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Research Paper

Modelling Information and Communication Technology (ICT) Factors on Economic Growth in Rwanda Using Multiple Regression Model

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ABSTRACT

The information and communication technology (ICT) has been accelerated dramatically over the past decade. Increased ICT production and use has the potential to influence economic growth. This research focuses on the linkage between ICT factors (e-commerce, e-health and mobile banking) to economic growth in Rwanda and we summarize the findings and the literature on the contribution of ICT to economic growth. In this research it was attempted to show statistically the influence of electronic commerce (e-commerce), e-health and mobile banking on economic growth at country level, since theses ICT factors promotes consumption, investment, savings, education and so on. Multiple regression model was used to examine the relationship between economic growth and ICT factors (mobile banking, e-commerce and e-health). The research for influence of ICT factors to economic growth in Rwanda, found that mobile banking adherence and e-health are statistically significant to economic growth and e-commerce is not statistically significant. The researcher approved that the predicted economic growth= 1.805+0.318 mobile banking-0.018 e-commerce-0.286e-health as the results from sample taken.

Key words: ICT, economic growth, mobile banking, e-commerce, e-health

INTRODUCTION

Today the trend of ICT development is gaining larger influence over countries' development and growth. The worldwide development of information and communication technology (ICT) has accelerated dramatically over the past decade, spurred by an increasingly global economy.

Technological advances and increased competition have led to falling prices for ICT goods and services, and that has provided a strong incentive to replace other forms of capital and labor with information technology equipment (Jorgenson, 2001).

In today's world economy, technology is a key factor that has a strong impact on economic growth both in short and long term. Thus, economists have become accustomed to associate long term economic growth with technological progress (Mokyr, 2005).

Most of Africa is underdeveloped and lacks many of the resources that other parts of the world have access to. One of the main resources Africa lacks access to the Internet, which is driving a large portion of today's economy. However, the government of Rwanda understands the direction of the global economy and believes the current situation in Rwanda presents an opportunity to become the leaders of the knowledge-

based Internet economy in Africa. (NISR, 2015)

Rwanda's standard of living is the most significant indicator of national economic performance. Economic growth is considered the most powerful engine for generating long term increases in standards of living. (NISR, 2015)

At the present time, ICT has become a serious part of economy. Almost all firms and consumers use computers and Internet connection for economic purposes, such as providing consumers with a more diversified and customized product, improving product quality, and selling goods and services. Jean Dréze (1999). Evidently, the extension of ICT and its influences on economic growth in both developed and developing countries has increased very fast during the last two decades. However, country data on computer, cell phone, and Internet users illustrate different ICT diffusion rates across countries and regions, ICT use indicators illustrate an increasing trend, despite the recent world economic crisis (Amartya Sen, 1981).

For example, the steady growth of the number of mobile cellular subscriptions is noticeable, reaching 67 per 100 inhabitants by the end of 2009 globally. This confirms that consumers are willing to continue spending part of their disposable income on mobile services - even at times of financial constraints (Hennessy, S. &Onguko B., 2010).

In fact, ICT is the 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. ICT is comprised of a variety of communication equipment which includes radio, TV and communication equipment and software. Therefore, ICT investment includes investments in both computer and telecommunications, as well as related hardware, software and services (Hennessy, S. &Onguko B., 2010).

Having recognized the importance of the ICT investments in achieving the socio-economic growth, the GR (Government of Rwanda) adopted the National Information and Communications Infrastructure Plan (NICI) in 2000. The first NICI Plan, NICI I (2000-2005) focused on establishing an enabling environment to promote the development and growth of Rwanda's ICT sector. The second plan, NICI II (2006-2010) focused on providing world-class communications infrastructure to serve as the backbone for current and future communication related requirements. The third plan, NICI III (2011-2015 Plan), focused on the development of services by leveraging ICTs to improve the delivery. NICI III's overarching goals focused on accelerating service developments through ICTs, thereby facilitating sustainable economic competitiveness and increasing ICTs' contributions to GDP.

Consequently, the adoption of aggressive ICT developments provides a basis for Rwanda to make a quantum leap forward to become a middle-income nation. In order for the ICT to be efficiently and proactively operated and managed, the strategy and plans require alteration and oriented in correlation to the current ICT and socio-economic status. This therefore calls for a new blueprint for ICT under the tag of SMART (Service-oriented, Modern, Accountable, and Real-Time) ICT.

Overview of Past Studies

The effect of ICT on economic growth has been analyzed by many authors in last decades. Most of the evidences in this area confirm that the positive effect of ICT on economic growth is not apparent before mid-1990s. Oliner and Sichel (2000) use ICT capital components such as computer hardware, software and telecommunication equipment along with capital and labor as inputs and empirically verify a very high ICT contribution to economic growth in the late 1990s, but they find no evidence of a positive relationship before the mid-1990s. In 2000, Jorgenson and Stiroh show that the contribution of IT in economic growth of

the United States is because of the substitution of computers, related equipment and services, not due to technological change.

Moreover, other studies explain the significant effect of ICT on economic growth such as Brynjolfsson and Yang (1996), Motohashi (1997). Most of these studies have been reviewed by Pohjola (2001). Jalava and Pohjola (2002) indicate that ICT use and production quality are the most important factors in US economic growth in the 1990s. In addition, they provide evidence that ICT boosts growth in Finland from 0.3% to 0.7% between the early and late 1990s.

In Europe, Schreyer (2000) explores the impact of ICT capital and indicates that the contribution of ICT to economic growth of four European countries, the United States, Canada, and Japan during 1990–1996 is about 0.17–0.29%. Daveri (2000) expands Schreyer's study to 13 European and five others and shows a much higher contribution of ICT for each country. Both of them conclude that large European countries are far behind the US in this area. Applying a broad data set, Van Ark et al. (2002) also confirm that the gains from ICT capital are higher in the US than in Europe.

Despite the numerous studies, the evidence of ICT contribution to economic growth in developing countries is still scarce. For instance, Dewan and Kraemer (2002) estimate the effect of IT investment on output growth for the panel data of 36 countries over the period 1985–1993 and discuss the contrasting policy implications for IT capital investment by developed and developing economies using two step analyses and they reveal that return from IT capital investment is positive and significant for the developed countries in the sample but not statistically significant for the developing ones. This study attributes this gap to the low level of IT investment as well as lack of complementary assets in developing countries. They explain that complementary investments in infrastructure, human capital, and knowledge-based structures are prerequisite for IT investments to be productive which are mostly available in developed countries rather than developing ones.

Moreover, Lee et al. (2005) indicate the significant impact of ICT on economic growth of many developed and Newly Industrialized Economies (NIEs), but not in developing countries. In line with this result, Edquist (2005) conclude that the vague impact of ICT on economic growth in developing countries may account for the late introduction of ICT in these countries; for example, Internet service was not available in most developing countries until the late 1990s.

In contrast with the above discussion, Antonelli (1991) suggests that developing countries may gain more benefit from ICT than developed countries since switching from the predominant technology to a new "ICT-oriented paradigm" enforce significant costs to developed countries. It can effectively lock developed countries into those paradigms while simultaneously, important opportunities open up for less-industrialized countries to catch up and even "leapfrog" beyond the industrialized countries because they have relatively lower switching costs Seo H, Lee Y (2006).

Generally, we can divide the empirical evidence of the impact of ICT on economic growth to two categories based on the methodology used in these literatures. The first is studies employing the growth accounting technique, which weights growth in inputs by their share in the value of output and express the contribution of ICT to economic growth in percentage point. Jorgenson DW (2001)

It should be noted that all the above evidences are at the national level whereas there are some other studies at the firm or industry level. For instance, O'Mahony and Vecchi (2005), applying heterogeneous dynamic panels method with a unique dataset covering the entire non-agricultural market economy at the industry level for the US and UK from 1976 to 2000, find a positive and significant effect of ICT on

economic growth and excess returns to ICT compared with non-ICT assets.

The second category consists of researches that use cross country regression techniques to investigate the impact of ICT on economic growth. Madden and Savage (1998), using the sample of 27 Central and Eastern European countries, show a positive and significant impact of telecommunication investment on economic growth during the period 1990–1995. Roller and Waverman (2001) also confirm a causal relationship among telecommunication investment and economic growth for 21 OECD countries over the period 1970 to 1990. Jacobsen (2003) and Waverman et al (2005) in a similar study indicate a positive impact of mobile phones on economic growth. Another study conducted by Koutroumpis (2009) for 22 OECD countries during 2002 to 2007, shows that there is a positive causal link among broadband infrastructure as a driving factor of ICT and economic growth, especially in the presence of critical infrastructure mass. Applying panel data of 29 countries, Seo et al. (2009) investigate the bidirectional relationship between ICT investment and economic growth. They only verify the positive impact of ICT on economic growth in the 1990s.

The positive and significant effect of mobile banking diffusion on both economic growth and productivity growth has proven by Gruber and Koutroumpis (2009) for 192 countries over the period 1990–2007. Although ICT is well known as a driving engine of economic growth, there are few evidences that show the negative effect of ICT on economic growth. For example, Kiley (1999), applying the traditional growth accounting framework in the US, explains the negative contribution of computers to economic growth due to adjustment costs. He indicates that the introduction of a new investment good like computers can impose large adjustment costs to the economy and decrease economic growth. Moreover, Pohjola (2002) finds no significant relationship between ICT investment and economic growth for the sample of 43 countries over the period of 1985–1999. In another research, Jacobsen (2003) reveals no significant positive impact of computer penetration on the economic growth of 84 countries during 1990–1999, although he confirms the positive link among mobile phone and growth.

However, the empirical results of the previous studies are somewhat fragile and depend on data period specifications and econometric techniques, the dominant impact of ICT as a production input on economic growth and productivity is positive Colecchia A, et al (2002) and Pilat D, et al (2002)

Maryam et. Al (2012) examined the impact of Information and Communication Technology (ICT) use on economic growth using the Generalized Method of Moments (GMM) estimator within the framework of a dynamic panel data approach and applies it to 159 countries over the period 2000 to 2009. The results indicated that there is a positive relationship between growth rate of real GDP per capita and ICT use index (as measured by the number of internet users, fixed broadband internet subscribers and the number of mobile subscription per 100 inhabitants).

Evidently, most of the literatures in the field of ICT effect on economic growth and productivity, concentrate on the ICT investment as a whole and evidence on the impact of ICT use on economic growth and productivity is scarce. Only a few studies investigate the effect of ICT use on economic performance applying different proxies such as telephone penetration estimated by number of telephones per 100 persons Noll RG (2000) and teledensity defined as the number of fixed-line and mobile phone subscribers per 100 persons Shiu A (2010). No study to date has used ICT use index presented by ITU. ITU (2009) to evaluate the impact of ICT use on economic growth.

Research Methods and Procedures

This research is quantitative in nature and uses a non-experimental design including case study, hypotheses and

longitudinal research designs to reach objectives of the whole undertaking.

The target population under this study consists of ICT users in Rwanda. As gender parity assumedly has the same implication in all parts of the world, the study seeks to make deductions tube applicable to the whole population so defined.

The data was collected by using deepness interview. The questionnaire was used to collect information on the influence of ICT factors to economic growth in Rwanda.

There are five classes of respondents that are banking, insurance, Education, health and farmer where all classes are represented similarly. Means that banking are 20 percent of respondents, insurance are 20 percent of respondents, education are 20 percent of respondents, health are 20 percent of respondents and also farmer that are 20 percent of respondents.

Summary statistics was used to present the collected data and provide general information about the study variables, including total and percentages and also data was displayed in the tables.

Multiple regression model had been used to examine the relationship between economic growth and ICT factors (mobile banking, e-commerce and e-health). In the search for influence of ICT factors to economic growth in Rwanda, the researcher adopted a multiple regression model as follows: The basic idea is that you find an equation that gives a linear relationship between the X independent variables and the Y dependent variable, like this: $Y=f(Xi)$, $\hat{Y}=a+b1X1i+b2X2i+b3X3i+ Ɛ$

The $\hat{Y}$ is the expected value of Y (economic growth) for a given set of X values (ICT factors). b1 is the estimated slope of a regression of economic growth (Y) on mobile banking, if all of the other ICT variables (X) could be kept constant, and so on for b2, b3, etc. a is the intercept and Ɛ is error term.

At the end of the study, a total number of people participated in the study was 400 indicating a response rate of a hundred percent. The information that respondents provided is important for understanding the behavior and knowledge of the population of interest with respect to the influence of mobile banking, e-commerce and e-health on economic growth in Rwanda. The individual questionnaire gathered information concerning respondents' gender, age group, level of education and its occupation. These characteristics are used to interpret findings elsewhere in the research paper.

The identification of respondents according to the gender whereby 50% males and 50% females has been asked. This clearly shows that there is equality of males and females in this study. Given the implication of age in analyzing demographic characteristics, outstanding attention was paid to making sure this statistic was accurately recorded in the research.

The study revealed that majority of respondents were 34 percent aged between 31-35, whereas 26.2 percent of respondent reported that they are aged between 18-24, slightly 17.8 percent of respondent reported that they are aged between 25-30, somewhat 5.8 percent of respondent reported that they are aged between 36-40 and then 16.2 percent of respondents are aged above 40. This shows that majority of the respondents were aged below 36 years.

The highest level of education attained by respondent whereas 24 percent of respondent have educational level of primary schools, 28 percent of respondents had secondary education as highest education level, 28 percent of respondents had bachelor's degree and also 12 percent of respondent had masters' degree, only 8 percent of respondents had others education like professional trainings and so on. This shows that majority of respondents had bachelor's degree and secondary as education level.

EMPIRICAL RESULTS

Table 1. Socio-demographic characteristics of respondents

		Count	Column N %
Identification of respondents according to sex	Male	200	50.0%
	Female	200	50.0%
Distribution of respondents by age	18-24	105	26.2%
	25-30	71	17.8%
	31-35	136	34.0%
	36-40	23	5.8%
	40 and Above	65	16.2%
highest level of education	Primary education	96	24.0%
	Secondary education	112	28.0%
	Bachelor' degree	112	28.0%
	Masters' degree	48	12.0%
	Others	32	8.0%
current occupation	Banking	80	20.0%
	Insurance	80	20.0%
	Education	80	20.0%
	Health	80	20.0%
	Farmer	80	20.0%

Source: Primary Data

Mobile banking adherence facilitates in accessing loans, savings, transfers and checking account; in this research on accessing loans through mobile banking; table2 shows that 48.8 percent of respondents said that mobile banking had not increased their level of income; 35.8 percent of respondents said that mobile banking doubled their level of income and also 15.5 percent of respondents said that to access loans through mobile banking tripled their level of income. Means that 52.2 percent of respondents argued that to access loans through mobile banking has increased their level of income whereas 44.2 percent of respondents had strongly agreed that mobile banking increases savings, whereas 51.8 percent of respondents agreed that mobile banking increases savings and only 4 percent of respondents had disagreed on increase of savings due to mobile banking. Means that the majority, 96 percent of respondents were strongly agreed and agreed with the statement said that "mobile banking increases savings".

Table 2 shows that 24.2 percent of respondents have strongly agreed that transfers through mobile money influence earning income, 71.8 percent have agreed with the statement and also 4 percent have disagreed. As it is shown on the table 4.2 the majority 71.8 agreed that transfers through mobile money influence earning income whereas 60 percent of respondents have strongly agreed that monitoring account using mobile influence level of income and 28 percent of respondents have agreed, 4 percent of respondents have disagreed and after 8 percent of respondents have strongly disagreed on the statement said that monitoring account by using mobile influence level of income. As shown on table 2 below, the majority of respondent 60 percent had strongly agreed with the statement.

Table 2. Influence of mobile banking on economic growth in Rwanda

Influence of mobile banking on economic growth in Rwanda.		Count	Percent%
To access loans through mobile banking has increased your income	None	195	48.8%
	Doubled	143	35.8%
	Tripled	62	15.5%
	Quadrupled	0	0.0%
	Other, specify	0	0.0%
Mobile banking increases your Savings	Strongly agree	177	44.2%
	Agree	207	51.8%
	Disagree	16	4.0%
	Strongly disagree	0	0.0%
Transfers through mobile money influence your income earning	Strongly agree	97	24.2%
	Agree	287	71.8%
	Disagree	16	4.0%
	Strongly disagree	0	0.0%
checking or monitoring account using mobile influence your level of income	Strongly agree	240	60.0%
	Agree	112	28.0%
	Disagree	16	4.0%
	Strongly disagree	32	8.0%

Source: Primary Data

The table.3 below shows that 36.5 percent of respondent have strongly agreed that cost-savings influence income, whereas 55.8 percent of respondent agreed that cost-savings influence income, 4 percent of respondent have disagreed with the statement and 3.8 have also strongly disagreed that cost-savings influence income. This table.3 shows that the majority of respondent 55.8 percent agreed that cost-savings influence income whereas 35.8 percent of respondent are strongly agreed that promoting consumption influence employment of economic players, 56.2 percent of respondent agreed that promoting consumption influence employment of economic players, 4 percent have disagreed and also 4 percent have strongly disagreed that promoting consumption influence employment of economic players. It means that the majority 56.2 percent of respondent have agreed with the statement said that consumption influence employment of economic players that lead to economic growth.

Table .3 below presents that 40.2 percent of respondent have strongly agreed that promoting investment in ICT influence output, whereas 43.5 percent agreed with that promoting investment in ICT influence output, 12 percent have disagreed and also 4.2 have strongly disagreed with that promoting investment in ICT influence output. Means that the majorities 43.5 percent have agreed and 40.2 percent have strongly agreed with that promoting investment in ICT influence output.

And after this table.3 below shows that 27.8 percent of respondent have strongly agreed that performance improvement influence level of income, whereas 56.2 percent of respondent have agreed, 12 percent have disagreed and after 4 percent have strongly disagreed with that performance improvement influence level of income. As it is shown on table.3 the majority 56.2 percent have agreed that performance improvement influence level of income.

Table.3 Influence of e-commerce on economic growth

Influence of E-Commerce on economic growth		Count	Percent %
cost-savings influence your income	Strongly agree	146	36.5%
	Agree	223	55.8%
	Disagree	16	4.0%
	Strongly disagree	15	3.8%
promoting consumption influence employment of economic players	Strongly agree	143	35.8%
	Agree	225	56.2%
	Disagree	16	4.0%
	Strongly disagree	16[a]	4.0%
promoting investment in ICT influence output	Strongly agree	161	40.2%
	Agree	174	43.5%
	Disagree	48	12.0%
	Strongly disagree	17	4.2%
performance improvement influence level of income	Strongly agree	111	27.8%
	Agree	225	56.2%
	Disagree	48	12.0%
	Strongly disagree	16	4.0%

Source: Primary Data

Table 4 shows that 39.8 percent of respondent have strongly agreed that ICT promote cost-effective of health facilities, 40.5 percent of respondents agreed that ICT promote cost-effective of health facilities, 15.8 percent of respondents disagreed and 4 percent have strongly disagreed that ICT promote cost-effective of health facilities. This table 4.4 below shows that the majority 39.8 percent and 40.5 percent have strongly agreed and agreed respectively whereas 32 percent of respondent have strongly agreed that health informatics influence health education, 44.8 percent of respondent have agreed with the statement, whereas 20.5 percent have disagreed and 2.8 have strongly disagreed that health informatics influence health education. This means that the majority 44.8 percent have agreed with

that health informatics influence health education that leads to economic growth.

It is shown in table 4 that 52 percent of respondent have strongly agreed that income increased due to the use of electronic health care, whereas 40 percent have agreed and also 8 percent have disagreed with statement said that Income increased due to the use of electronic health care. As the table below presents it, the majority 52 percent have strongly agreed that income increased due to the use of electronic health care. This table 4 shows that 28 percent of respondent have strongly agreed that knowledge of ICT tools of e-health cause to obtain a better job, 60 percent have agreed with the statement, 4 percent have disagreed and also 8 percent have strongly disagreed that knowledge of ICT tools of e-health cause to obtain a better job. It means that the majority 60 percent have agreed with the statement said that knowledge of ICT tools of e-health cause to obtain a better job.

Table.4 Influence of e-health on economic growth

Influence of E-health on economic growth		Count	Percent%
ICT promote cost-effective of health facilities	Strongly agree	159	39.8%
	Agree	162	40.5%
	Disagree	63	15.8%
	Strongly disagree	16	4.0%
health informatics influence health education	Strongly agree	128	32.0%
	Agree	179	44.8%
	Disagree	82	20.5%
	Strongly disagree	11	2.8%
income increased due to the use of electronic health care	Strongly agree	208	52.0%
	Agree	160	40.0%
	Disagree	32	8.0%
	Strongly disagree	0	0.0%
Does knowledge of ICT tools cause obtain a better job	Strongly agree	112	28.0%
	Agree	240	60.0%
	Disagree	16	4.0%
	Strongly disagree	32	8.0%

Source: Primary Data

The F-ratio in the ANOVA table (see below) tests whether the overall regression model is a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable, F (3,3 96) = 7.440, p <0.0005 it means that the regression model is a good fit of the data.

Table5 ANOVA Table

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.113	3	4.371	7.440	.000[b]
	Residual	232.647	396	.587		
	Total	245.760	399			
a. Dependent Variable: economic growth						
b. Predictors: (Constant), e-health, e-commerce, mobile banking						

Source: Calculated from Primary Data

The general form of the equation to predict economic growth from mobile banking, e-commerce, e-health, is: the predicted economic growth= 1.805+0.318 mobile banking-0.018 e-commerce-0.286e-health.

This is obtained from the coefficients table.6, as shown below:

Table.6 Coefficients table

Coefficients[a]							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	1.805	.173		10.448	.000	1.466	2.145
mobile banking	.318	.081	.199	3.941	.000	.159	.476
e-commerce	-.018	.085	-.010	-.210	.834	-.185	.150
e-health	-.286	.083	-.175	-3.454	.001	-.449	-.123
a. Dependent economic growth							

Unstandardized coefficients indicate how much the dependent variable varies with an independent variable when all other independent variables are held constant. Consider the effect of age in this example. The unstandardized coefficient, B1, for mobile banking is equal to 0.318 (see Coefficients table). This means that for one increase of mobile banking adherence there is an increase in economic growth of 0.318. The unstandardized coefficient, B2, for e-commerce is equal to -0.018 (see Coefficients table). This means that for one increase of using e-commerce there is a decrease in economic growth of 0.018. The unstandardized coefficient, B2, for e-health is equal to -0.286 (see Coefficients table). This means that for one increase of e-health there is a decrease in economic growth of -0.286.

We can test for the statistical significance of each of the independent variables. This test whether the unstandardized (or standardized) coefficients are equal to 0 (zero) in the population. If p <0,05 you can conclude that the coefficients are statistically significantly different to 0 (zero).

The t-value and corresponding p-value are located in the "t" and "Sig." columns, respectively, as highlighted below:

Coefficients[a]							
Model		Unstandardized Coefficients		Standardized Coefficients	*t*	*Sig.*	95.0% Confidence Interval for B
		B	Std. Error	Beta			Lower Bound / Upper Bound
	(Constant)	1.805	0.173		*10.448*	*0.000*	1.466 / 2.145
	mobile banking	0.318	0.081	0.199	*3.941*	*0.000*	0.159 / 0.476
	e-commerce	-0.018	0.085	-0.010	*-0.210*	*0.834*	-0.185 / 0.150
	e-health	-0.286	0.083	-0.175	*-3.454*	*0.001*	-0.449 / -0.123
a. Dependent economic growth							

The research found that mobile banking and e-health coefficients are statistically significant and e-commerce coefficient is not statistically significant.

CONCLUSION

The study concludes that Information and Communication Technology factors influence economic growth in Rwanda and we argued that ICT factors like mobile banking, e-commerce and e-health have great impact on economic growth in Rwanda as access on loans, savings, transfers and checking account increase level of income; cost-savings, consumption, promoting investment in ICT and performance improvement influence level of income and then ICT promote cost-effective of health facilities, health informatics influence health education that lead to economic growth, income has increased due to the use of electronic health care and we ensures that knowledge of ICT tools of e-health cause to obtain a better job in Rwanda.

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