of people are still excluded from financial services. A study showed that 0.7 million (i.e. 11% of population) were not using any financial service or product in 2015. Simply, they were financially excluded (AFR, 2016). However, the levels of exclusion vary considerably across the country from 22% in rural districts to 3% in the Capital City (Kigali). Although some improvements have been made over last six years, the barriers to financial services are still present.

For example, a time taken to reach to a financial institution is still long. The average time taken to reach to a bank branch is 53:30 minutes; 53:37 minutes to ATMs and 31:00 minutes to mobile money agent (AFR, 2016). Among other solutions, the usage of ICT such as mobile payment, mobile banking and electronic payment such as debit and credit cards plays a role in financial inclusion by acting as an intermediary between financial institutions and the excluded people.

ICT rollout is growing rapidly in Rwanda. By taking into consideration the exclusion to financial services, digital financial services such as mobile payment, mobile banking, internet banking are regarded as opportunity to reach the excluded people. Several econometric studies have covered the impact of ICT to economic growth in advanced economies' context. However, less accurate evidences are available for less-developed countries due to the most recent uptake of ICT and lack of complete time series data. It is against this background, this study will examine the way ICT in financial services can contribute to access to financial services and its effect on financial deepening and economic growth in Rwanda.

1.3. Objective of the Study

The core objective of this study is to examine the contribution of ICT to economic growth of Rwanda, through financial deepening. Specifically, this study has the following objectives:

- By using econometric analysis, explore the level of ICT contribution on financial deepening ;
- Analyze whether the introduction of ICT tools in financial services has generated a significant contribution to economic growth.

1.4. Research questions

This study will answer the following questions:

- *Whether there is a causal relationship between ICT and financial deepening in Rwanda;*
- *Whether there is a positive effect of ICT to economic growth through financial deepening in Rwanda;*
- *Whether financial deepening has accompanied economic growth in Rwanda.*

1.5. Significance of the Study

A lot of literatures have concentrated on examining the link between ICT and economic performance of developed countries, but a number of studies on Sub-Saharan Africa are limited. In addition, the benefits generated by ICT in financial services are often explained by reduction of time spent by users or minimizing the costs of providing banking services. But, ICT can also generate quantifiable economic contribution. It is in this regard, this study will provide a firsthand image of economic effect of ICT in financial services in Rwanda.

1.6. Organization of the study

This study is composed of five chapters:

Chapter one provides the general introduction of the study, stating the research problem, motivation of this study, objectives, research questions and hypotheses.

Chapter two presents the review of literature. Because there are several theories, debates and researches on this subject, we will review them in this chapter as the foundation of understanding the objective and expectation from this study.

Chapter three presents the methodology and techniques of collecting and analyzing data. It discusses the source of data, how they were collected, arranged and analyzed in order to achieve reliable and authentic information.

Chapter four is about the analysis of ICT policies, strategies and reports at a country level. It will explore the Rwanda's economic growth and its relationship with the emergence of ICT.

Chapter five will present the findings of data analysis with interpretation. In this chapter, the data will be organized and processed as a basis of conclusion.

Chapter six concludes the study. In this chapter, we will answer the research questions, approve or reject the research hypothesis and provide some recommendations for future studies and policies.

1.7. Meaning of Information and Communication technology (ICT)

The World Bank says that “ICT consists of hardware, software, networks, and media for collection, storage, processing, transmission, and presentation of information: voice, data, text and images” (WB, 2003). ICT is “a technology that enables communication, electronic capturing, processing and transmission of information” (Rafi & Murtaza, 2008). Rafi and Murtaza explained that these technologies include “product and services such as desktop computers, laptops, handheld devices, wired or wireless intranet, business productivity software such as text editor and spreadsheet, enterprise software, data storage and security, network security mobile phones and so on”.

While in common sense, ICT tends to refer to the newer technologies of phone and internet, the term includes also “more traditional communication media such as radio and television” (OECD, 2005). Dzidonu stressed that “ICT cuts across a variety of technologies including computer, microelectronics and related technologies including microchip and microprocessor-based technologies; multimedia and other information processing technologies and systems;

telecommunications technologies and infrastructure (fixed line, wireless, satellite-based and mobile infrastructure); and communication network technologies and infrastructure including local and wide area communications and computer networks for voice, data and video” (Dzidonu, 2010).

ICT is also defined as “a concept that include computers and other information equipment as well as computer software, that covers computers, peripheral equipment and other information-related office equipment (photocopiers, cash registers, calculators), communications equipment, and instruments” (Farhadi, Ismail, & Fooladi, 2012). Farhadi summarized a term as “a combination of electronics, telecommunications, software, networks, and decentralized computer work stations, and the integration of information media, all of which impact firms, industries, and the economy as a whole”.

According to Gerster and Zimmermann, “ICTs facilitate the creation, storage, management and dissemination of information by electronic means, and it has always been available”. But the only difference is that “rapid advances in technology have improved the traditional ways in which information was processed

and communications were conducted”. They even went further and highlighted the four characteristics describing these modern ICTs, namely: “(1) *interactivity*: ICTs are effective two-way communication technologies, (2) *permanent availability*: the new ICTs are available 24 hours a day, (3) *global reach*: geographic distances hardly matter anymore, (4) *reduced costs for many*: relative costs of communication have shrunk to a fraction of previous values” (Gerster & Zimmermann, 2003).

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

One of the most important subjects in economic analysis is to study the determinants of economic growth. Identifying sources of growth is important for all nations, especially for developing countries, and it is, in fact, one of the longest standing issues in development economics (Stanley, Doucouliagos, & Steel, 2015). In this chapter, we will explain different conceptual theories on the contribution of technology to the economy as well as exploring other empirical studies about this subject.

2.2. Theoretical Foundation

ICT is reflected as the main contributor to economic growth. Lack of ICT is also considered as a main factor of a large gap between rich and poor countries (Avgerou, 2003)

2.2.1. Neoclassical Growth Theory

Scholars in neoclassical or exogenous growth theories explained the determinants of the long-run growth. According to Solow neoclassical growth theory, the income per capita growth rate is explained merely by the exogenous rate of technological rate (Kabanda, 2013). This theory argues that technological revolution plays a significant role in economic growth, and the latter cannot be sustainable without advances in technology. Thus, technological advances impact the economic growth that cannot take place unless technological developments are available.

2.2.2. Endogenous Growth Theory

Endogenous Growth Model is a long-run growth model and underlines that “a technological change is influenced by economic incentives and determined by the working of the market system” (Kabanda, 2013). According to Romer, a technological change lies at the heart of economic growth (Romer, 1990). Unlike Solow growth model, this theory explains that a transformation of technology

predominantly arises because of people's reactions on market incentives. In short, this model claims that a technology change is endogenous rather than exogenous.

2.2.3. Technology Adoption Model

Technology Adoption Model or Davis model is considered as a foundation of many technology adoptions and diffusion researches. It states that "there are two important independent variables of actual use of technology: (i) perceived ease of use, i.e. the degree to which a person believes that using a particular system would be free of effort and (ii) perceived usefulness, i.e. the degree to which a person believes that using a particular system would enhance his or her performance" (Riyadh, Akter, & Nayeema, 2009). Basically, this theory is founded on the assumption that the use of ICT is determined by the perceptions of the users.

2.2.4. General Purpose Technologies (GPT)

Technological change is an essential determinant of modern economic growth. This is an idea that most economists would easily agree. However, it requires more

empirical justification to make this hypothesis clear. Bekar et al. defined GPT as “a single technology, or closely related group of technologies, that is widely used or has many uses across most of the economy” (Bekar, Carlaw, & Lipsey, 2016). GPT technologies are also characterized by the potential for general use in different functions and by their technological dynamism (Bresnahan & Trajtenberg, 1995). This technology is therefore applied to several production activities, allows further improvements and facilitates innovation through co-inventions. Because ICT is the enabler of product, process and organizational innovation in ICT-using sectors, it qualifies to be the GPT.

2.3. Review empirical studies

2.3.1. The role of ICT in economic growth and poverty reduction

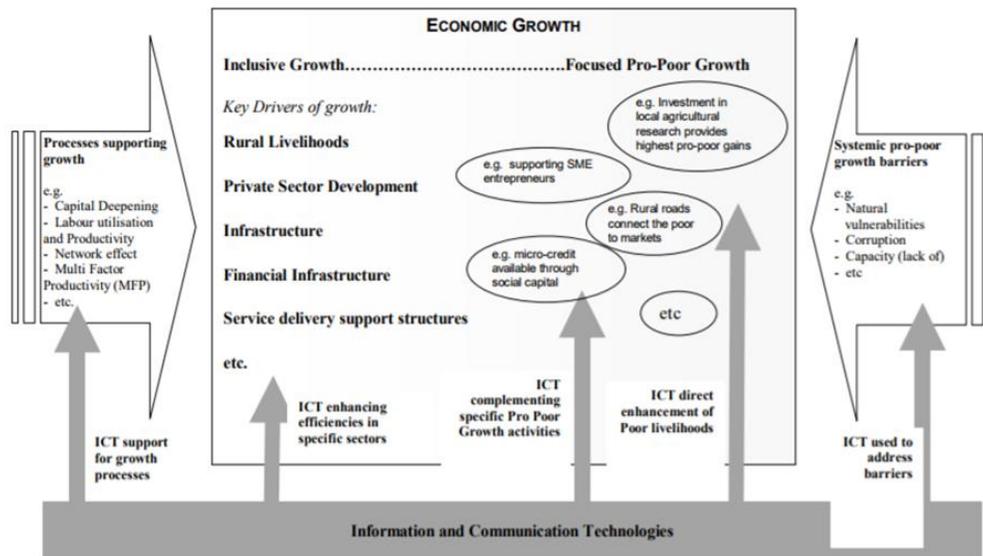
Usage of ICT can create opportunities of economic growth in either developed or developing economies. ICT has the potential to change the way governments, businesses and people operate and communicate. A number of researches have

demonstrated that ICT can contribute to economic development of developing countries as other basic utilities do.

Dzidonu stated that “a deployment of ICT in various sectors of the economy has a direct effect on economy through the growth of ICT sector and indirectly through assisting the growth of other sectors and such ICT-based growth can contribute to poverty reduction in poor rural and urban communities” (Dzidonu, 2010). There are five ways the technology can help the economy: “ (i) ICT is one of the most direct job creating sectors, (ii) ICT can contribute to GDP through e-commerce and emerging industries, (iii) emergence of e-services for citizens and businesses, (iv) workforce transformation by dividing tasks into small components that can then be outsourced to contract workers and, (v) ICT contributes to business innovation, reaching out to customers and competing for market share” (Kvochko, Elena, 2013). Other studies justified that “developing countries are deprived of opportunities for economic development and life improvement enjoyed by advanced economies because of the scarcity of ICT” (Avgerou, 2003). Stanley et al. applied a meta-regression analysis to 58 studies and explored the impact of ICT on economic growth. The result of their study showed that on average ICT had positively contributed to economic growth (Stanley, Doucouliagos, & Steel, 2015).

Nowadays, increasing access to digital technologies can bring more choice and greater convenience. ICT is not only about technologies but more about information sharing and communication (Gerster & Zimmermann, 2003). The World Bank claimed that “getting access to ICT creates many opportunities that were previously unreachable by the poor and underprivileged groups through inclusion, efficiency and innovation” (WB, 2016).

Figure 1: Contribution of ICTs to pro-poor economic growth



Source: OECD, 2005

ICT contribution to economic growth in developing countries is negligible and regarded as a concern of industrialized countries, because they have advanced human capital and digital skills, rich endowment of infrastructures and their potentiality in cyber security. In their publications, several scholars argued that technology is not among priority policies and strategies for development and poverty reduction in developing countries, and in Africa in particular.

In their study, Dewan and Kraemer revealed that “return from IT capital investment is positive and significant for developed but not significant for developing countries” (Dewan & Kraemer, 2000). Gholami et al. also supported the statement that “a significant impact of ICT on economic growth is therefore pragmatic in several developed and Newly Industrialized Economies but not in developing countries” (Lee, Gholami, & Tong, 2005). According to David Henley, African development models have focused not pragmatically on mass outreach and rapid impact in the battle against poverty, but on ideas of technological and cultural modernity based on conditions in already rich countries (Henley, 2015).

a) Access to information and services: Digital inclusion

In exploring the effects of ICT on well-being dimensions, Graham and Nikolova found that “ICT can positively affect the well-being of people by making their daily activities much easier and simple, especially in remote areas with inadequate infrastructures” (Graham & Nikolova, 2012) . For instance, mobile phone accounts, e-commerce transactions, online reputation mechanisms, and digital identification systems all help to overcome the barriers of accessing to information. The Ultimate benefit of accessing to information and services is the creation of the market through trade expansion, job creation, access to public services and promoting inclusion (WB, 2016).

b) Improved productivity: Efficiency

In 1970s and 1980s, many studies presented negative or zero impact of investment in ICT on productivity. This situation led the economist Solow to state that: "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). This statement means that “as more investment is made in information

technology, worker productivity may go down instead of up”. However, this analysis has found some contradictory evidence of a positive impact of ICT on labor productivity and other researchers agreed the importance of ICT on productivity of factors.

Some evidences have shown that best performing countries in terms of wealth creation, are those on frontlines in developing and integrating ICTs into their economies and societies (Dzidonu, 2010). Oliner & Sichel examined the role of information technology and growth contribution of computers and related inputs. They found that “using information technology such as computer hardware, software and communication equipment contribution contributed massively to productivity growth in the second half of the 1990s” (Oliner & Sichel, 2000). Papaioannou investigated ICT effects on productivity and economic growth in developed and developing countries from 1993-2001. He reached the conclusion that “ICT has a positive and significant effect on economic growth in studied countries, but this effect in developing countries is greater” (Papaioannou, 2005).

Dedrick et al. showed that “there is also strong evidence that developing countries are now benefiting from productivity growth associated with investment in

information” (Dedrick, Kenneth, & Shih, 2011). The findings of the study conducted by Samimi and Mahshad in 45 sample countries confirmed that “ICT through penetration of capital can lead to more labor force productivity and economic development” (Samimi & Mahshad, 2011). Investment in new technology is therefore the essential element in achieving sustainable growth. According to the World Bank, digital technologies increase the productivity of factors not substituted. Those technologies help managers in supervising their workers, politicians to monitor the provision of services, and workers to become more productive (WB, 2016).

2.3.2. ICT as enabler of developmental goals

During the Millennium Summit in 2000, the UN adopted the MDGs, in which ICT was considered as a critical enabler of sustainable development. For instance, it stated that “in cooperation with the private sector, the countries would make available the benefits of new technologies, especially information and communications”. As per the MDGs implementation report, “the number of mobile-cellular subscriptions grew almost tenfold in 15 years, from 738 million in 2000 to over 7 billion in 2015 and internet penetration from just 6 per cent of the

world's population in 2000 to 43 per cent in 2015" (UN, 2015). The World Bank advised ICT that "ICT can provide new tools to address poverty in direct and indirect ways by enabling people to have access to information, creating opportunities and contributing to pro-poor market developments such as microfinance and mobile money" (WB, 2012).

In 1990s, a number of debates among development experts focused on prioritization of ICT over other development strategies in underdeveloped states. On the other hand, the concern of this 21st century is no longer whether ICT is important or not but how it can be integrated within other development and poverty reduction programs. Despite high demand of social interventions in developing countries such as education, basic infrastructure, peace, security and others, evidences have shown that ICT is also a powerful tool in development strategies. However, "grabbing the opportunities of ICT requires innovative and close partnerships among individuals, governments, private sector and civil society" (WB, 2003).

2.3.3. ICT and financial services

“Financial inclusion can be defined by using indicators of access to financial services such as number of bank branches, of ATMs and usage of such services like number of accounts, of account holders and of transactions” (IMF, 2017). Financial inclusion is also a fundamental objective of developing countries as many research findings linked it to economic growth in developing nations. Demirgüç-Kunt et al. found that “inclusive financial systems allow broad access to financial services by eliminating price and non-price barriers to their use” (Demirgüç-Kunt & Klapper, 2012). In addition, digital technologies offer affordable and convenient ways for individuals, households and businesses to save, make payments, access credit and obtain insurance.

Apart from assessing the role of ICT in economic growth in general, several literatures explain the role of ICT at financial sector level. Villasenor identified that “mobile penetration and acquisition of cheaper smartphones provide easier access to financial services through well-designed and user-friendly applications to illiterate people” (Villasenor, 2013). However, he pointed out that “difficulties of inflexible interfaces on basic feature phones for more advanced products may

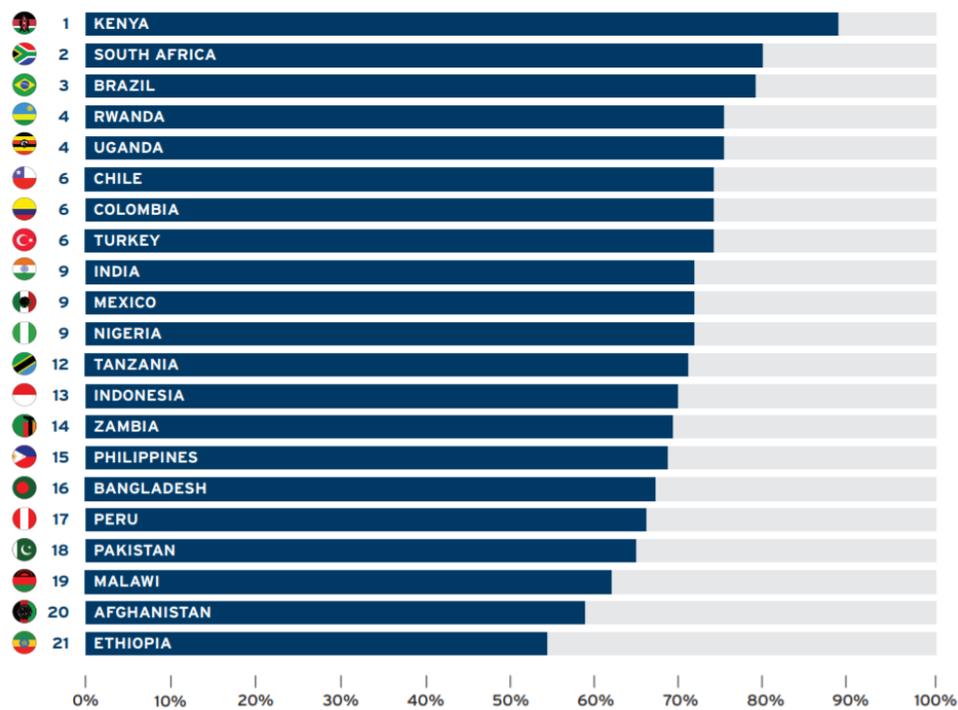
hinder people's access to account information, switching between accounts and submitting loan applications". Dzionu said "banking and financial services are to a large extent the most ICT-driven sectors in developed and developing countries" (Dzionu, 2010). Shirley and Sushanta explained that "ICT in financial services can generate cost advantage: cut down operational costs of banks and create network effect: facilitate transactions among customers within the same network" (Shirley & Sushanta, 2006).

The poor in rural areas of developing countries are financially excluded, with insufficient income and limited savings. Even when they get a source of small incomes, they are not familiar with operations of financial institutions (Tossy, 2016). On other side, financial institutions consider the poor as unattractive customers, because of their irregular and small size liquid assets relatively to the costs endured by financial institutions in servicing them. In this situation, ICT can help to bridge the gap between the rural poor and financial institutions by minimizing the costs of servicing remote regions.

The Brookings FDIP Report (2015) examined "both traditional formal financial services and digital financial services, including mobile money in 21 countries

across the world”. This study focused on four dimensions related to financial inclusion namely: “(i) country commitment, (ii) mobile capacity, (iii) regulatory environment and, (iv) adoption of traditional and digital financial services”. The study concluded that “investing in accessible and affordable digital infrastructure contributes to the availability and adoption of digital financial services among underserved populations”.

Figure 2: FDIP Overall Scorecard



Source: FDIP, 2015

In this report, the best performing countries proved to “have substantial commitment to stimulate financial inclusion, took policy, regulatory, and technological steps to speed up that progress toward inclusion”. Villasenor et al. concluded that “having access to digital technology is one way to improve access to financial services in developing countries” (Villasenor, Darrell, Robin, 2015).

CHAPTER THREE: EMERGENCE OF ICT IN FINANCIAL SERVICES AND ITS IMPLICATIONS TO RWANDAN ECONOMY

3.1. Introduction

This chapter focuses on analysis of the emergence of ICT in financial services. This section starts with a synopsis to the readers about the Rwanda's economic situation, ICT policies and strategies in place.

3.2. Economic Growth of Rwanda

Overview of Rwanda

Rwanda is a small and landlocked country, located in Eastern-Central Africa at the coordinates 2°00'S 30°0'E. Its total area is 26,338 sq km (10,169 sq miles) and is bordered by the Democratic Republic of Congo to the west, Uganda to the north, Tanzania to the east and Burundi to the south.

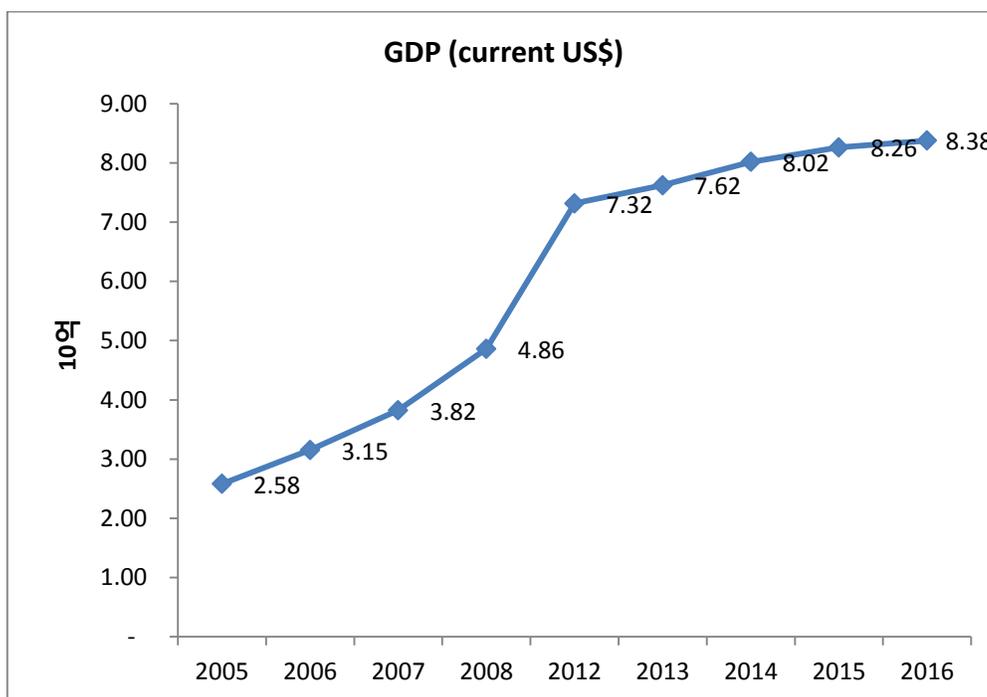
Table 1: Rwanda's economic overview

| No | Indicator | Number |
|----|---------------------------|----------------------|
| 1 | GDP (Current US\$) | 8.376 billion (2016) |
| 2 | GDP Per Capita (US\$) | 702.84 (2016) |
| 3 | GDP Growth (market price) | 6.9% (2015) |
| 4 | Population (million) | 11.92 (2016) |
| 5 | Life Expectancy | 65 years (2016) |
| 6 | Inflation Rate | 3.5% (July 2017) |
| 7 | Mobile Penetration | 72.45% (May 2017) |
| 8 | Internet Penetration | 39.76 (May 2017) |

Rwanda has experienced remarkable economic growth since 1994, the darkest year in its history when over one million people were killed in only 100 days. The Genocide against the Tutsis left the country ruined and all sectors of production were totally devastated. Despite this tragedy, Rwanda is among fastest developing countries in the world, thanks to successful structural changes and transformative policies. However, the economy is still largely depending on agriculture that employs about 80% of the population and contributing 33% to the GDP. The industry and service sector generate 14% and 47% of the GDP respectively. Particularly, ICT sector is a rising driver of the economy. For example, ICT sector

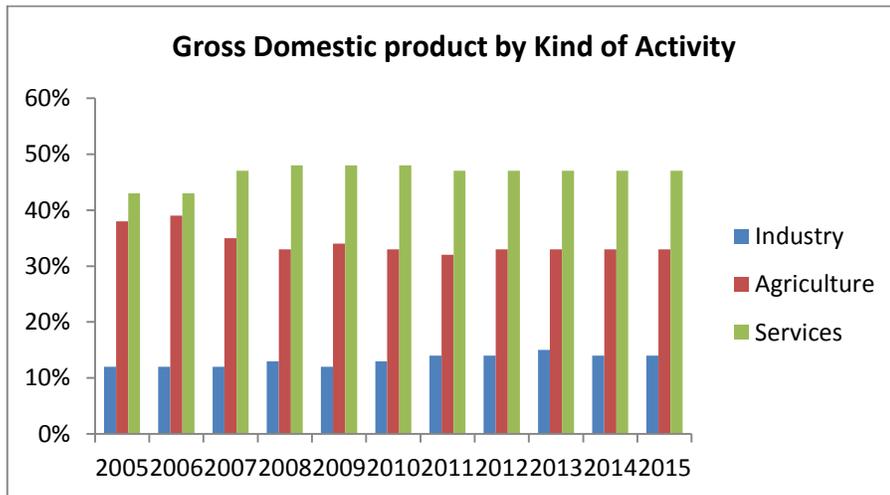
recorded an average growth of 16% ahead of the rest of the economy which grew at 6.9% in 2015.

Figure 3: Rwanda's GDP growth



Source: WDI. 2017

Figure 4: Sector contribution to GDP



Source: NISR, 2016

3.3. ICT Sector in Rwanda

Since 2000, the GoR aimed to transform the country from a low-income to a middle-income level by 2020. To achieve this target, the GoR believed in use of ICT as a transformational foundation from agriculture-based to knowledge-based economy. Furthermore, a lack of access to the sea and ports, inflated airfreight rates required the country to invest in a knowledge-based economy, ICT as a cornerstone. From this background, the GoR initiated a five-year NICI Plans, with the ambition to accelerate the progress towards Vision 2020.

3.3.1. ICT policy environment in Rwanda

ICT in Rwanda is the important backbone for economic growth. Having limited resources necessitates adopting different strategies for development that diverge from those of other countries (Mumporeze & Prieler, 2017). The GoR has also emphasized on ICT in financial services to build a cashless economy and scale up the rate of financial inclusion through digital payments.

Table 2: Pillars of Vision 2020 and its cross-cutting areas

| Pillars of Vision 2020 | Cross-cutting areas of Vision 2020 |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Good governance and a capable state | 1. Gender equality 2. Protection of environment and sustainable natural resource management 3. Science and technology, including ICT . |
| 2. Human resource development and a knowledge-based economy | |
| 3. A private sector-led economy | |
| 4. Infrastructure development | |
| 5. Productive and market-oriented agriculture | |
| 6. Regional and international economic integration | |

Source: Rwanda Vision 2020, 2012

The GoR believes that ICTs can offer opportunities through key stages of industrialization and switching from subsistence agriculture-based economy to service and high knowledge-based and competitive economy on global market. Within the context of the broad socioeconomic development objectives, the GoR enacted ICT policy and strategy in 2000, a five year NICI plans to promote digital penetration (GoR, 2001). The goal of the 1st NICI Plan (2001-2005) was to build the foundation and create the enabling environment for ICT development by putting in place the required institutional framework and policies in order to transform Rwanda into a knowledge-based society. NICI Plan II (2006-2010) aimed to develop and deploy world class ICT infrastructure that will support and accelerate ICT development and growth. The goal of the NICI Plan III (2011-2016) was to accelerate service development through ICT thereby facilitating sustainable economic competitiveness and ICT contribution to GDP. The goal of the NICI Plan IV (2016-2020) was to “consolidate the process towards achieving a middle income status and information-rich knowledge-based society and economy”. Recently, the NICI Plan IV has been renamed as Smart Rwanda Master Plan (2015-2020). The objective of Smart Rwanda Master Plan is to “strengthen Rwanda’s economic base and improve its economic environment for accelerated

growth towards achieving a predominantly information and knowledge-based economy” (MYICT, 2015).

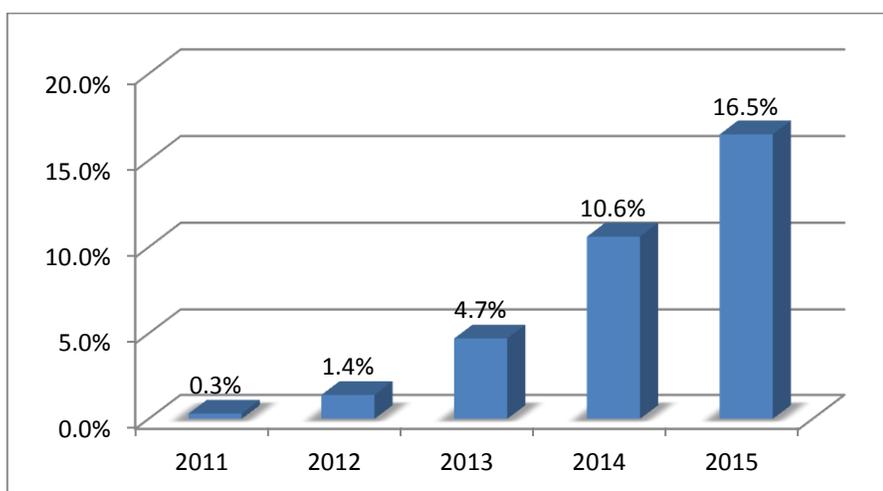
3.3.2. ICT and access to financial services in Rwanda

Access to financial services is one of the key social and economic challenges in developing countries. Different propositions have been developed to increase financial deepening. Those propositions are ranging from mobile money applications and affordable banking financial institutions to the expansion of banking services through banking agent networks from small retailers. However, to make it happen requires the ability to create low cost channels that allow low income population to have access to payment services (ATMIA, 2016)

The objective of the GoR is to “scale up the payment transactions done electronically to 75 percent, increase the number of internet users per 100 people to 50 in 2020 and mobile subscriptions per 100 people to 75 in 2017” (MINECOFIN, 2013). With regard to this objective, the GoR elaborated Rwanda Financial Sector Strategy (2013-2018) which governs the entire financial sector of Rwanda. A particular attention was “to reach out the underserved people through fast expansion of private credit which has to be accompanied by saving as a key enabler

to finance productive activities”. The strategy focuses on the following most critical priorities: “(i) mobilizing savings and investment, (ii) access to finance, (iii) financial inclusion, (iv) modernized payment systems, (v) skills development for the financial sector and, (vi) serving as an international financial service center” (MINECOFIN, 2013). For the purpose of creating a permitting environment for financial institutions to increasingly deliver financial services at a low cost as well as stimulating savings and deposits for financially excluded people, the use of electronic payments such as mobile payment and mobile banking can play a major role.

Figure 5: The ratio of e-payment to GDP



Source: BNR, 2016

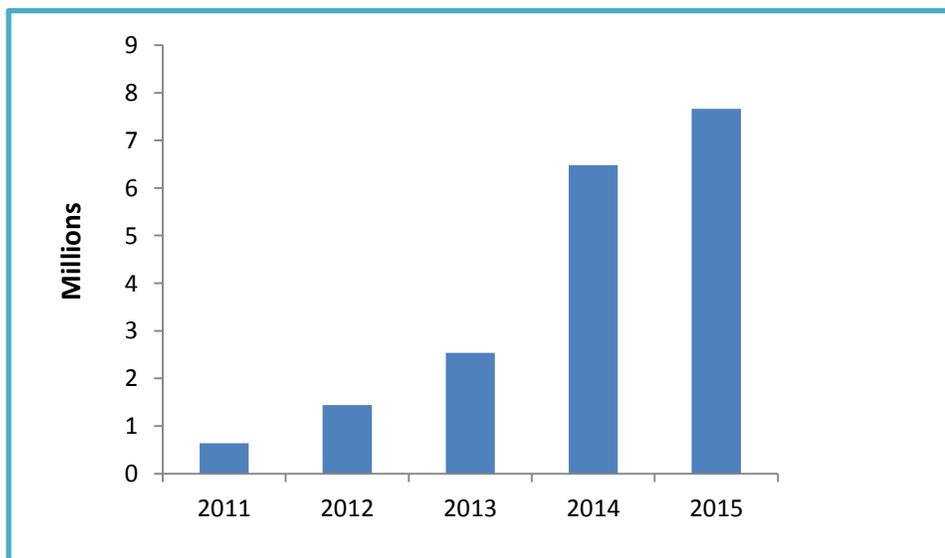
ICT continues to boost the financial sector and contributing to digital inclusion in Rwanda. This is explained by the improved use of ICT in delivering financial service, increasing number of mobile payment subscription, electronic transactions, electronic billing machines deployment, online tax payments, etc. And the benefits generated by use of ICT in financial services are “effective and efficient processes, cashless payments and more business opportunities” (MYICT, 2015).

Mobile payments

Bringing financial services closer to clients by decreasing a walked distance can increase the numbers of bank accounts and financial deepening. A long distance imposes costs of transportation as well as the opportunity cost of a time used especially in rural areas. For bridging this gap, it is essential to make financial services available and accessible over digital and low cost devices. Facts show that “financial services sector in Africa is changing rapidly and mobile banking revolution is the fundamental factor of this transformation” (Jones, Woods, & Ndung’u, 2016).

By observing ICT trend in Rwanda, mobile money services have been playing a crucial role in transforming the business processes, improving the citizens' life style through more and more innovation in the financial services industry. The use of mobile in payment and financial transaction is perhaps the most remarkable developments in terms of utilization of ICT in financial services. Data from the National Bank of Rwanda shows that in 2015, mobile money subscribers across all mobile network operators have reached 7,663,199 from 639,673 recorded in 2011.

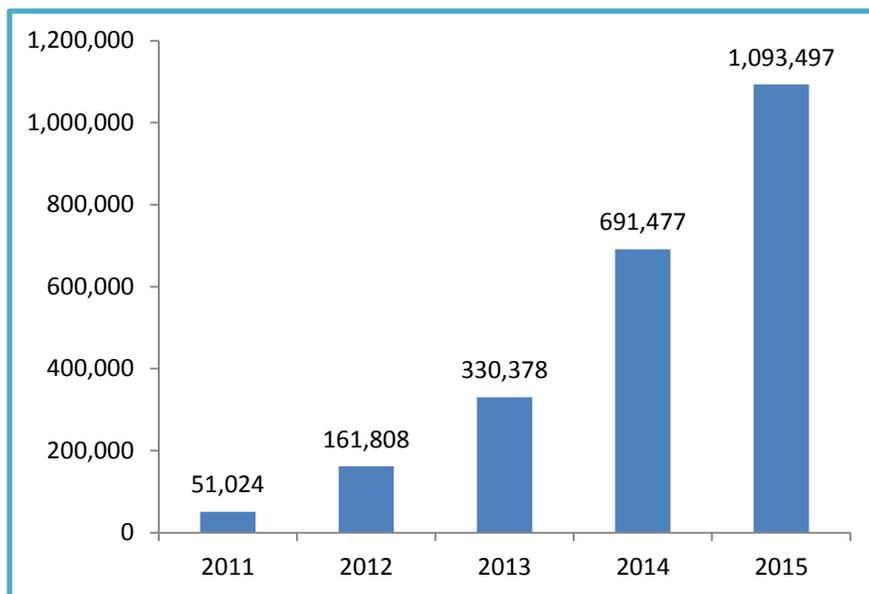
Figure 6: Number of mobile payment users



Source: BNR, 2015

A significant growth is also justified by a shift of the value of money transacted from 51 billion in 2011 to 1,093 billion in 2015.

Figure 7: Value of mobile money transactions (Million Frw)



Source: BNR, 2015

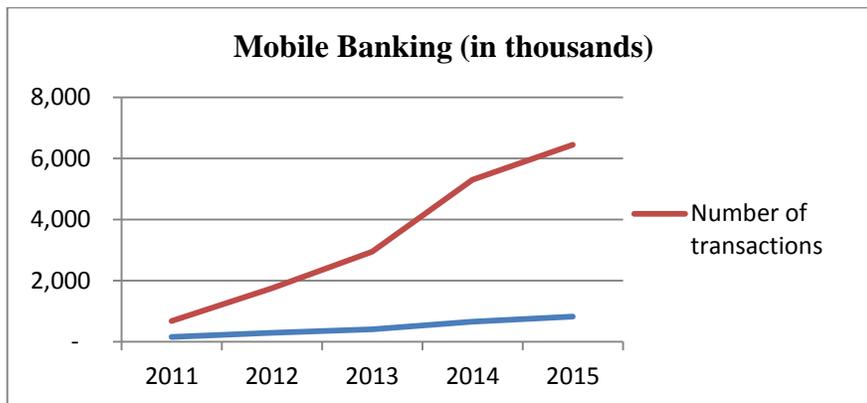
Mobile Banking

Mobile banking is “a service provided by a bank or other financial institution that allows its customers to conduct financial transactions remotely using a mobile

device such as a smartphone or tablet” (Wikipedia). A tremendous increase of mobile devices and increased value of mobile-related businesses have brought much attention on mobile as the main network for the forthcoming banking operations (Krishman, 2014). The main criterion to take into consideration and against which mobile banking should be judged is whether it brings people into the formal financial sector. From this perspective, mobile banking is considered as the most effective driving factor towards greater financial inclusion in Rwanda.

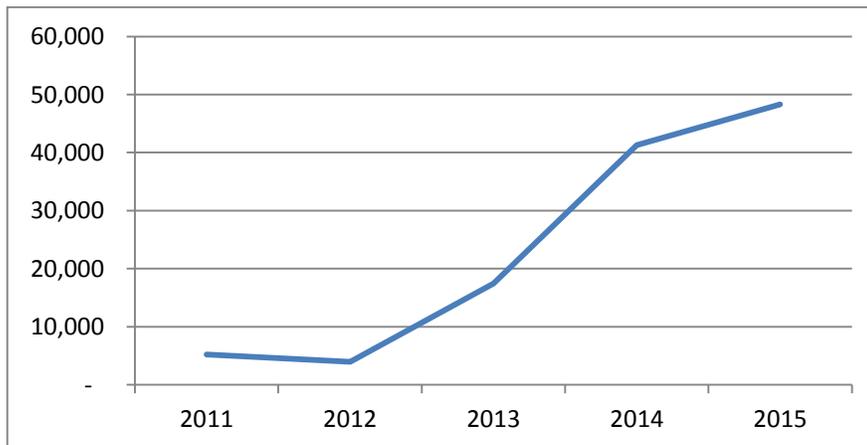
A growth of mobile penetration in Rwanda has facilitated not only a remarkable increase of mobile payments but with the mobile banking as well. While mobile money service was the first to be launched, cash deposit and withdrawal have been also equally successful in providing basic bank services to previously unbanked populations. In this regards, banks have introduced their own mobile banking products to attract an increasing number of mobile banking subscribers.

Figure 8: Number of mobile banking transactions and subscribers



Source: BNR, 2015

Figure 9: Value of mobile banking transactions (Million Frw)



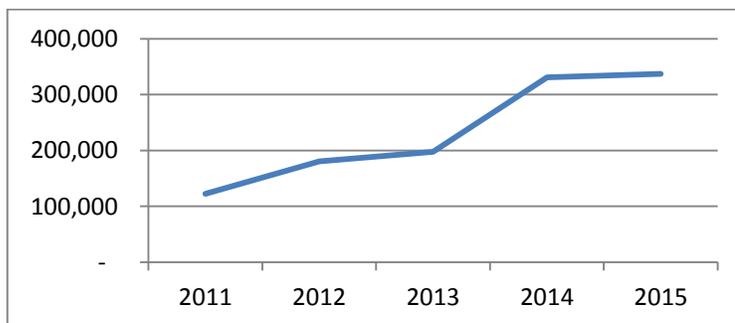
Source: BNR, 2015

Automated Teller Machines

ATM is a very important and effective tool in financial services. RAJEVAC-GRUJIĆ et al. explained that “a concern is not to agree whether it is desirable or not but how the introduction of emerging technologies can promote banking sector growth, more productivity, more trade, improve banking records keeping, greater modernization and better-living standard” (RAJEVAC-GRUJIĆ, KALIČANIN, KALIČANIN, & DIMITRIJEVIĆ, 2016).

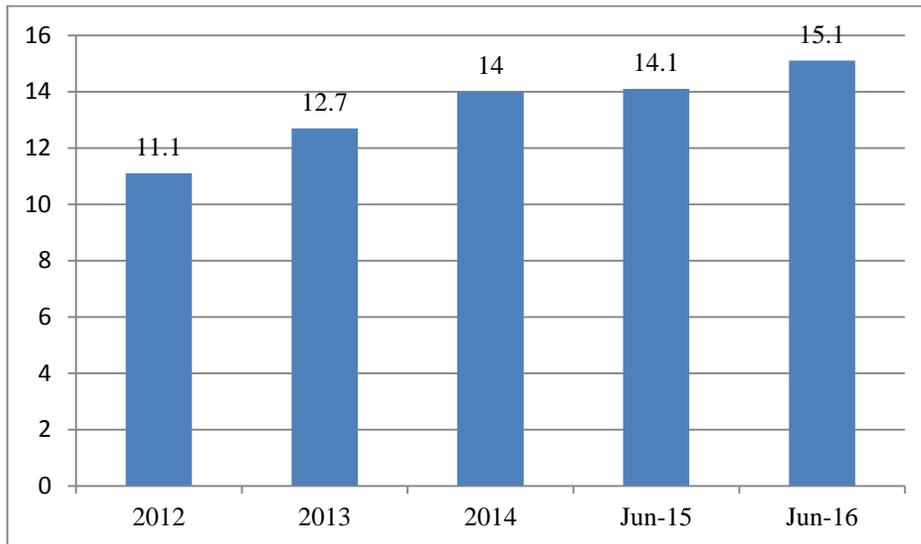
The banking sector in Rwanda has integrated numerous technologies in its daily operations. Among others, the introduction of ATMs is an instrument that brings banking services closer to clients and providing them better services.

Figure 10: Evolution of number of ATMs (Million Frw)



Source: BNR, 2015

Figure 11: Evolution of number of ATMs per 1000 Km²



Source: BNR, 2015

In Rwanda, ATMs have been deployed across the country to dispense cash to consumers, tourists, visitors and business operators. From 2012 to 2016, a number of ATMs increased by 36.3%. However, in terms of location, more than 50% of ATMs are located in Kigali City.

CHAPTER FOUR: METHODOLOGY AND DATA

4.1. Introduction

Research methodology is “a way to systematically solve the research problems” (Kumar, 2008). It may be understood as “a science of studying how research is done scientifically”. This chapter presents a scientific approach, methods and techniques that will be used in collecting and analyzing data.

4.2. Research design

(Gorard, 2013) described research design as “a way of organizing a research project from its inception in order to maximize the likelihood of generating evidence that provides a convincing answer to the research questions for a given level of resource”. It states the “methods and procedures for collecting and analyzing the desired information in the research”. Moreover, the quality of data is one of the cornerstones in the data-intensive paradigm of scientific research. It is determined by multiple factors but the trust and authenticity of data are the major ones. Because we use the secondary data in this study, the emphasis is on the authenticity and reliability of the data.

The correlation design in this study helps to explain the relationship among dependent variable (GDP per capita growth) and independent variables. However, we do not attempt to control or manipulate these variables rather we try to understand the link among them. It is against this reasons, our research design aims to know the extent to which the ICT and the economic growth of Rwanda co-vary in line with conventional theories of economic growth. According to (Salkind, 2010), the main purpose of explanatory research is to test the theory. With explanatory study, a researcher analyzes the variables and come up with evidence that supports or disapproves the hypothesis that there is a cause-and-effect between variables.

4.3. Data collection

This study involves the examination of studies of other researchers, articles, reports, journals, textbooks or any other formal research sources. Secondary data will be collected, analyzed and interpreted from either national or international sources. At national level, we shall use reports of the accredited entities such as BNR, NISR and MYICT. At international level, we shall use data from World Development Indicators of the World Bank.

4.4. Data and variables

Since our study is limited to one country, we shall use time series data analysis. Time series data analysis studies a relationship among two or more variables to explain the dependence of each other over time. The advantage of using time series analysis is to explain the past and present relationship between variables as well as to forecast the future variations of a dependent variable.

With time series data analysis, we study whether there is a significant relationship between Rwanda's GDP growth rate and the usage of ICT in financial services from 2011 to 2015. Since data are collected on quarterly basis, we have 20 observations in this study. However, no single source can generate all data needed in this study; we shall use data collected from different accredited sources.

4.1.1. Dependent variable

- ❖ *grgdp_cap* represents the growth rate of GDP per capita. Time series data were collected from the WDI from 2011 to 2015. We therefore collected data for five years. Quarterly numbers are estimated from annual time series data.

4.1.2. Independent variables

- ❖ *loan_gdp* is the ratio of loans to real GDP. The value of loans and GDP were collected from quarterly reports of BNR from 2011 to 2015. A researcher used these data to calculate the value of *loan_gdp*.
- ❖ *logATM_trans* is the logarithm of value of ATM transactions from 2011 to 2015. The data for 20 quarters have been collected from the payment systems reports of BNR.
- ❖ *logmob_bank* is the logarithm of value of mobile banking from 2011 to 2015. The data for 20 quarters were collected from the payment systems reports of BNR.
- ❖ *r* is the lending interest rate by banks. These data are collected from the quarterly reports of BNR from 2011 to 2015 to get 20 observations.

4.1.3. Control variables

Control variables are those that the researcher is not interested in but have been justified to have a relationship with a dependent variable. The control variables of my model are *electr*, *save* and *grpop*.

- ❖ *electr* represents the percentage of population having access to electricity from 2011 to 2015. The data used are from WDI published by the World Bank. The researcher used annual data collected to estimate quarterly values of variables.
- ❖ *save* is the gross national saving to GDP ratio. Data are from WDI of the World Bank. The estimated data for 20 observations have been gathered from WDI by the World Bank.
- ❖ *grpop* is the annual population growth rate from 2011-2015. The estimated data for 20 observations have been gathered from WDI by the World Bank.

4.5. Method of data analysis

In analyzing these data, a researcher will use a quantitative method. A quantitative method is used to test theories by examining the relationship between dependent and explanatory variables (Creswell, 2014). In this regard, the econometric model will be utilized to analyze the relationship between ICT and economic growth, focusing on the link between the introduction of ICT in financial services and growth of the economy. Simply, the model aims to demonstrate the causal

relationship between the use of ICT in financial services and growth of the Rwandan economy.

4.5.1. Ordinary Least Squares (OLS)

OLS regression is probably the most used technique to analyze data and it forms the basis of many other techniques. OLS regression is “a generalized linear modeling technique that can be used in modeling a single response variable which has been recorded on at least in the interval scale”. It shows a relationship between a continuous response variable (Y) and a continuous explanatory variable (X). In case a linear regression model consists of one explanatory variable, it is simple regression model. The OLS regression model can be extended to include multiple explanatory variables. In case a linear regression model consists of two or more explanatory variables, we call it a multiple regression model.

The researcher will use a multiple regression model in this study. Y refers to GDP per capita growth or financial deepening depending on the hypothesis being verified or research question we intend to answer. The findings of this study will be presented and interpreted based on the following hypothesis:

H0: $\beta_1=\beta_2=\beta_n=0$: Use of ICT in financial services does not contribute to economic growth.

H1: $\beta_1, \beta_2, \dots, \beta_n \neq 0$: Use of ICT in financial services contributes to economic growth. The mathematical representation of the first model is as follow:

$$loan_gdp_t = \beta_0 + \beta_1 \log ATM_trans_t + \beta_2 \log mob_bank_t + \beta_3 r_t + \mu_t \quad (1)$$

Where $loan_gdp_t$ is the financial deepening during quarter, ATM_trans_t is the volume of ATM transaction, mob_bank_t is the value of mobile banking, r_t is the lending interest rate, μ_t is a value of the error term and; t represents the current period.

4.5.2. Distributed lag model

A distributed-lag model is used in case the effect of explanatory variables on dependent variable occurs over time rather than all at once. Simply, a distributed lag model is a model used for time series data in which a regression equation is used to predict the current value of a dependent variable based on lagged (past period) values of explanatory variables.

In this study, we shall use the time series data to construct a distributed lagged data model to investigate the contribution of ICT to economic growth in Rwanda. The mathematical representation of the second model is as follow:

$$grgdp_cap_t = \beta_0 + \beta_1 loan_gdp_{t-4} + \beta_2 grpop_{t-4} + \beta_3 electr_{t-4} + \beta_4 save_{t-4} + \mu_{t-4} \quad (2)$$

Where $grgdp_cap_t$ is the GDP per capita growth (as a proxy of economic growth) at time t, $loan_gdp_{t-4}$ is the lagged variable of the predicted financial deepening from the model (1), $grpop_{t-4}$ is the lagged variable of population growth rate, $electr_{t-4}$ is the lagged variable of the percentage of people with access to electricity, $save_{t-4}$ is the lagged variable of ratio of the gross national saving to GDP and μ_{t-4} is the lagged variable of the error term.

A distributed lag model method was selected to analyze whether $grgdp_cap$ is to be affected by the change in value of independent variables in the previous four quarters. In this model, a researcher will use the lag length of 4 ($t-4$). A researcher selected a lag length of (4) because the data are collected at quarterly basis. Some literature suggest to use lag length of (1) for yearly time series data, lag length of (4) for quarterly time series data and lag length of (12) for monthly time series data.

CHAPTER FIVE: FINDINGS, DATA ANALYSIS AND INTERPRETATION

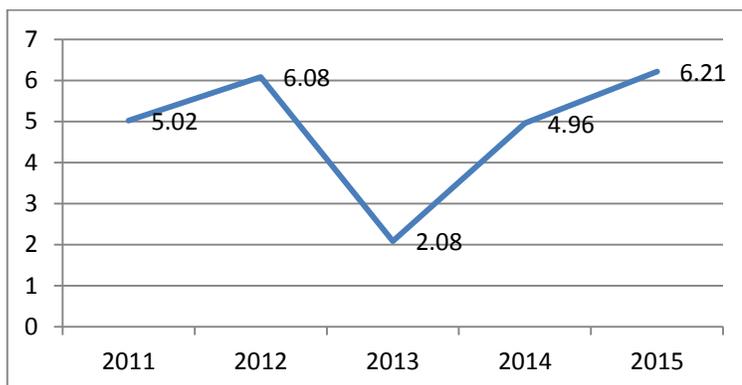
5.1. Introduction

This chapter discusses the main findings of our research. The findings are used to test the hypothesis and research questions posed in the first chapter. The analysis of data is presented in descriptive statistics, correlation tests, multiple regression and statistical test of significance.

5.2. Descriptive Statistics

GDP is the commonly used method to measure the level of the economy. It is defined as an annual economic turnover within the country. GDP is simply the market value of all final goods and services produced in a country in a given time period. A GDP growth is measured by comparing the GDP of the current period with the previous period. In short, the GDP growth rate demonstrates how the economy grows and develops. GDP per capita divides a country's GDP by total population. In this study we shall use time series data on GDP per capita growth as a proxy of the economic growth.

Figure 12: Rwanda's GDP per capita (2011-2015)



Source: World Bank, 2015

Table 3: Descriptive statistics

| Variable | Mean | Std. Dev. | Min | Max | N |
|------------------------------------------------|--------|-----------|--------|--------|----|
| GDP per capita growth | 4.87 | 1.53 | 2.08 | 6.21 | 20 |
| Value of ATM transactions (Frw million) | 61,531 | 26,189 | 30,634 | 97,613 | 20 |
| Value of Mobile Banking (Frw million) | 6,226 | 5,613 | 981 | 19,447 | 20 |
| Loan-to-GDP Ratio | 0.12 | 0.02 | 0.07 | 0.16 | 20 |
| Lending Interest Rate | 17.08 | 0.40 | 16.30 | 17.82 | 20 |
| Population growth rate | 2.53 | 0.04 | 2.47 | 2.59 | 20 |
| Access to electricity (% of population) | 16.70 | 5.21 | 10.80 | 24.90 | 20 |
| Gross Nation Saving ratio to GDP | 0.15 | 0.02 | 0.12 | 0.18 | 20 |

5.3. Correlation Matrix Results

Table 4: Correlation matrix

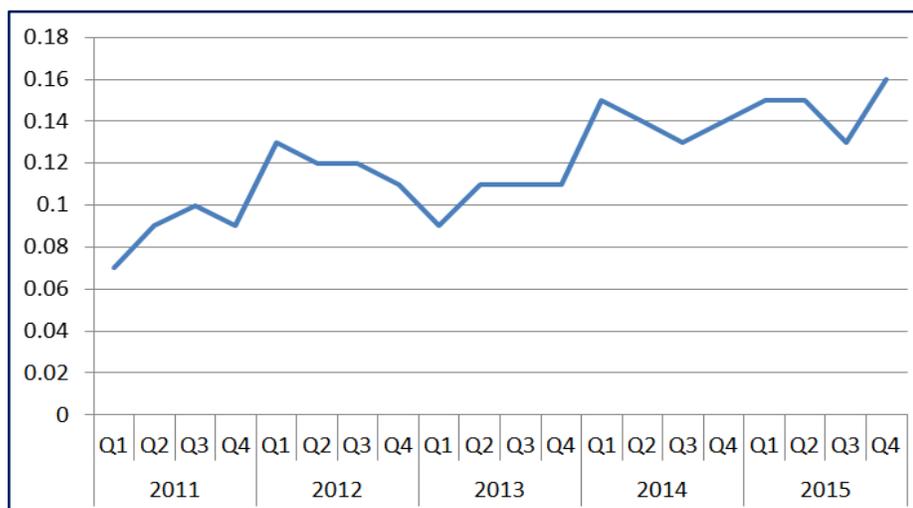
| Variable | grgdp_cap | loan_gdp | logATM_trans | logmob_bank | r | grpops | electr | save |
|--------------|-----------|----------|--------------|-------------|---------|---------|---------|------|
| grgdp_cap | 1 | | | | | | | |
| loan_gdp | 0.4257 | 1 | | | | | | |
| logATM_trans | -0.0674 | 0.7664 | 1 | | | | | |
| logmob_bank | -0.0076 | 0.7193 | 0.8797 | 1 | | | | |
| r | -0.4119 | 0.2553 | 0.5413 | 0.5738 | 1 | | | |
| grpops | -0.1197 | -0.8293 | -0.9474 | -0.9131 | -0.4949 | 1 | | |
| electr | 0.2608 | 0.8274 | 0.8774 | 0.9076 | 0.4317 | -0.9796 | 1 | |
| save | -0.6250 | -0.6691 | -0.3745 | -0.1087 | 0.1798 | 0.3837 | -0.3653 | 1 |

According to the table 4, there is strong positive correlation between *electr* and *logmob_bank*. In other words, the higher percentage of people with electricity is associated with the larger value of mobile banking. On the other hand, the highest negative correlation is between *electr* and *grpops*.

5.4. Financial deepening regression analysis

The economy of Rwanda has been characterized by the persistent high growth rate over the last two decades. Following macroeconomic and social improvement, its financial sector has enormously contributed to this change. For instance, The figure 13 explains that the ratio of loan to GDP has increased from 7% in the first quarter of 2011 to 16% in the last quarter of 2015.

Figure 13: Financial deepening index in Rwanda



Source: Author's calculation based on BNR data

The objective of this analysis is to explain the role of ICT in financial deepening. The dependent variable is the financial deepening presented as a loan-to-GDP ratio. The independent variables are value of ATM transactions, value of mobile banking and lending interest rate.

Table 5: Financial deepening regression analysis

| Variable | Coefficient |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Dependent variable: Loan to GDP ratio (<i>loan_gdp</i>) | |
| Constant | -0.8017411** (-2.20) |
| logATM_trans_t | 0.0964055** (2.20) |
| logmob_bank_t | 0.0130692 (0.81) |
| r_t | -0.0140625 (-1.24) |
| R²: 0.6488 Adj. R²: 0.5830 t-stat in parentheses *significant at the 10% level **significant at the 5% level ***significant at the 1% level | |

The results of the financial deepening regression are presented in the table 5. First, R² of 0.6488 indicates that 64% of the change in *loan_gdp* (financial deepening) in

our model can be explained by the changes in value of ATM transactions, mobile banking and lending interest rates. Second, the regression result shows that ATMs and mobile banking have positive relationship with loan to GDP ratio, but only $\log ATM_trans_t$ is significant.

Theoretically, mobile banking developments open up new channels for getting to formal financial services. However, the findings of my study did not approve the significant relationship between mobile banking and financial deepening in Rwanda. Since both variables (used as a proxy of ICT in financial services) have positive coefficients and one variable is significant, we conclude that ICT contributes to financial deepening in Rwanda.

In analyzing the results of my regression, I considered findings of other studies as my reference and for comparison. In 2015, a survey on digital financial services was conducted to 2003 Rwandans aged 15 and above. The report explained that 25% of mobile money accounts were used to pay utility bills (i.e. water, electricity, fees, fines, etc.), while only a 1% was used for loan activity (InterMedia, 2015). At that time, 8% of respondents did not have digital access to a bank account. The findings

of both studies justified that the evolution of mobile banking did not influence any increase in financial deepening, measured by loan to GDP ratio.

5.5. Economic growth regression analysis

The aim for this study is to discover whether the ICT is a significant contributor to Rwanda's economic growth through financial deepening. In other words, to examine if an increase of ICT in financial services is associated with a significant increase of GDP per capita.

For the sake of finding a contribution of ICT to GDP per capita, we shall use the result obtained in the previous regression (summarized in the table 5). At this stage of regression analysis, a predicted value of *loan_gdp* will enter into the second model (refer to table 6) as explanatory variable. The main objective of second regression analysis is to test the contribution of ICT to economic growth through financial deepening. Simply speaking, the regression analysis will help us to identify a significance of the lagged value of ICT variables (*logATM_trans* and *logmob_bank*) to GDP per capita growth vis-à-vis lagged values of *electr*, *grpop*

and *save* (control variables). The first regression here below is the benchmark of the second in the table 7.

Table 6: Economic growth regression analysis (1)

| Variable | Coefficient |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Dependent variable: GDP per capita growth (<i>grgdp_cap</i>) | |
| Constant | 22.0386 (0.32) |
| loan_gdp_{t-4} | 23.50893 (0.48) |
| grpop_{t-4} | -11.38456 (-0.45) |
| save_{t-4} | 59.54834*** (4.88) |
| R²: 0.6786 Adj. R²: 0.5983 t-stat are in parentheses *significant at the 10% level **significant at the 5% level ***significant at the 1% level | |

Referring to the table 6 above, the R^2 of 0.6786 describes the fitness of the model. It shows that a 67% change in *grgdp_cap* is explained by a change in variables *loan_gdp*, *grpop* and *save*. The coefficient 59.54834 of the variable *save_{t-4}* is significant at 1% level. This means that an increase of 1 unit in gross national saving ratio to GDP in the last four quarters, other things being equal, would

increase GDP per capita by 59%. On the other hand, the coefficient of $loan_gdp_{t-4}$ (financial deepening) is not statistically significant. Even though ICT has a positive and significant contribution to financial deepening, this contribution is not turned into economic growth.

As shown by the results of the regression above (see table 6), the saving is the most significant contributor to economic growth among other explanatory variables. In the second regression model of economic growth below (see table 7), we shall introduce the new control variable $electr_{t-4}$ to replace the variable $save_{t-4}$. The motives of this change are: (i) to re-test whether financial deepening is still not significant even when it is separated from the significant variable ($save_{t-4}$) in the model; (ii) because of the small sample size, it is not possible to run one regression with all control variables at the same time. For this reason, the new variable $electr_{t-4}$ is introduced in the next regression.

In our second regression, the new variable $electr_{t-4}$ is positive and significant. This means that electricity and saving are both significant contributors to economic growth of Rwanda. After running the two regressions, we can conclude that ICT contributes to financial deepening but not to economic growth.

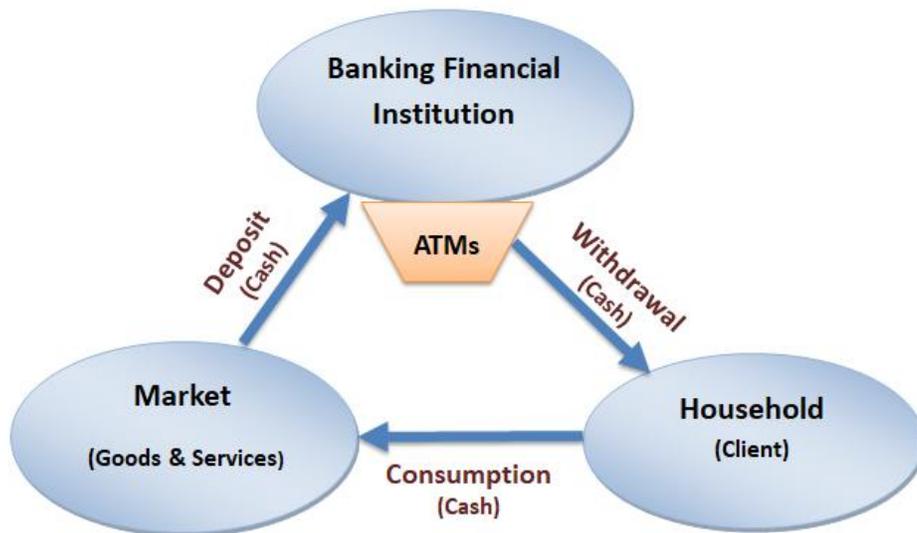
Table 7: Economic growth regression analysis (2)

| Variable | Coefficient |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Dependent variable: GDP per capita growth (<i>grgdp_cap</i>) | |
| Constant | -161.156 (-1.17) |
| loan_gdp_{t-4} | -31.22072 (-0.43) |
| grpop_{t-4} | 61.20337 (1.21) |
| electr_{t-4} | 93.12575** (2.18) |
| R²: 0.3115 Adj. R²: 0.1394 t-stat are in parentheses *significant at the 10% level **significant at the 5% level ***significant at the 1% level | |

The insignificance of ATM (as a significant proxy of ICT in financial services) to economic growth was also explained in other studies. Cáamara and Tuesta (2014) found that “availability of ATMs captures the extent of accessibility to the formal financial system only partially”. First, the findings of my studies demonstrated that ATMs in Rwanda are used more frequently for withdrawing cash for consumption. Second, once the cash is withdrawn from ATM, people use them to buy goods and services. This long way ends up with cash withdrawn from ATMs going back into

safety deposit boxes of banks. Third, the insignificance of ATMs to economic growth is explained by their distribution. In Rwanda, there are about 400 ATMs, but more than 50 percent of them are placed in Kigali city and others in urban areas instead of remote rural areas. Although ATMs are rapid, easy and appropriate instruments to quickly get cash in hands, they are weakly associated with productive activities.

Figure 14: ATM cash out journey



Source: Author's own analysis

5.6. Limitations of the Study

The biggest challenge in this study was the availability of quarterly time series data. Data on GDP per capita, population growth, electricity and saving are published at annual basis. In this case, we utilized annual data to estimate quarterly time series data.

Because of lacking enough quarterly time series data, we used also a small sample size of only 20 observations ranging from 2011 to 2015. Thus, the analysis with a small sample size might be biased and sometimes could not provide the accurate results.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

A contribution of ICT and financial sector on the economic growth of any country has been a subject of several studies. This study was set out to scrutinize whether and how the usage of ICT in financial services contributed to Rwanda's economic growth over the period of 2011 to 2015. Particularly, this study sought to respond the following questions:

- Whether there is a causal relationship between ICT and financial deepening in Rwanda;
- Whether there is a positive effect of ICT to economic growth through financial deepening in Rwanda.
- Whether financial deepening contributes to economic growth in Rwanda.

This chapter seeks to synthesize the findings of my study and provide well-analyzed information to policymakers.

6.1. Summary of Empirical Findings

The main empirical findings of this study have been discussed throughout data analysis. This section will basically answer the research questions based on the findings of this study.

The empirical findings of financial deepening regression approved the relationship between the value of ATM transaction and financial deepening, but mobile banking is not significant.

In answering whether there is a positive effect of ICT to economic growth through financial deepening in Rwanda; the empirical findings did not approve a significant effect of ICT to economic growth through financial deepening. The reasons of insignificant role of ICT to economic growth are different. For example, we found that ATMs are mostly used for consumption. In this situation, the transactions of ATMs are not channeled to investment and economic growth. Second, the usage of mobile banking is basically related to consumption such as paying utility bills and buying prepaid airtimes; and the role of mobile banking for saving and loan applications is too minimal.

The last research question was whether financial deepening contributes to economic growth in Rwanda. The findings approved that Rwanda's economy has grown fast, and financial deepening has accompanied the economic growth. However, the positive relationship between financial deepening and economic growth are probably caused by other factors other than the usage of ICT in financial transactions.

6.2. Policy implications

Recall that the findings of our regression pointed out that the contribution of ICT in financial services to economic growth is not statistically significant. From this result, we recommend the policymakers to introduce new indicators of ICT in financial services. For instance, the value of ATM transactions and mobile banking are not significant indicators to measure the use of ICT in financial services and its implication to economic growth.

The findings of this study suggest also a reform in ATM infrastructures. Financial institutions should operate and link ATM infrastructures to economic growth. First, there is a need of ATMs that can deliver cash deposit services. The use of ATMs is

important for improving financial service delivery but is not an efficient tool towards digital financial services in Rwanda. In addition, the government should encourage the use of electronic payment in consumption. The more people are engaged in electronic payments, the more level of deposits available for loans and investment. However, this policy recommendation to be successful, it requires more education and mobilization on the costs of not and benefits of using digital transactions and payments.

As shown in the previous sections, mobile banking does not significantly contribute to financial deepening. Since mobile banking operations are co-managed by telecommunication companies and financial institutions; this study suggests the extension of the interoperability linking mobile banking platforms of financial institutions to mobile money services of telecommunication companies.

6.3. Recommendations for future studies

This study has focused on demand side of financial services. However, financial deepening is generated by the interaction of demand and supply of financial

services. I recommend the future studies to collect and utilize the information of demand and supply side in their analyses.

Additionally, this study has concentrated on Rwanda with OLS regression method. Further studies can be conducted by introducing other econometric techniques with regional and continental level of analysis.

6.4. Conclusion

People's access to financial services is important factor to economic growth and development. The role of financial deepening defined in this research as the ratio of loans to GDP, is to generate the capital for economic activities.

This study has tested and approved the positive contribution of ICT to financial deepening. Nevertheless, this study found that the increase in value of ATMs transaction does not justify their contribution to economic growth. This study recommended some structural policies to stimulate the usage of ATMs in productive sectors that would lead to economic growth.

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국문초록

본 연구는 르완다의 경제 성장에 재정심화에 활용된 ICT(정보통신기술)가 기여하는 정도를 검토한다. 가설을 검증하기 위해 OLS 회귀 분석과 분배시차모형을 활용했다. 경제 성장의 정도를 확인하는 척도로 1인당 GDP를 사용했다; ATM을 이용한 거래와 모바일 뱅킹의 수치는 금융 거래의 ICT의 활용을 확인하는 척도로 삼았다.

본 연구를 통해 금융 거래의 ICT 활용과 재정심화 사이의 유의한 연관성을 발견하였다. 르완다의 금융 거래 상 ICT 활용 여부는 확인했으나, 이가 르완다의 경제 성장에 뚜렷하게 기여를 한다는 결론에 다다르지는 못했다. 분석 결과 금융 거래 상 ICT 활용은 생산과 투자보다는 주로 소비와 관련이 있음을 확인했다.

본 연구의 주요 함의는, 만일 금융 서비스 정책 개혁에 있어 ICT가 더욱 조명이 된다면 르완다가 경제 성장 상에서 얻을 잠재적 이익에 대한 것이다. 본 연구는 생산 활동에 있어 ICT를 적극적으로 활용하는 정책을 제안하였다. 이를 통해 ICT를 재정심화와 경제 성장과 연결 지을 수 있을 것이다.

주요어: 르완다의 경제 성장, 정보 통신 기술, 재정 포함
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