Applied Economics Journal Vol. 25 No. 2 (Demember 2018): 19-33

ISSN: 2586-9124 (PRINT)
ISSN: 2586-9132 (ONLINE)

Received: 14 March 2018
Received in revised form: 26 June 2018
Accepted: 2 July2018

The Impact of Internet on Economic Growth in Africa

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Abstract

The objective of this study is to estimate the effect of internet on economic growth in Africa as this region has recently been a rapidly growing number of internet users as well as high economic growth. Using the constructed panel data set of 19 African countries from 2003 to 2014 and employing the Fixed Effect-Iterated Generalized Least Square (FE-IGLS) estimation to correct for autocorrelation and heteroskedasticity, the results show no spurious regression problem. It indicated that internet has an impact on economic growth when it is complementary with physical capital and technology. Our main finding suggests that African governments should support their children to enter in education higher than secondary level and encourage labor using internet to boost up their knowledge.

Keywords: Economic Growth, Internet, Africa, Panel Data

JEL Classification: C23, L86, O47

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1. Introduction

Africa is the world's second fastest growing economy after East Asia. The regional real GDP growth is estimated at 3.6%, which is higher than that of the global economy (3.1%) and the Euro area (1.5%)[2]. Technology development is one of the reason that has driven the economic growth in Africa. This is consistent to Romer (1990) which proposed that technology change arisen from intentional investment decisions made by profit-maximizing agents has driven the country economic growth. Several studies confirm the study of Romer (1990) such as Holt and Jamison (2009), Oulton (2001), and Oliner and Sichel (2003), they investigated the effect of different forms of technology, especially Information and Communication Technology (ICT) on economic growth.

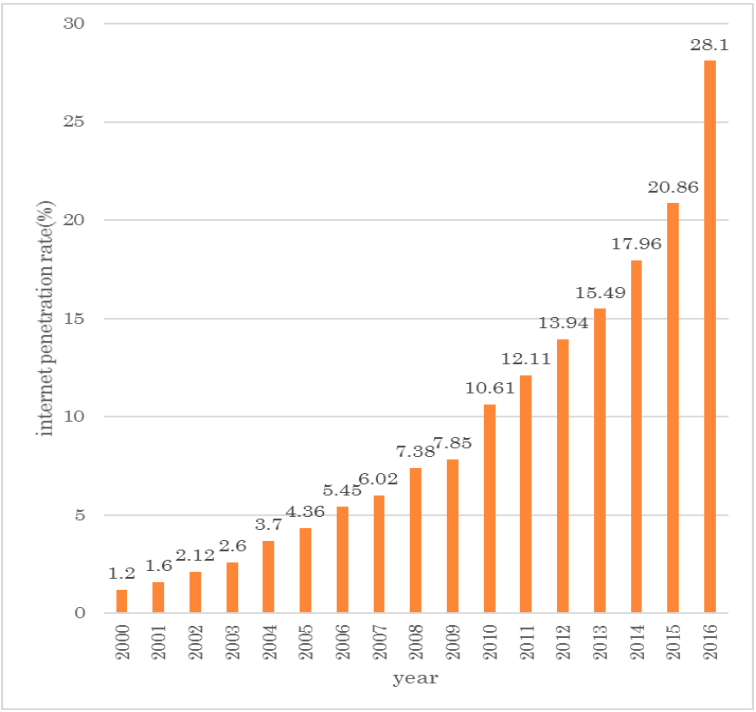
Internet has been viewed as a major type of ICT, which accelerates the economic growth by facilitating the development and adoption of innovation and development of new products and business models (Czernich, 2009). Several studies found that the impact of internet on economic growth could be viewed through various channels which are improving productivity across regions as well as different stages of development (Bertschek & Niebel, 2016), enhancing competition in markets by providing accurate information and lower cost of entry (Freund and Weinhold, 2004), and providing an efficient and less expensive platform for marketing and advertising (Chukwu & Uzoma, 2014).

This has led researches focused on the impact of impact of internet on economic growth in several countries or regions, such as USA (Altig and Rupert ,1999; Holt and Jamison, 2009), developing countries (Kenny, 2003), 207 countries (Choi and Yi, 2009), 33 upper-middle income countries (Hadavand, 2011), OECD countries (Czernich *et al*., 2011), South East Asian countries (Meah, 2012), EU countries (Koutroumpis, 2009; Gruber *et al*. 2014), Sub-Saharan Africa (Albiman and Sulong, 2016; Tripathi and Inani, 2016), South Africa (Salahuddin and Gow, 2016), Arab and Middle Eastern countries (Harb, 2017). Most of these studies found positive impact of internet on economic growth, except for Meah (2012) found that negative relationship between internet and GDP per capita in South East Asian countries. The other factors related to internet access were also studied. For example, Niebel (2018) found positive relationship between ICT and economic growth in developing emerging and developed countries.

Figure 1 shows the fact that Africa has been experiencing exponential growth of internet penetration rate. It was 1.2% in year 2000 and 28.1% in year 2016. The rapidly growing number of internet penetration rate in Africa has motivated the need to examine the contribution of internet to the development process.

[2] African Economic Outlook, 2016

Figure 1: Internet Penetration Rate in Africa from 2000 to 2016.



Source : International Telecommunication Union (ITU)

The purpose of this study is to estimate the effect of internet on the economic growth in Africa. This study covers 19 Africa countries[3] with estimated population of 500 million of people. Section 2 will discuss the economic background and internet penetration in the 19 Africa countries. Section 3 presents theoretical framework, model and data. Results and conclusion are discussed in Section 4 and 5, respectively.

2. Economic Background in the 19 Africa Countries

The World Bank classified countries into four groups: low income; lower-middle income; upper-middle income; and high income, based on Gross National Income (GNI) per capita. Among the 19 African countries, eight countries are classified as low income which are Burundi, Burkina faso, Chad, Malawi, Mali, Mozambique, Rwanda and Uganda. Nine countries are in lower-middle incomes group which are Cameroon, Ghana, Kenya, Lesotho, Morocco, Mauritania, Tunisia, Niger, and Sudan. Two countries are in upper-middle income group which are South Africa and Mauritius. The economic background and internet penetration of these 19 African countries will be summarized and classified according to income classification in Table 1.

[3] They are Burundi, Burkina faso, Chad, Malawi, Mali, Mozambique, Rwanda, Uganda, Cameroon, Ghana, Kenya, Lesotho, Morocco, Mauritania, Tunisia, Niger, Sudan, South Africa and Mauritius.

Table 1: Economics Background and Internet Penetration of the 19 African Countries

Countries		Economic Background
Low income	(1) Burundi	**Located:** East **Significant Natural Resources:** Gold(including gold plated with platinum) **Significant agricultrual product:** coffee(not roasted, not decaffeinated) **Popoulation (2016):** 11.553 million people **Real GDP per capita growth:** -6.8% (2015) -3.6%(2016) **Inflation:** 5.55% (2015) 5.54% (2016) **Internet Penetration Rate:** 4.9 % of a total population (2015) 5.2 % of a total population (2016)
	(2) Burkina Faso	**Located:** West **Significant Natural Resources:** Gold(including gold plated with platinum) **Significant agricultrual product:** cotton (not carded/combine) **Popoulation (2016):** 18.634 million people **Real GDP per capita growth:** 0.9% (2015) 2.9%(2016) **Inflation:** 0.95% (2015) -0.25% (2016) **Internet Penetration Rate:** 11.4% of a total population (2015) 13.96% of a total population (2016)
	(3) Chad	**Located:** West **Significant Natural Resources:** petroleum and bitumenous oils, crude. **Significant agricultrual product:** - **Popoulation (2016):** 14.497 million people **Real GDP per capita growth:** -1.4% (2015) -9.9%(2016) **Inflation:** 3.67% (2015) -% (2016) **Internet Penetration Rate:** 3.5% of a total population (2015) 5% of a total population (2016)
	(4) Malawi	**Located:** South **Significant Natural Resources:** - **Significant agricultrual product:** Tobacco, dried leguminous crops **Popoulation (2016):** 17.750 million people **Real GDP per capita growth:** -0.2% (2015) -0.5%(2016) **Inflation:** 21.87% (2015) 21.71% (2016) **Internet Penetration Rate:** 9.3% of a total population (2015) 9.6% of a total population (2016)
	(5) Mali	**Located:** West

		Significant Natural Resources: Gold (incl. gold plated with platinum), in unwrought forms (excl. Powder) **Significant agricultrual product:** Cotton, not carded/combed **Popoulation (2016):** 18.135 million people **Real GDP per capita growth:** 2.9% (2015) 2.7%(2016) **Inflation:** 1.44% (2015) -1.80% (2016) **Internet Penetration Rate:** 10.3% of a total population (2015) 11.1% of a total population (2016)
	(6) Mozambique	**Located:** South **Significant Natural Resources:** Aluminium, not alloyed, natural gas liquefied **Significant agricultrual product:** - **Popoulation (2016):** 28.751 million people **Real GDP per capita growth:** 3.6% (2015) 0.9%(2016) **Inflation:** 2.39% (2015) 9.97% (2016) **Internet Penetration Rate:** 16.9% of a total population (2015) 17.5% of a total population (2016)
	(7) Rwanda	**Located:** East **Significant Natural Resources:** Niobium/tantalum/vanadium ores, gold **Significant agricultrual product:** Coffee, not roasted, not decaffeinated. **Popoulation (2016):** 11.883 million people **Real GDP per capita growth:** 6.2% (2015) 3.4%(2016) **Inflation:** 2.52% (2015) 5.73% (2016) **Internet Penetration Rate:** 18% of a total population (2015) 20% of a total population (2016)
	(8) Uganda	**Located:** West **Significant Natural Resources:**Gold (incl. gold plated with platinum). **Significant agricultrual product:** coffee(not roasted), cocoa (whole/broken, raw) **Popoulation (2016):** 40.323 million people **Real GDP per capita growth:** 1.8% (2015) 1.3%(2016) **Inflation:** 5.42% (2015) 5.46% (2016) **Internet Penetration Rate:** 17.8% of a total population (2015) 21.9% of a total population (2016)
Lower-Middle Income	(1) Cameroon	**Located:** Central Africa **Significant Natural Resources:** oil and gas, high-value timeber species, minerals, **Significant agricultrual product:** coffee, cotton, cocoa, maize, and cassava

		Popoulation (2016): 23.924 million people **Real GDP per capita growth:** 2.9% (2015) 1.8%(2016) **Inflation:** 2.7% (2015) 2.2% (2016) **Internet Penetration Rate:** 20.7% of a total population (2015) 25% of a total population (2016)
	(2) Ghana	**Located:** West **Significant Natural Resources:** Gold, petroleum oils and bituminous oil, crude. **Significant agricultrual product:** Cocoa beans, whole/broken, raw/roasted **Popoulation (2016):** 28.033 million people **Real GDP per capita growth:** 1.6% (2015) 1.3%(2016) **Inflation:** 17.15% (2015) 17.47% (2016) **Internet Penetration Rate:** 31.4% of a total population (2015) 34.7% of a total population (2016)
	(3) Kenya	**Located:** East **Significant Natural Resources:** Petroleum oils and oils obtained from bituminous minerals **Significant agricultrual product:** Tea, black tea(fermented/partly), cut flowers **Popoulation (2016):** 47.251 million people **Real GDP per capita growth:** 3.o% (2015) 3.2%(2016) **Inflation:** 6.58% (2015) 6.29% (2016) **Internet Penetration Rate:** 21% of a total population (2015) 26% of a total population (2016)
	(4) Lesotho	**Located:** South **Significant Natural Resources:**Diamonds, non-industrial, unworked/simply sawn **Significant agricultrual product:** Men/women clothing of cotton. **Popoulation (2016):** 2.16 million people **Real GDP per capita growth:** 1.2% (2015) 1.0%(2016) **Inflation:** 3.18% (2015) 6.61% (2016) **Internet Penetration Rate:** 25% of a total population (2015) 27.4% of a total population (2016)
	(5) Morocco	**Located:** North **Significant Natural Resources:** Ignition wiring sets, Phosphoric acids **Significant agricultrual product:** - **Popoulation (2016):** 34.817 million people **Real GDP per capita growth:** 3.1% (2015) -0.2%(2016)

		Inflation: 1.56% (2015) 1.64% (2016) **Internet Penetration Rate:** 57.1% of a total population (2015) 58.3% of a total population (2016)
	(6) Mauritania	**Located:** North **Significant Natural Resources:**.iron and copper ores concentrates. **Significant agricultrual product:** octopus, toher than fresh/chilled **Popoulation (2016):** 4.166 million people **Real GDP per capita growth:** -1.5% (2015) -0.8%(2016) **Inflation:** 0.48% (2015) 1.49% (2016) **Internet Penetration Rate:** 15.2% of a total population (2015) 18% of a total population (2016)
	(7) Tunisia	**Located:** North **Significant Natural Resources:** Ignition wiring sets used in vehicles/aircraft/ship. **Significant agricultrual product:** olive oil, virgin. Clothing of cotton. **Popoulation (2016):** 11.375 million people **Real GDP per capita growth:** -0.01% (2015) 0.02%(2016) **Inflation:** 4.86% (2015) 3.71% (2016) **Internet Penetration Rate:** 48.5% of a total population (2015) 50.9% of a total population (2016)
	(8) Niger	**Located:** West **Significant Natural Resources:** Gold (plated with platinum), petroleum oils. **Significant agricultrual product:** sesame seed whether or not broken. **Popoulation (2016):** 20.715 million people **Real GDP per capita growth:** 0.05% (2015) 1.09%(2016) **Inflation:** 1.0% (2015) 0.17% (2016) **Internet Penetration Rate:** 2.5% of a total population (2015) 4.3% of a total population (2016)
	(9) Sudan	**Located:** North **Significant Natural Resources:** Petroleum oils and gold (incl. Gold plated platinum) **Significant agricultrual product:** live sheep **Popoulation (2016):** 41.176 million people **Real GDP per capita growth:** 2.4% (2015) 2.2%(2016) **Inflation:** 16.91% (2015) 17.75% (2016) **Internet Penetration Rate:** 26.6% of a total population (2015)

		28% of a total population (2016)
Upper-Middle Income	(1) South Africa	**Located:** West **Significant Natural Resources:** Gold plated with platinum, platinum. **Significant agricultrual product:** - **Popoulation (2016):** 54.979 million people **Real GDP per capita growth:** -0.08% (2015) -1.01%(2016) **Inflation:** 4.59% (2015) 6.33% (2016) **Internet Penetration Rate:** 52% of a total population (2015) 54% of a total population (2016)
	(2) Mauritius	**Located:** South **Significant Natural Resources:** Petroleum oil and bituminous oil, diamonds. **Significant agricultrual product:** Tunas, skipjack and bonito **Popoulation (2016):** 1.277 million people **Real GDP per capita growth:** 3.3% (2015) 3.7%(2016) **Inflation:** 1.29% (2015) 1.02% (2016) **Internet Penetration Rate:** 50% of a total population (2015) 53.2% of a total population (2016)

Source: http://www.africaneconomicoutlook.org/en/statistics
https://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG
https://data.worldbank.org/indicator/FP.CPI.TOTL.Z

3. Theoretical Framework, Model and Data

3.1 Theoretical Framework and Model

The endogenous growth theory, by Romer (1989), suggested to add technological change to production function as internal means to drive up the economic growth. Technological change (*A*) is arised from intentional investment decision made by profit maximizing firm. In addition to the labor (*L*), the endogenous growth theory disaggregate capital into physical capita (*K*) and human capital (*H*). Thus, we have the equation (1).

$$y = f(L, K, H, A(t)) \quad (1)$$

We adopt both the endogenous growth theory, represented by equation (1) to study the output determination of 19 Africa countries from 2003 to 2014. By following Barro (1996), we use life expectancy at birth ($LIFE_{it}$) and the number of the population with secondary education ($EDUC_{it}$)[4] to measure the quality of human capital; the number of internet users (NET_{it}) to measure the technology input, the subscript *it* represents country *i* at time period *t*. Hence, the equation (1) can be rewritten for this study as follows.

[4] This data is calculated by the secondary school enrollment (%) multiply by the population aged less than 15 years.

$$y_{it} = f(L_{it}, K_{it}, LIFE_{it}, EDUC_{it}, NET_{it}, t) \quad (2)$$

where the variable time trend (t) is added to the model to account for other forms of technology and innovations apart from internet penetration. We use the translog function form to represent for the parametric production frontier in the equation (2) which is written by

$$\begin{aligned}\ln y_{it} = {} & \beta_0 + \beta_L \ln L_{it} + \beta_K \cdot \ln K_{it} + \beta_{LIFE} \cdot \ln LIFE_{it} + \beta_{EDUC} \cdot \ln EDUC_{it} + \beta_{NET} \cdot \ln NET_{it} + \beta_t \cdot t \\ & + \beta_{LK} \ln L_{it} \cdot \ln K_{it} + \beta_{LLIFE} \ln L_{it} \cdot \ln LIFE_{it} + \beta_{LEDUC} \ln L_{it} \cdot \ln EDUC_{it} + \beta_{LNET} \ln L_{it} \cdot \ln NET_{it} \\ & + \beta_{Lt} \ln L_{it} \cdot t + \beta_{KLIFE} \ln K_{it} \cdot \ln LIFE_{it} + \beta_{KEDUC} \ln K_{it} \cdot \ln EDUC_{it} + \beta_{KNET} \ln K_{it} \cdot \ln NET_{it} \\ & + \beta_{Lt} \ln K_{it} \cdot t + \beta_{LIFEEDUC} \ln LIFE_{it} \cdot \ln EDUC_{it} + \beta_{LIFENET} \ln LIFE_{it} \cdot \ln NET_{it} \\ & + \beta_{LIFEt} \ln LIFE_{it} \cdot t + \beta_{EDUCNET} \ln EDUC_{it} \cdot \ln NET_{it} + \beta_{EDUCt} \ln EDUC_{it} \cdot t + \\ & + \beta_{NETt} \ln NET_{it} \cdot t + 0.5\beta_{Lsq} \ln^2 L_{it} + 0.5\beta_{Ksq} \ln^2 K_{it} + 0.5\beta_{LIFEsq} \cdot \ln^2 LIFE_{it} \\ & + 0.5\beta_{EDUCsq} \cdot \ln^2 EDUC_{it} + 0.5\beta_{NETsq} \cdot \ln^2 NET_{it} + 0.5\beta_{tsq} \cdot t^2 + \alpha_i + v_{it} \quad (3)\end{aligned}$$

where the actual output y measured by real GDP, the physical capital K is measured by gross fixed capital formation, L is labor force, α_i is unobserved effect with invariant over time, and v_{it} is stochastic disturbnace term. The data of all variables for the nineteen African countries started from 2003 to 2014 are obtained from the World Development Indicators (WDI , World Bank, 2016). The descriptive statistics of sample is shown in Table 2.

Table 2: Descriptive Statistics of all Variables in the Nineteen African Countries

Variables	Unit	Mean	Maximum	Minimum	Standard Deviation
y	Constant 2010 USD Million	38,408	412,096	1,538	79,671
L	people	7,282,443	20,001,038	533,478	4,815,121
K	Constant 2010 USD Million	8,304.40	85,249.28	246.46	16,057.98
LIFE	Years	58.07	74.60	43.53	7.77
EDUC	people	3,294,861	15,751,521	239,787	3,564,893
NET	people	2,347,610	12,612	26,488,737	4,608,331

4. Results

4.1 Fixed Effect Estimation

Based on equation (3), α_i represents unobserved effects with invariant overtime such as political policy, natural resources, religion, and belief. These unobserved effects can be correlated with inputs. For example, government policy might correlate to internet usage, education and health expenditure; while natural

resources of each country might affect physical capital. Hence, fixed effect model is appropriate to adopted in this study[5].

The results of fixed effect estimation shows that only nine from twenty-seven coefficients are significantly different from zero at 10% significant level. We check the serial correlation of the model as suggested in Wooldridge (2002)[6], the pool ordinary least square (POLS) regrssion of $e_{it} = \rho e_{i,t-1} + error_{it}$ is estimated, where e_{it} is the fixed effect residuals. The robust *t*-statistics for pool ordinary least square (POLS) is used to test the null hypothesis H_0: $\rho = 0$. The result shows that the robust *t*-statistics is 4.20 and its P-value is 0.001. This indicates that autocorrelation exists in the model. Moreover, when heteroskedasticity is checked using the White test, $e_{it}^2 = \gamma_i + \boldsymbol{\delta x_{it}} + error_{it}$, where $\boldsymbol{x}$ is the vector of independent variables. Using the fixed effect model, the result shows that the F-statistics for testing H_0: $\boldsymbol{\delta} = 0$ is 2.05 and its *p-value* is 0.0029. The heteroskedasticity also exists in the model. Hence, the standard errors in the fixed effect model are not correct.

4.2 Fixed Effect- Iterated GLS (FE-IGLS) Estimation

When the model has serial correlation and heteroskedasticity, Woodridge (2002: page 276) suggested to use Fixed Effect GLS estimators which is more efficient then FE estimators. We estimate the model by Fixed Effect-Iterated Generalized Least Square (FE-IGLS) where serial correlation and heteroskedasticity are allowed. Table 3 shows that there are thirteen from twenty-seven coefficeints significantly different from zero. We check if the result is spurious by testing if the residuals of FE-IGLS estimate are stationary or nonstationary. The panel unit root test proposed by Levin – Lin – Chu is adopted, the result shows that the *t*-statistics is –5.10 and its p-value is 0.000. Hence, the residual of FE-IGLS is stationary, or the estimation results are not spurious.

The results of FE-IGLS estimates show that ln *L* and *t* have positive and significant impact on economic growth; while ln *K*, ln *LIFE*, and ln *NET* have negative and significant impact on ecoonomic growth. The result indicates that ln *EDUC* has no impact on economic growth. When we consider the squared terms of these inputs, we found that $0.5\ln^2 LIFE$ has positive impact on ecnomic growth; while $0.5\ln^2 NET$ and $0.5t^2$ have negative effect on economic growth; $0.5\ln^2 L$, $0.5\ln^2 K$ and $0.5\ln^2 EDUC$ have no impact on economic growth. This implies that ln *L* and ln *K* have constant impact on economic growth, regardless of level of ln *L* and ln *K*. The effect of ln *LIFE* to economic growth can be reflected by u-shape, which indicates that ln *LIFE* would have positive impact on economic growth for African countries with the level of ln *LIFE* beyond the minimum point of the u-shape. On the other hand, we found that the effect of ln *NET* and *t* to economic growth can be reflected by open downward u-shape, this implies that ln *NET* and *t* would have positive impact on economic growth for African countries with the level of ln *NET* and *t* not beyond the maximum point of the downward u-shape.

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[5] We use 19 African countries (N=19) and time periods started from 2003 to 2014 (T= 12). In the case of *T* is not large, panel-cointegration is not appropriate.

[6] Wooldridge, J. M. (2002) Econometric Analysis of Cross Section and Panel Data. The MIT Press, London, England, page 275.

When we consider the interaction terms of these inputs, we found that ln *L*•ln *LIFE*, ln *L*•*t* and ln *K*•*t* have negative impact on economics growth. This implies that the effect of ln *L* depends on the level ln *LIFE*, or vice versa. The effect of ln *L* and ln *K* depends on *t*, or vice versa. Moreover, we found that ln*K*•ln*NET* and ln*NET*•*t* have positive impact on economics growth. This implies that the effect of ln *K* and *t* depends on the level of ln*NET*, or vice versa.

We calculate the elasticity of output (*y*) with respect to each labour (*L*) by $\frac{\partial \ln y}{\partial \ln L}$ which equals to 7.331 − 0.011•ln *K* − 1.171•ln *LIFE* − 0.088•ln *EDUC*+ 0.066•ln *NET* −0.045 •*t* − 0.114• ln *L*. Since the coefficiencts of ln *L*•ln *K*, ln *L*•ln *EDUC*, ln *L*•ln *NET* and $0.5\ln^2 L$ are insignificant, $\frac{\partial \ln y}{\partial \ln L}$ = 7.331 − 1.171•ln *LIFE* − 0.045 •*t*. The other input elasticity can be calculated in the same way. All of inputs elasticities are shown in Table 4.

We found that the elasticity of output with respect to labor equals to 7.331 if ln *LIFE* and *t* are zeros and it can be lower if ln *LIFE* and *t* are higher. This implies that developement of technology other than internet can be substituted for labor. The Longer life expectancy can lead to elderly people stay in labor force longer, which might lead to less productivity and lower labor elasticity.

The capital elasticity is –1.549 if ln *NET* is zero and is higher if ln *NET* increases. This implies that African countries might have problem of capital, such as capital might not be used in an efficient way. Internet might be one of communication technology to acknowledge how to use capital more efficient.

We found that the elasticity of output with respect to *LIFE* depends on ln *L* and its value of ln *LIFE*. The increasing rate in *LIFE* might lead to higher in $\frac{\ln y}{\ln LIFE}$. This implies that the governments should invest in public health to increase life expectancy at birth. Moreover, increasing in labor might have negative effect on $\frac{\ln y}{\ln LIFE}$, this implies that when more people get through labor force, the human capital related to life expectancy at birth might be less concerned by the governments. The elasticity of with output respect output human capital is zero. This implies that African countries might have problem of secondary education, such as education system might not be suitable to production in their countries.

The results show that internet usage elasticity $\left(\frac{\ln y}{\ln NET}\right)$ has positive relationship to ln *K* and *t*; and has negative relationship to ln *NET*. This implies that the usage of internet cannot be the solely input to to increase output; it should be use as complementary to captial and technology other than internet.

Finally, the results show that the elasticity of output with respect to technology other than internet has positive relationship with internet, and negative relationship with labor and capital. This implies that when more people get through labor force or more capital is invested, technology other than internet might be less concerned. Furthermore, we found that higher people use internet support technology to produce output more efficient.

Table 3: Fixed Effect – Iterated GLS (FE-IGLS) Estimation

Variables	Estimator	Variables	Estimator
ln *L*	7.331	ln *K*• *t*	−0.011
	(2.13)***		(0.005)*
ln *K*	−1.549	ln *LIFE*•ln *EDUC*	0.013
	(0.56)***		(0.54)
ln *LIFE*	−40.234	ln *LIFE*•ln *NET*	−0.024
	(9.21)***		(0.14)
ln *EDUC*	−2.891	ln *LIFE*• *t*	−0.045
	(2.11)		(0.03)
ln *NET*	−1.175	ln *EDUC*•ln *NET*	−0.026
	(0.58)**		(0.06)
t	0.676	ln *EDUC*• *t*	0.014
	(0.14)***		(0.01)
ln *L*•ln *K*	−0.011	ln *NET*• *t*	0.020
	(0.05)		(0.005)***
ln *L*•ln *LIFE*	−1.171	$0.5\ln^2 L$	−0.114
	(0.483)**		(0.16)
ln *L*•ln *EDUC*	−0.088	$0.5\ln^2 K$	−0.011
	(0.15)		(0.04)
ln *L*•ln *NET*	0.066	$0.5\ln^2 LIFE$	14.713
	(0.04)		(2.57)***
ln *L*• *t*	−0.045	$0.5\ln^2 EDUC$	0.192
	(0.01)***		(0.20)
ln *K*•ln *LIFE*	−0.005	$0.5\ln^2 NET$	−0.072
	(0.17)		(0.03)**
ln *K*•ln *EDUC*	0.106	$0.5\ t^2$	−0.005
	(0.07)		(0.001)***
ln *K*•ln *NET*	0.068	Constant	68.027
	(0.02)***		(15.22)***

Note The values in ( ) are standard error;

***, **, and * represents for 1%, 5%, and 10% significant level, respectively.

Table 4: The Effects of Inputs Variable to the Elasticity of *y*

Coefficients	Elasticity of *y* with restpect to inputs					
	$\frac{\partial \ln y}{\partial \ln L}$	$\frac{\partial \ln y}{\partial \ln K}$	$\frac{\partial \ln y}{\partial \ln LIFE}$	$\frac{\partial \ln y}{\partial \ln EDUC}$	$\frac{\partial \ln y}{\partial \ln NET}$	$\frac{\partial \ln y}{\partial t}$
Constant	7.331***	−1.549***	−40.234***	—	−1.175**	0.678***
ln *L*	—	—	−1.171**	—	—	−0.045***
ln *K*	—	—	—	—	0.068***	−0.011*
ln *LIFE*	−1.171**	—	14.713***	—	—	—
ln *EDUC*	—	—	—	—	—	—
ln *NET*	—	0.068***	—	—	−0.072**	0.020***
t	−0.045***	—	—	—	0.020**	−0.005***

***, **, and * represents for 1%, 5%, and 10% significant level, respectively.

5. Conclusion and Policy Implication

As being the world's second fastest growing economy after East Asia and relatively higher growth rates of internet penetration compared to the other regions in the world, this paper aims to study the effect of internet on economic growth in African. Data included 19 African countries from 2003 to 2014 and applied with the Fixed Effect- Iterated Generalized Least Square (FE-IGLS) estimation to correct for serial correlation and heteroskedasticity problems. We found that the residuals of the model are stationary based on Levin – Lin – Chu panel unit root test. This implies that the model has no spurious regression problem, we can use the results to interpret the growth in the 19 African countries.

We found that an input elasticity would depends on the level of other inputs. The internet usage itself cannot boost outputs in the 19 African countries, but it can raise outputs when adopting internet usage with capital and technology other than internet. The results also indicated that increasing in labour deteriorate the elasticity of output with respect to human capital in longer life expectance and with respect to technology other than internet. Capital enhanced the output elasticity with respect to internet usage but it eroded the output elasticity with respect to technology other than internet. We found that human capital investment related to longer life expectancy would deteriorate the output through decreasing in labor elasticity. However, human capital investment in secondary education would not help to increase output. Finally, technology other than internet worsen the elasticity of output with respect to labor but enhanced the internet usage elasticity.

These results imply that Afrian government should not promote internet usage solitary, but it should facilitate the internet usage along with technology other than internet and captial investment. Secondary education was not enough to support growth. African governments should support children to enter in education higher than secondary level and encourage labor using internet to boost up their knowledge. Moreover, they should provide training to labors to raise their productivity, for example, training how to use capital and technology efficiently.

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