Linkages between Formal Institutions, ICT Adoption and Inclusive Human Development in Sub Saharan Africa

Andrés, Antonio R. and Amavilah, Voxi and Asongu, Simplice A

August 2016

AFRICAN GOVERNANCE AND DEVELOPMENT INSTITUTE

A G D I Working Paper

WP/16/026

Linkages between Formal Institutions, ICT Adoption and Inclusive Human Development in Sub Saharan Africa

Antonio R. Andrés [1], Voxi Amavilah [2], & Simplice A. Asongu [3]

[1] School of Business, Universidad del Norte, Barranquilla Colombia.
E-mail: antoniorodriguez@uninorte.edu.co

[2] REEPS, Arizona, USA.
E-mail: amavilah@msn.com

[3] African Governance and Development Institute, Yaoundé, Cameroon.
E-mail: asongusimplice@yahoo.com/ asongus@afridev.org

AGDI Working Paper

Research Department

Linkages between Formal Institutions, ICT Adoption and Inclusive Human Development in Sub Saharan Africa

Antonio R. Andrés, Voxi Amavilah, & Simplice A. Asongu

August 2016

Abstract

Using data for 49 African countries over the years spanning 2000-2012, and controlling for a wide range of factors, this study empirically assesses the effects of formal institutions on ICT adoption in developing countries. It deploys 2SLS and FE regression models, (a) to estimate what determines ICT adoption and (b) to trace how ICT adoption affects inclusive development. The results show that formal institutions affect ICT adoption in this group of countries, with government effectiveness having the largest positive effect and regulations the largest negative effect. Generally, formal institutions appear more important to ICT adoption in low income countries than middle income countries, whereas population and economic growth tend to constrain ICT adoption with low income countries more negatively affected than middle income countries. The results further demonstrate that ICT adoption affects development strongly, and that such effects are comparable to those of domestic credit and foreign direct investment. *Ceteris paribus*, external factors like foreign aid are more limiting to inclusive development than internal factors. This suggests that developing countries can enhance their ICT adoption for development by improving formal institutions and by strengthening domestic determinants of ICT adoption. Both represent opportunities for further research.

Keywords: Formal institutions, ICT adoption, panel data models, cross-country analysis.
JEL: G20; I10; I32; O40; O55

1. Introduction

In the past twenty years or so, there has been a major change in thinking about the appropriate role of telecommunications as growth and development enhancers. The formal literature on the topic is extensive. For instance, it has been stated that the adoption with diffusion of information and communication technologies (ICTs) promote growth and growth promotes ICTs adoption and diffusion (Norris, 2001; Steinmueller, 2001; Brynjolfsson & Hitt, 2003; Wallsten, 2005, Harggitai, 1999; Quibria et al., 2000; Dasgupta et al., 2001; Oxley & Yeung, 2001; Robison & Crenshaw, 2002; Kiiski & Pohjola, 2002; Bellock & Dimitrova, 2003; Chinn & Fairlie, 2007). Billón, Marco and Lera-Lopez (2009) studied the patterns and factors affecting the adoption[1] of ICTs in developed and developing countries. They found that economic growth especially the service sector of it, education, and government effectiveness explain high ICT adoption rates in developed countries, while in developing countries it is the age of the urban population and internet costs that affect ICT adoption rates positively and negatively, respectively. Kiessling (2007) associated ICT adoption in 82 developed and developing countries with economic, financial, and political institutions, as well as with per capita income and education. He discovered that institutional effects on ICT adoption varied across countries, but that they were comparable in terms of magnitude to those of education and per capita GDP. However, studies like Kiessling's remain few and even fewer of them address the role of formal institutions in ICT adoption. In this limited sense, Dekimpe, Parker and Sarvary (2000) are correct in asserting that existing models "*are not very useful to explain the breadth of technology adoption across countries, [mainly because] they treat each country as a homogeneous unit, and cannot explain why some countries have a higher probability of adopting in a given year than others*" (p. 3). Such models neglect the "wildfire phenomenon" in the spread of innovations outlined in Amavilah (2008; 2007). Moreover, Wejnert (2002) and Young (2004; 2005; 2007) address similar issues as well. Furthermore, formal comparisons of the relative influences of each institutional quality indicator on ICT within developing countries are also missing from existing literature (for an extensive review of technology adoption theories, see for instance, Geroski, 2000; Rogers, 1995).

The aim of this study is, first, to empirically assess the effects of good governance on ICT adoption at the country level. We analyze variations in ICT adoption across a group of 49 African countries as an illustration of how ICT catalyzes development in developing countries

[1]Where the term "adoption" appears in this study, it should be read and understood as "adoption with diffusion." Under conditions of rapid technological change an ICT that is just adopted, may never be diffused, and for this reason we stress ICTs that have been adopted and penetrating the economy as catalysts for inclusive development.

(Appendix 1). Particularly, on the left-hand side (LHS) of our estimations we consider the adoption of two technologies: cellular (mobile) phone, and Internet. Obviously this list can be extended to include personal computers, broadband users, land telephone lines, etc. However, among ICTs newer technologies and/or new uses of old technologies have had stronger impacts than others. Hence, our choice of the two is enough to explain the disparities in ICT adoption among developing countries and the implications of doing so for catalyzing development.

As we discuss further later, some of the dependent variables employed in this study are: mobile phone, and internet, penetration rates. The disparity in these rates approximate differences in ICT adoption, so that we include measures of the quality of formal institutions as predictors, and several controls. Second, once we estimated factors influencing ICT adoption, we examine how ICT catalyzes development. Such an approach departs from previous studies which have used indexes of institutional quality such that aggregation ignores the relative importance of the weight of the factors in the index (Billón et al., 2009; Caselli & Coleman, 2001) in all this. Our main hypothesis is that cross-country differences in institutional quality, and hence ICT adoption enhances or limits inclusive development. As proxies for good governance, we employ the World Bank indicators of governance.

The paper is organized as follows: Section 2 below provides a short theoretical stand behind the empirical model in Section 3. We describe key variables and data in Section 4, and implement the empirical model in Section 5. The results and their implications are in Section 6, and Section 7 draws conclusions from the exercise.

2. Theoretical Standing

We assume a basic Schumpeterian model in which the economic activity is described as

$$Y_i = \left(A_i^{\alpha_i} \mathrm{S}_\mathrm{i}^{\beta_\mathrm{i}} \mathrm{X}_\mathrm{i}^{\gamma_\mathrm{i}}\right) \exp(\mu_i) \qquad (1)$$

where, Y_i is the real GDP of the i^{th} economy. In Schumpeter's terminology A_i (technology, including ICT) and S_i (socio-economic setting, including institutions) are "evolution components" and X_i are "growth components", including conventional factors of production (Schumpeter, 2005[1911]; cf. Becker, Eblinger, Hedtke, and Knudsen, 2005; Bazhal, 2016). Key to growth among X_i is capital accumulation, which over time depends on investment (I) equal to savings in a steady state, and savings come from profit made possible by technological change and the socio-economic setting surrounding it. The evolution of the socio-economic

environment is a function of resources, technology, and the level of development. In other words,

$$\frac{dK_{it}}{dt} = k\left[\frac{dI_{it}}{dt} = f\left(\pi_i(A_i, S_i)\right)\right], \frac{dS_{it}}{dt} = s(X_i, A_i, S_i), \pi = profit \quad (2)$$

A Schumpeterian technological change is discontinuous due to five initiators: (a) introduction of new ideas, requiring technological know-how; (b) introduction of new production techniques for which funds (credit) is essential; (c) discovery of new sources of supply; (d) discovery of new markets; and (e) change in the structure and organization of the industry involved. Thus, in dynamic form (1) is characterized by the Schumpeter-Kondratiev waves (cycles), such that A_i is sinusoid, i.e.,

$$A_i(t) = A_0 \exp\ (\varphi\, t + Cos\ (bt + \ \psi)$$

and for φ < 0, A_i is decaying, and expanding if φ > 0. Such a view is consistent with Dekimpe, Parker, and Sarvary's (2000) Equations 3 and 4 (p. 6), but we do not pursue this line of thought further. Instead, from (1) we solve for A_i as

$$A_i = Y_i^{1/\alpha_i} S_i^{-\beta_i/\alpha_i} X_i^{-\gamma_{i/\alpha_i}} \quad (3)$$

Then dividing both sides of (3) by some specific $X_i = X_i^*$ such as population or labor (worker), and taking the natural logs on both sides, we get a per capita (per labor, per worker, per head) indicator of adoption with diffusion) as follows:

$$\dot{A}_i = \alpha_i^* \dot{y}_i + \ \beta_i^* \dot{s}_i + \gamma_i^* \dot{x}_i + \mu_i \quad (4)$$

where $\dot{A} = \log(\frac{A_i}{X_i^*}) = ICT_i;\ \alpha_i^* = \frac{1}{\alpha};\ \dot{y}_i = economic\ growth; \beta_i^* = \frac{\beta_i}{\alpha_i}; \dot{s}_i = \log\left(\frac{S_i}{X_i^*}\right) =$ $economic\ setting\ (governance)\ ; \gamma_i^* = \frac{\gamma_i}{\alpha_i};\ \dot{x}_i = \frac{X_i}{X_i^*} =$ $primary\ and\ other\ drivers; and\ \mu_i = the\ random\ classical\ error\ term.$ The model is next.

3. Empirical Model

The empirical set-up formally examines the impact of formal institutions (S) on ICT adoption (Ȧ), i.e., the estimated (4) has the following general (reduced) form:

$$\dot{A}_i \equiv ICT_i = Constant + \alpha_i^* EconGrowth_i + \beta_i^* Institutions_i + \gamma_i^* Controls_i + \lambda_i + \nu_i \quad (5)$$

for λ = country-fixed effect. Although assumed fixed we understand country-effect are all bunches other dummy-effects due to time and regional variations.

Again, ICT represents the average ICT adoption as cellular (mobile) phones and internet in this case, and $\alpha_i^*, \beta_i^*, and\ \gamma_I^*$ are parameters to be estimated. Moreover, to illustrate how ICT adoption catalyzes development we insist that economic growth promotes ICT adoption, and the relationship between GDP and ICT adoption is well documented in the development literature. For example, Harggitai (1999), Quibria et al (2000), Kiiski and Pohjola (2002), Bellock and Dimitrova (2003), and Chinn and Fairlie (2007) all have shown that GDP is a large determiner of Internet access. Also GDP helps us assess the effects of the income levels on ICT adoption among developing countries. Furthermore, the education attainment of the population can also affect the delay in adopting ICT technologies. We expect this variable to have a positive association with ICT adoption decisions.

Finally, ICT catalyzes development. However, there is no commonly agreed up definition of development. In general development implies structural change in the economy that is accompanied by measurable improvement in quality of life of the people. That leaves us with the difficulties of measuring development. Many times development is measured as improvements in the human development index (HDI), real GDP per capita, labor markets (low unemployment, high wages, better working conditions, etc.), financial markets, productivity, competitiveness, poverty reduction, human capital and technological knowledge, globalization, health, and security. Even so, we can still specify Development as a function of ICT estimated in (5), i.e.,

$$Development_i \equiv IHDI_i = \delta_{0i} + \delta_{1i} ICT_i^* + \delta_{2i} Z_i + \varepsilon_i, \quad (6)$$

where, IHDI is the inequality adjusted human development index, δ are coefficients of development to be estimated, $ICT_i^* \equiv \dot{A}_i$ is estimated from (5), and Z are the determinants of Development not already included in (5). There is a lot on (5) in the literature, see, e.g., Baliamoune-Lutz (2003), Detschew (2007), UN (2004), Papaioannou, and Dimelis (2007), Gholami et al. (2010), Seo et al. (2009), and so on, but first consider key variables and data next. The next section provides details about the key variables and associated data.

4. Key Variables and Data

4.1 Dependent variables for ICT adoption (A = ICT)

As proxies for ICT adoption, we examine two ICT technologies: mobile phone penetration and internet penetration rates. Of course, this can be extended to broadband users, telephone lines, etc. Unlike Caselli and Coleman (2001) who measure adoption of computers as investment per worker of computer produced domestically and/or imported, here dependent variables are measured as the rate of adoption of ICT per 100 people. The adoption of these dependent variables is consistent with recent African knowledge economy literature (Tchamyou, 2015).

4.2 Determinants of ICT adoption with diffusion

Many factors determined ICT adoption. However, in this chapter we stress only a few predictors, beginning with formal institutions.

4.2.1 Institutions and Institutional Quality (S)

Our key explanatory variable of interest is governance, which is a multidimensional and broad term. We define governance as the way in which policy makers are empowered to make decisions and the manner in which policy decisions are formulated and executed. The governance data come from Kauffmann, Kraay, and Mastruzzi's (2010) and the World Bank[2].

To operationalize this concept, we use a set of governance indicators that capture different aspects of governance. The World Bank indicators meet this requirement because they are constructed from several sources including polls of experts, and surveys of residents, and entrepreneurs within a country, and they could be grouped into three concepts (Kaufmann et al., 2010). The first concept is about the process by which those in authority are selected and replaced (Political Governance): voice and accountability, and political stability. The second has to do with the capacity of government to formulate and implement policies, and to deliver services (Economic Governance): regulatory quality and government effectiveness. The last deals with the respect for citizens and the state of institutions that govern the interactions among them (Institutional Governance): rule of law, and control of corruption.

Each indicator, normalized to range from −2.5 to 2.5, with a zero mean and a standard deviation of one, provides a subjective assessment of some aspect of a country's quality of governance. Higher values signal better governance. Although the quality of available data suffers from the data aggregation problems, one of the advantages of aggregate indicators is

[2]The World Bank data is available at: http://info.worldbank.org/governance/wgi/index.aspx#home.

that they are more informative about broad concepts of governance. Individual data provides a noisy signal of the broader concept of governance, which is good for statistical significance and not necessarily for economic significance. Aggregate indicators also provide a countrywide coverage than individual indicators do. Moreover, we employ each indicator in isolation as they measure different aspects of the impact of formal institutions on ICT adoption.

When looking at institutional quality indices, note that there is likely to be less random variations, or significant trends over time. Even so, institutional quality is expected to influence ICT adoption. Although we do not test for it, the causality channel is likely to be as follows: poor institutions would influence aggregate economic growth through productivity improvements. This would be an important channel for the effect of institutions on economic growth. Moreover, we control for other variables like per capita income, level of education, and so on as pointed out previously.

4.2.2 Other variables (X)

Previous research has used many explanatory variables. Billón et al. (2009), for example, argued that disparities in ICT adoption depend on GDP per capita, population aged 15-64 years old, the fraction of GDP that comes from the service sector, foreign trade as a percentage of GDP, the country's population density, the country's size of the urban population, educational level measured conventionally as years of schooling, government effectiveness, and dummies for the dominant market structure in, language, and income level of the country.

Focusing on the computers, Caselli and Coleman (2001) associate adoption with income per worker, and investment per worker calculated either as investment in the computing power of the country, value of imports of computing goods and services, or the sum of the two. Other variables they included were: the shares of GDP originating from agriculture and manufacturing, government spending as a percentage of GDP, manufactured imports from the Organization of Economic Co-operation and Development (OECD) as well as non-OECD countries, the country's structure of property rights, and a dummy for language. A notable exception here is the omission of human capital.

Kiessling (2007) examines cellular telephony, internet, and personal computers (PC). His study is closest to ours in the stress it places on economic, financial, and political institutions. Good economic institutions attract foreign interactions (investment, trade, aid), and are effective tools in devising effective government anti-diversion and anti-corruption policies (no corruption). Among economic variables, Kiessling (2007) also includes general price levels represented by consumer prices indices (CPIs). This inclusion is good because cross-country

comparison based on common prices are better than those made based on exchange rates; many developing countries have more than one exchange rates running parallel.

Financial institutions are intermediaries that either provide free market opportunities, or are friendly to the creation and delivery of such opportunities. How good these institutions are, is normally reflected in going rates of return on private investment, existence of a vibrant entrepreneurial activity and private credit, effective demand for ICTs (supply is not so important since ICTs can be transferred from abroad, for instance). Note that the existence of entrepreneurs with access to private credit is a key driver of capital formation in a Schumpeterian model – Equation 2 above. Among political institutions Kiessling used Polity 2, freedom of press, and rule of law, and ended his specification with the importance of education and income.

It is abundantly clear that ICT adoption depends on economic development measured as GDP per capita. The impacts on ICT adoption of human capital, and the percentage of population who have completed some form of tertiary education, the percentage of human resources in research and development (R & D), and cultural variables like language are critical, and we consider these as controls.

4.3 Key Development Dependent variables (Development)

The literature on the link between ICT and development is huge. The work by the UNCTAD (2006; 2011), UNDP (2008; 2010), and World Bank (2009; 2012) alone counts in hundreds of papers, conferences, workshops, meetings, and so on. The problem is that development is one of those things that nearly everyone knows it and no-one knows how to measure it, or at best there is no agreed upon measure of development. Some measure development as economic development, approximated by economic (real GDP per capita) growth. In truth development is broader than economic development, which is in turn wider than economic growth. However, it would not be appropriate to use GDP per capita growth again, because we used it already as a determinant of ICT.

An alternative measure of development is the Human Development Index (HDI). The HDI is broader than real GDP as it encompasses real GDP, and human capital formation in its health and education dimensions. It also has an additional advantage that it can be adjusted for inequalities due to income, wealth, poverty, gender, and so on. One of the HDI weaknesses is that it is an index, and therefore lacks sufficient variation and may cause some statistical problems in small sample regressions. However, Binder and Georgiadis (2011) argued that the

HDI and real GDP are affected by variables such as macro-policies differently. In this study we opt for the inequality-adjusted HDI (IHDI).

4.4 Key Development Determinants

The determinants of development are probably just as many and complex as development itself.

Estimated ICT (Ȧ ≡ ICT*)

For a set of predictors, we emphasize the role of ICT adoption as estimated in Equation 5. This is just another way of acknowledging the importance of formal institutions in development acting through ICT adoption, which differs from Binder and Georgiadis (2011), Rodrik (2000; 2001), Acemoglu and Robinson (2008), Acemoglu, et al., (2001), Rodrik, Subramanian and Trebbi (2004), and many others.

Other development determinants (Z)

Along with ICT, other determinants of development would include: Geography, foreign trade, FDI, remittances, and so on. Here too the literature is vast (see, e.g..,Anand et al., 2012; Mlachila et al., 2014; Asongu & Nwachukwu, 2016a). In a recent paper Livramento and Foray (2007), development is represented by "high growth entrepreneurship," which is driven by trade-related intellectual property rights (TRIPS). The paper is a Baumolian-Schmpumpterian emphasis on the entrepreneur as a driver of dynamic development, long with the level of the country's development, inflation rate, interest rate, and unemployment rate. We use domestic credit as a proxy for local capital market performance.

4.5 Data

Appendix 1 lists the group of countries included in this study. We modify the World Bank country classification in only two groups: low income and middle income. We do so because in the high income category there are only two African countries: Equatorial Guinea and Seychelles. The upper middle income group has only five African countries. This adjustment is defensible because one can argue that these countries are not advanced in terms of ICT.

As Appendix 2 shows the data used in this study were extracted from several sources. For instance, Appendix 2.1 defines ICT variables and data sources. Appendices 2.2 and 2.3 display ICT descriptive statistics and a uniform sample correlation matrix. Our ICT dependent variables are internet penetration and mobile penetration rates.

Appendices 3.1, 3.2, and 3.3, respectively, deal with variable definitions and data sources, descriptive statistics, and uniform size correlation matrix for the development variable, which we measure as inequality-adjusted human development index (IHDI).

The human development index (HDI) is defined as the average of results in three main areas, notably: (i) knowledge, (ii) decent living standards and (iii) health and long life. In addition to accounting for the average levels of achievements, the IHDI further accounts for the manner in which such achievements are distributed within the population by controlling the mean values of achievements for inequality. It follows that the IHDI adjusts the HDI for inequality. Control variables for the human development equation are: development assistance, private domestic credit, remittance and foreign direct investment. The choice of these variables is consistent with recent literature on inclusive development/growth (Anand et al., 2012; Mlachila et al., 2014; Asongu & Nwachukwu, 2016a). Their expected signs are discussed concurrently with the presentation of results.

5. Empirical strategy

Our strategy involves estimating a set of Equations 5 and 6. The first regression in both cases is for the entire sample of 49 countries, disregarding income level categories. The second regression focuses on 28 low-income countries; the third on 21middle income countries. We use two related estimators: Two Stage Least Squares (2SLS) and instrumental variable (IV) Fixed Effects (FE), corrected for an unknown form of heteroscedasticity. The latter acknowledges issues regarding the joint determination (causality) of ICT adoption and development. The former acknowledges that the link between ICT and development may not be a direct one.

This simple approach is informative as an indirect test for the efficiency and consistence of parameters, as well avoiding potential endogeneity issues.

6. Results

Tables 1-5 present the results obtained from the 2SLS and the IV FE estimation of Equations 5 and 6 above. Specifically Table 1 shows 2SLS effects of formal institutions on mobile phone penetration across the full sample of 49 African countries (Panel A), and across the sub-samples of 28 low income (Panel B) and 21 middle income (Panel C) countries. On average for all countries formal institutions promote ICT adoption, with the governement effectiveness contributing the largest. Considering the 28 low income and the 21 middle income countries separately, formal institutions strongly determine ICT adoption in all cases, except for the

quality of regulations which undermines ICT adoption in middle income countries. This is probably because the regulations in place are not sufficiently tailored towards enhancing ICT adoption. Moreover, the positive effects of corruption-control and political govenrance (political stability and voice & accountability) are not significant for ICT adoption in low income and middle income countries, respectively.

Regarding control variables, economic and population growth have disadvantaged ICT adoption in this group of countries. This result is reasonable, because if population grows faster than GDP growth, then per capita GDP upon which the calculation of economic growth is based would be low and ICT adoption similarly constrained. Furthermore, if growth does not trickle down to the poor segment of the population, then population segments that are socially under-privileged are unlike to increase ICT adoption. Such a narrative would be consistent with the position that in Africa, the rich prefer quality to quantity of children, and therefore have fewer kids than the poor (Asongu, 2013). Hence, population growth is mostly traceable to poor segments of the population. Overall, this interpretation is buttressed further by the fact that the recent growth resurgence in Africa that began in the mid 1990s has not benefited the poor (Fosu, 2015). In fact, a World Bank report on Millennium Development Goals (MDGs) has revealed that the extreme poverty been decreasing in all regions of the world with the exception of Africa where 45% of countries in SSA were susbtantially off-track from the MDG extreme povery target (Asongu & Nwachukwu, 2016b). While population and economic growth have demoted ICT adoption, openness to trade and human capital accumulation enhance ICT adoption in these countries.

By 2SLS formal institutions also promote ICT adoption meausred as internet penetration (Table 2). As with cellular (mobile) phone penetration, the quality of regulation is inversely correlated with ICT adoption in middle income countries. Unlike in the full sample, population growth, and trade allied with regulation, political stability, and the rule of law affect ICT when the sample is disaggregated by income levels. Even so, we can still say formal institutions, with the exception of the quality of regulation, improves ICT adoption in these countries. Howver, the improvement varies by income level. Accordingly, it is apparent from the results that ICT adoption in SSA is driven fundamentally by formal institutions more in low income countries than middle income countries.

Table 1. Mobile Phone Penetration and Governance, Eq. 5, 2SLS

	Dependent Variable: Mobile Phone Penetration Panel A: Full Sample					
	Political Governance		**Economic Governance**		**Institutional Governance**	
	Political Stability /Non Violence	Voice & Accountability	Regulation Quality	Government Effectiveness	Rule of Law	Corruption Control
Constant	**26.505*** (0.001)**	**25.298*** (0.003)**	**27.077*** (0.002)**	**24.833*** (0.003)**	**26.146*** (0.002)**	**20.469** (0.012)**
Political Stability(IV)	**6.256*** (0.000)**	---	---	---	---	---
Voice & Accountability(IV)	---	**7.841*** (0.000)**	---	---	---	---
Regulation Quality(IV)	---	---	**11.064*** (0.000)**	---	---	---
Government Effectiveness(IV)	---	---	---	**12.392*** (0.000)**	---	---
Rule of Law (IV)	---	---	---	---	**9.810*** (0.000)**	---
Corruption Control (IV)	---	---	---	---	---	**10.970*** (0.000)**
Economic Growth	-0.402 (0.107)	**-0.581** (0.022)**	**-0.573** (0.023)**	**-0.663*** (0.008)**	**-0.505** (0.046)**	**-0.492** (0.048)**
Trade Openness	**0.105** (0.016)**	**0.141*** (0.000)**	**0.146*** (0.001)**	**0.156*** (0.001)**	**0.132*** (0.003)**	**0.153*** (0.000)**
Population Growth	**-7.197*** (0.001)**	**-6.584*** (0.002)**	**-6.485*** (0.005)**	**-5.079** (0.016)**	**-6.473*** (0.003)**	**-5.517** (0.010)**
Primary School Enrolment	**0.148*** (0.002)**	**0.144*** (0.006)**	**0.145*** (0.006)**	**0.150*** (0.004)**	**0.156*** (0.002)**	**0.172*** (0.001)**
Adjusted R^2	0.226	0.229	0.233	0.244	0.228	0.234
Fisher	**13.40*****	**13.88*****	**16.69*****	**14.96*****	**13.71*****	**14.97*****
Observations	336	336	336	336	336	336
	Panel B: Low Income Countries					
Constant	2.453 (0.743)	5.354 (0.526)	7.781 (0.377)	5.641 (0.548)	5.062 (0.601)	-2.922 (0.729)
Governance (IV)	**5.547*** (0.001)**	**6.872*** (0.005)**	**10.803*** (0.000)**	**8?872*** (0.004)**	**7.577** (0.025)**	3.742 (0.301)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.172	0.165	0.184	0.162	0.155	0.140
Fisher	**10.14*****	**9.37*****	**12.42*****	**10.25*****	**10.13*****	**8.13*****
Observations	223	223	223	223	223	223
	Panel C: Middle Income Countries					
Constant	**54.265* (0.053)**	**40.600* (0.080)**	**39.309* (0.079)**	**38.280* (0.094)**	**42.641* (0.062)**	**33.900*** (0.141)**
Governance (IV)	5.791 (0.127)	2.915 (0.468)	**-0.982* (0.051)**	**10.629** (0.039)**	**8.660* (0.054)**	**12.334*** (0.006)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.186	0.175	0.176	0.201	0.195	0.223
Fisher	**6.32*****	**5.85*****	**6.73*****	**6.97*****	**7.18*****	**8.69*****
Observations	113	113	113	113	113	113

***,**,*: significance levels at 1%, 5% and 10% respectively.IV: Instrumental Variable. Governance (Political stability/non violence, voice & accountability, regulation quality, government effectiveness, rule of law and corruption-control).

Table 2. Internet Penetration and Governance, Eq. 5, 2SLS

	Dependent Variable: Internet Penetration					
	Panel A: Full Sample					
	Political Governance		**Economic Governance**		**Institutional Governance**	
	Political Stability /Non Violence	Voice & Accountability	Regulation Quality	Government Effectiveness	Rule of Law	Corruption Control
Constant	**11.095*** (0.000)**	**10.665*** (0.000)**	**9.825*** (0.000)**	**10.304*** (0.000)**	**11.144*** (0.000)**	**9.319*** (0.000)**
Political Stability(IV)	**1.780*** (0.000)**	---	---	---	---	---
Voice & Accountability(IV)	---	**2.177*** (0.000)**	---	---	---	---
Regulation Quality(IV)	---	---	0.746 (0.179)	---	---	---
Government Effectiveness(IV)	---	---	---	**2.466*** (0.000)**	---	---
Rule of Law (IV)	---	---	---	---	**2.883*** (0.000)**	---
Corruption Control (IV)	---	---	---	---	---	**2.944*** (0.000)**
Economic Growth	0.068 (0.321)	0.018 (0.794)	0.037 (0.609)	0.007 (0.913)	0.037 (0.585)	0.043 (0.531)
Trade Openness	-0.008 (0.348)	0.001 (0.840)	-0.001 (0.912)	0.003 (0.760)	-0.001 (0.895)	0.005 (0.608)
Population Growth	**-3.074*** (0.000)**	**-2.888*** (0.000)**	**-3.234*** (0.000)**	**-2.739*** (0.000)**	**-2.865*** (0.000)**	**-2.626*** (0.000)**
Primary School Enrolment	**0.019** (0.026)**	**0.018** (0.048)**	**0.028*** (0.003)**	**0.022** (0.011)**	**0.020** (0.020)**	**0.026*** (0.004)**
Adjusted R^2	0.252	0.254	0.210	0.214	0.258	0.256
Fisher	**9.95***	**5.681***	**10.00***	**10.24***	**10.75***	**9.85***
Observations	330	330	330	330	330	330
	Panel B: Low Income Countries					
Constant	0.381 (0.749)	-0.112 (0.931)	0.787 (0.506)	1.071 (0.408)	1.491 (0.253)	0.182 (0.885)
Governance (IV)	**0.724*** (0.001)**	0.433 **(0.244)**	**1.179** (0.022)**	**1.385*** (0.001)**	**1.477*** (0.001)**	**1.090** (0.050)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.088	0.058	0.085	0.089	0.095	0.070
Fisher	**6.07***	**2.73**	**2.73**	**4.25***	**4.62***	**3.94***
Observations	221	221	221	221	221	221
	Panel C: Middle Income Countries					
Constant	**18.058*** (0.002)**	**14.432** (0.011)**	**14.585** (0.019)**	**14.063** (0.022)**	**14.424** (0.012)**	**13.0119** (0.035)**
Governance (IV)	1.744 (0.144)	1.474 (0.195)	**-3.640*** (0.007)**	-0.326 (0.864)	0.044 (0.809)	1.671 (0.279)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.183	0.180	0.207	0.169	0.176	0.180
Fisher	**5.78***	**6.05***	**5.35***	**5.44***	**5.83***	**5.82***
Observations	109	109	109	109	109	109

***,**,*: significance levels at 1%, 5% and 10% respectively.IV: Instrumental Variable. Governance (Political stability/non violence, voice & accountability, regulation quality, government effectiveness, rule of law and corruption-control).

To examine the strengths of the 2SLS results, we ran the Hausman test for endogeneity, and the choice of the IV FE approach was based on that outcome. IV FE results are reported by Tables 3 and 4. In this case government effectiveness and population growth demotes ICT adoption, all else have positive effects. Strangely, by income levels the IV FE estimator yields negative instituitional effects on ICT adoption except for the corruption. Moreover, for all 49 countries, corruption, regualtion, trade, and population growth assist ICT adoption, and all else have negative effects, although statistically insignificant in most cases. Disaggregated by income levels, political stability, and corruption decrease ICT adoption in low income countries, and ICT adoption is favored by political stability, regulatory quality , and government effectivenes in middle income coume countries. The negative effects may be tracaeable to the fact that formal institutions are a necessary but not a sufficient condition for ICT adoption when country-specific effects are considered. In interpretting the results, it is also important to note that the findings in Tables 1-2 obtained only with control for simultaneity, while those in Tables 3-4 result from controlling for both simultaneity and unobserved heterogeneity. The broad implication herethen is that while formal institutions could enhance the adoption of ICT in SSA, sampled governments need to take into account country-specific institutional arrangements in the determination of ICT adoption policy outcomes. A corollary explanation may be that the weight of countries with negatively skewed government quality variables significantly influences the outcome of the sign of the estimated coefficient.

Table 3. Mobile Phone Penetration and Governance, Eq. 5,IV FE

Dependent Variable: Mobile Phone Penetration

Panel A: Full Sample

	Political Governance		**Economic Governance**		**Institutional Governance**	
	Political Stability /Non Violence	Voice & Accountability	Regulation Quality	Government Effectiveness	Rule of Law	Corruption Control
Constant	**-58.915*** **	**-77.499*** **	**-70.767*** **	**-101.188*** **	**-82.532*** **	**-54.858*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**
Political Stability(IV)	-1.091	---	---	---	---	---
	(0.789)					
Voice & Accountability(IV)	---	**-19.217** **	---	---	---	---
		(0.012)				
Regulation Quality(IV)	---	---	**-15.022***	---	---	---
			(0.059)			
Government Effectiveness(IV)	---	---	---	**-32.896*** **	---	---
				(0.000)		
Rule of Law (IV)	---	---	---	---	**-21.239*** **	---
					(0.009)	
Corruption Control (IV)	---	---	---	---	---	4.747
						(0.461)
Economic Growth	**-0.655** **	**-0.565** **	**-0.662** **	**-0.481***	**-0.672** **	**-0.671** **
	(0.019)	**(0.012)**	**(0.017)**	**(0.078)**	**(0.015)**	**(0.017)**
Trade Openness	0.039	0.051	0.035	-0.001	0.066	0.048
	(0.686)	(0.596)	(0.715)	(0.984)	(0.497)	(0.628)
Population Growth	0.804	1.837	1.238	4.641	2.597	0.068
	(0.839)	(0.640)	(0.753)	(0.238)	(0.513)	(0.986)
Primary School Enrolment	**0.836*** **	**0.875*** **	**0.855*** **	**0.958*** **	**0.876*** **	**0.840*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Hausman test	**26.23*** **	**32.71*** **	**30.90*** **	**46.70*** **	**33.23*** **	**22.56*** **
Within R^2	0.154	0.170	0.162	0.204	0.172	0.153
Fisher	**10.28*** **	**11.79*** **	**11.11*** **	**14.71*** **	**11.88*** **	**10.39*** **
Countries	45	45	45	45	45	45
Observations	336	336	336	336	336	336

Panel B: Low Income Countries

Constant	**-59.305*** **	**-67.618*** **	**-71.693*** **	**-117.286*** **	**-106.260*** **	**-68.206*** **
	(0.001)	**(0.001)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.001)**
Governance (IV)	-5.702	-11.355	-14.384	**-36.718*** **	**-32.822*** **	-12.576
	(0.157)	(0.151)	(0.104)	**(0.000)**	**(0.000)**	(0.102)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.212	0.212	0.215	0.283	0.261	0.215
Fisher	**10.19*** **	**10.20*** **	**11.35*** **	**14.94*** **	**13.36*** **	**10.36*** **
Countries	29	29	29	29	29	29
Observations	223	223	223	223	223	223

Panel C: Middle Income Countries

Constant	**-93.280** **	**-75.570***	-73.832	**-96.030** **	**-81.145***	**-123.568*** **
	(0.045)	**(0.096)**	(0.116)	**(0.040)**	**(0.082)**	**(0.009)**
Governance (IV)	**20.397***	**-43.392** **	-18.625	**-32.938***	4.248	**37.581*** **
	(0.088)	**(0.025)**	(0.364)	**(0.080)**	(0.839)	**(0.003)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.142	0.162	0.123	0.144	0.115	0.194
Fisher	**3.07** **	**3.57*** **	**2.58** **	**3.10** **	**2.40** **	**4.45*** **
Countries	16	16	16	16	16	16
Observations	113	113	113	113	113	113

***,**,*: significance levels at 1%, 5% and 10% respectively.IV: Instrumental Variable. Governance (Political stability/non violence, voice & accountability, regulation quality, government effectiveness, rule of law and corruption-control).

Table 4. Internet Penetration and Governance (Eq. (5))IVFE

	Dependent Variable: Internet Penetration Panel A: Full Sample					
	Political Governance		**Economic Governance**		**Institutional Governance**	
	Political Stability /Non Violence	Voice & Accountability	Regulation Quality	Government Effectiveness	Rule of Law	Corruption Control
Constant	-1.883 (0.552)	-3.517 (0.306)	-0.998 (0.767)	-4.387 (0.233)	-3.003 (0.406)	-0.535 (0.866)
Political Stability(IV)	0.719 (0.357)	---	---	---	---	---
Voice & Accountability(IV)	---	-1.023 (0.484)	---	---	---	---
Regulation Quality(IV)	---	---	1.727 (0.266)	---	---	---
Government Effectiveness(IV)	---	---	---	-1.459 (0.339)	---	---
Rule of Law (IV)	---	---	---	---	-0.443 (0.780)	---
Corruption Control (IV)	---	---	---	---	---	**2.842**** **(0.023)**
Economic Growth	-0.086 (0.107)	-0.078 (0.144)	-0.083 (0.120)	-0.075 (0.163)	-0.084 (0.116)	**-0.090*** **(0.090)**
Trade Openness	0.019 (0.298)	0.020 (0.290)	0.019 (0.304)	0.017 (0.362)	0.020 (0.296)	0.024 (0.199)
Population Growth	1.236 (0.104)	**1.365*** **(0.073)**	1.247 (0.100)	**1.479*** **(0.058)**	**1.343*** **(0.081)**	0.913 (0.235)
Primary School Enrolment	0.028 (0.235)	0.031 (0.187)	0.026 (0.258)	0.034 (0.151)	0.030 (0.205)	0.032 (0.169)
Hausman test	**20.16*****	**20.37*****	**18.15*****	**19.14*****	**18.77*****	**12.75****
Within R^2	0.030	0.028	0.031	0.030	0.027	0.044
Fisher	1.75	1.67	1.83	1.76	1.59	**2.64****
Countries	44	44	44	44	44	44
Observations	330	330	330	330	330	330
	Panel B: Low Income Countries					
Constant	-1.144 (0.604)	2.097 (0.408)	-3.274 (0.215)	**-6.129**** **(0.032)**	**-5.484*** **(0.051)**	-0.216 (0.931)
Governance (IV)	**0.996**** **(0.042)**	0.003 (0.923)	-0.558 (0.616)	**-2.027*** **(0.058)**	-1.799 (0.105)	**1.702*** **((0.085)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.071	0.050	0.051	0.068	0.063	0.065
Fisher	**2.88****	**2.01***	**2.05***	**2.76****	**2.55****	**2.63****
Countries	28	28	28	28	28	28
Observations	221	221	221	221	221	221
	Panel C: Middle Income Countries					
Constant	3.314 (0.782)	4.188 (0.725)	-0.965 (0.935)	2.796 (0.817)	2.589 (0.828)	-3.807 (0.757)
Governance (IV)	-1.084 (0.724)	-5.439 (0.261)	**9.844**** **(0.049)**	-0.364 (0.938)	2.788 (0.589)	**5.678*** **(0.075)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2	0.049	0.061	0.089	0.048	0.051	0.082
Fisher	0.92	1.16	1.73	0.89	0.95	1.57
Countries	16	16	16	16	16	16
Observations	109	109	109	109	109	109

***,**,*: significance levels at 1%, 5% and 10% respectively.IV: Instrumental Variable. Governance (Political stability/non violence, voice & accountability, regulation quality, government effectiveness, rule of law and corruption-control).

The findings in Table 5 are about ICT as a catalyst for inclusive development estimated by the 2SLS (Columns 2-5) and IV FE (Columns 6-9) methods. Full sample, ICT adoption (mobile phone and internet penetration) clearly and strongly affect inclusive human development. The effects of ICT adoption on development are comparable to those of private domestic credit availability and foreign direct investment. The fact that foreign aid limits inclusive human development is consistent with conclusions of Asongu (2014) in Africa. Moreover, positive effects of private domestic credit and foreign direct investment are also in accordance with recent inclusive growth/development literature on developing countries (Anand et al., 2012; Mlachila et al., 2014;Asongu & Nwachukwu, 2016c). Clearly, ICT adoption increases inclusive development, and the propensity to do so is higher in low income countries than in middle income countries. However, just as clearly, the evidence of this study shows that holding ICT adoption constant, there is competition between domestic factors and forces tending to increase development and external factors and forces ending the opposite direction.

Table 5. ICT and Inclusive Human Development (2SLS and Fixed Effects)

	Dependent Variable: Inequality Adjusted Human Development Index							
	Two-Stage Least Squares				Instrumental Variable Fixed Effects			
	Panel A: Full Sample							
Constant	**0.403*** (0.000)**	**0.402*** (0.000)**	**0.422*** (0.000)**	**0.415*** (0.000)**	**0.436*** (0.000)**	**0.434*** (0.000)**	**0.430*** (0.000)**	**0.427*** (0.000)**
Mobile Phone Penetration (IV)	**0.001*** (0.000)**	**0.001*** (0.000)**	---	---	**0.0005*** (0.000)**	**0.0006*** (0.000)**	---	---
Internet Penetration (IV)	---	---	**0.007*** (0.000)**	**0.007*** (0.000)**	---	---	**0.002*** (0.000)**	**0.002*** (0.000)**
Foreign Aid	**-0.001*** (0.000)**	**-0.001*** (0.001)**	**-0.002*** (0.003)**	**-0.002*** (0.005)**	**-0.0001* (0.088)**	-0.0001 (0.200)	**0.002*** (0.000)**	-0.0002 (0.160)
Private Domestic Credit	**0.001*** (0.002)**	**0.001*** (0.001)**	**0.001*** (0.000)**	**0.001*** (0.000)**	-0.00003 (0.925)	0.00009 (0.799)	(0.102) **0.0006* (0.053)**	**0.0009** (0.020)**
Remittances	---	-0.00009 (0.739)	---	-0.0002 (0.349)	---	0.0003 (0.338)	---	0.0001 (0.792)
Foreign Direct Investment	---	0.001 (0.138)	---	**0.001** (0.029)**	---	**0.0005** (0.025)**	---	**0.0005** (0.026)**
Hausman test	---	---	---	---	**42.48*****	**38.82*****	**23.60*****	**26.45*****
Within R^2/R^2	0.463	0.534	0.434	0.556	0.302	0.363	0.199	**0.265**
Fisher	**94.30*****	**43.22*****	**87.75*****	**64.47*****	**47.36*****	**30.19*****	**26.37*****	**18.43*****
Countries					44	39	44	39
Observations	375	308	365	299	375	308	365	399
	Panel B: Low Income Countries							
Constant	**0.374*** (0.000)**	**0.389*** (0.000)**	**0.381*** (0.000)**	**0.390*** (0.000)**	**0.377*** (0.000)**	**-68.20*** (0.001)**	**0.370*** (0.000)**	**0.369*** (0.000)**
Mobile Phone Penetration (IV)	**0.001*** (0.000)**	**0.001*** (0.000)**	---	---	**0.0007*** (0.000)**	-12.576 (0.102)	---	---
Internet Penetration (IV)	---	---	**0.010*** (0.000)**	**0.010*** (0.000)**	---	---	**0.005*** (0.000)**	**0.005*** (0.000)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2/R^2	0.296	0.266	0.236	0.339	0.378	0.440	0.375	0.467
Fisher	**48.28*****	**14.47*****	**24.25*****	**28.82*****	**42.82*****	**25.24*****	**41.29*****	**27.21*****
Countries	---	---	---	---	28	24	28	24
Observations	242	189	237	184	242	189	237	184
	Panel C: Middle Income Countries							
Constant	**0.494*** (0.000)**	**0.472*** (0.000)**	**0.514*** (0.000)**	**0.492*** (0.000)**	**0.531*** (0.000)**	**0.511*** (0.000)**	**0.523*** (0.000)**	**0.501*** (0.000)**
Mobile Phone Penetration (IV)	**0.001*** (0.000)**	**0.001*** (0.000)**	---	---	**0.0004*** (0.000)**	**0.0004*** (0.000)**	---	---
Internet Penetration (IV)	---	---	**0.005*** (0.000)**	**0.005*** (0.000)**	---	---	**0.001** (0.019)**	**0.001** (0.035)**
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R^2/R^2	0.382	0.546	0.399	0.582	0.253	0.314	0.147	0.191
Fisher	**25.31*****	**27.96*****	**34.24*****	**44.13*****	**12.91*****	**9.09*****	**6.29*****	**4.49*****
Countries	---	---	---	---	16	15	16	15
Observations	133	119	128	115	133	119	128	115

***,**,*: significance levels at 1%, 5% and 10% respectively. IV: Instrumental Variable.

7. Conclusion

We have argued in the chapter that ICT adoption is a catalyst for inclusive development of developing countries, and scrutinized data for 49 African countries to support our argument. Using 2SLS and IV FE strategies, first we examined the impact of formal institutions on ICT adoption and found them strong at both the aggregate and disaggregated levels, with government effectiveness having the largest positive effects and regulations the biggest negative effects. Overall formal institutions appear more important to ICT adoption in low income countries than in middle income countries, suggesting increasing returns to ICT in low income countries and constant or diminishing returns in middle income countries. Population and economic growth tend to constrain ICT adoption with low income countries more negatively affected than middle income countries.

Next we have assessed how estimated ICT adoption catalyzes development. Here the results are unambiguous that ICT adoption has strong and statistically significant effects on inclusive development. The positive effects on inclusive development of ICT adoption compare well to those of domestic private credit and foreign direct investment. Given positive ICT adoption impacts, we conclude that it is external factors like foreign aid than internal factors like the availability of credit which hinder development in these countries. Middle income countries gain more from ICT adoption for development than low income countries. However the disparities are complicated by other factors limiting development. We conclude further that for this group of countries, domestic factors and forces have tended to increase, while external forces have restricted, development.

The policy implications of the results suggest the need for improvements in formal institutions, and the strengthening of domestic sources of ICT adoption and inclusive development. Doing so may require less stress on external factors like foreign aid, and that too would carry an opportunity cost. For future research there remains a need to broaden the sample to include more or all developing countries, and to fine-tune both the modelling and estimation techniques.

Appendices

Appendix 1.Country Classification by Income Level

Countries are classified by the World Bank as developing if they are low income ($0- $1,045 per capita) and lower middle income ($1,046-$4,125 per capita). Countries with upper middle incomes ($4,126-$12, 735 per capita) and high incomes ($12,736 or higher) are classified as being developed. A few remarks are worth keeping in mind: The classification is arbitrary. No particular line of reasoning is given for why the cut-off point is at $12,735, and there is no reason to believe that a country just below the cut-off line cannot be more "developed" than a country just above it. For instance, Equatorial Guinea has a higher income than both China and South Africa, but its industrial and technological structure is miles far behind. This is one of the reasons we modified the World Bank and group African countries into two groups: low income group consisting of 28 countries, and middle income group made up of 21 countries. This reclassification is consistent with our understanding of both ICT and development in these countries. The latter is broader than income level, the former more reflective of the general technological advancement of these countries.

Income Levels	Countries
Low income countries ($ 1,045 or less)	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Congo, Dem. Rep, Eritrea, Ethiopia, Gambia, The, Guinea, Guinea-Bisau, Dem. People's Rep.¸ Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Somalia , South Sudan, Tanzania, Togo, Uganda, Zimbabwe
Middle Income countries ($1,046- 12,735)	Angola, Cape Verde, Cameroon, Congo, Rep., Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Gabon, Ghana, Kenya, Lesotho, Mauritania, Mauritius, Morocco,? Namibia, Nigeria, São Tomé and Principe, Senegal, Sudan, Swaziland, Zambia

Source: World Bank available at http://data.worldbank.org/about/country-and-lending-groups#Low_income (Accessed on June 2016)

Appendix 2.1.ICT Variable Definitions and Data Sources

Variables	Signs	Definitions	Sources
Mobile Phone	Mobile	Mobile phone subscriptions (per 100 people)	WDI
Internet	Internet	Internet subscriptions (per 100 people)	WDI
Telephone	Telephone	Telephone subscriptions (per 100 people)	WDI
Political Stability	PolS	"Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism".	WGI
Voice & Accountability	VA	"Voice and accountability (estimate): measures the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media"	WGI
Government		"Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from	

Effectiveness	GE	political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments' commitments to such policies".	WGI
Regulation Quality	RQ	"Regulation quality (estimate): measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development".	WGI
Corruption-Control	CC	"Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests"	WGI
Rule of Law	RL	"Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence"	WGI
GDP growth	GDPg	GDP growth rate	WDI
Trade Openness	Trade	Import plus Exports of Goods and Services (% of GDP)	WDI
Population growth	Population	Total Population growth (anual %)	WDI
Education	PSE	Primary School Enrolment (% of Gross)	WDI

WGI: World Governance Indicators. WDI: World Development Indicators. GDP: Gross Domestic Product.

Appendix 2.2.ICT Summary Statistics

	Mean	SD	Min	Max	Obs
Mobile Phone Penetration	23.379	28.004	0.000	147.202	572
Internet Penetration	4.152	6.450	0.005	43.605	566
Telephone Penetration	3.039	5.810	0.005	32.455	565
Political Stability	-0.543	0.956	-3.323	1.192	578
Voice & Accountability	-0.646	0.737	-2.233	0.990	578
Government Effectiveness	-0.771	0.620	-2.450	0.934	577
Regulation Quality	-0.715	0.644	-2.665	0.983	578
Corruption-Control	-0.642	0.591	-1.924	1.249	579
Rule of Law	-0.741	0.662	-2.668	1.056	578
GDP growth	4.714	6.322	-47.552	63.379	608
Trade Openness	78.177	36.138	20.964	209.874	597
Population Growth	2.361	0.948	-1.081	6.576	588
Education	97.446	25.895	32.199	181.700	470

SD: Standard deviation. Min: Minimum. Max: Maximum. Obs: Observations. Adj: Adjusted.

Appendix 2.3: ICT Correlation Matrix (Uniform sample size: 407)

Governance Variables						Control Variables				Dependent Variables			
PolS	VA	GE	RQ	CC	RL	GDPg	Trade	Popg	PSE	Mobile	Internet	Telephone	
1.000	0.636	0.605	0.538	0.614	0.767	-0.084	0.253	-0.271	0.255	0.298	0.312	0.470	PolS
	1.000	0.740	0.727	0.612	0.787	0.018	0.014	-0.250	0.248	0.274	0.325	0.459	VA
		1.000	0.845	0.979	0.874	0.030	0.021	-0.335	0.212	0.293	0.320	0.504	GE
			1.000	0.649	0.772	-0.025	-0.002	-0.247	0.217	0.264	0.176	0.286	RQ
				1.000	0.817	-0.090	-0.014	-0.309	0.118	0.273	0.342	0.565	CC
					1.000	-0.044	0.109	-0.286	0.219	0.274	0.332	0.530	RL
						1.000	0.029	0.157	0.083	-0.043	-0.002	-0.052	GDPg
							1.000	-0.380	0.167	0.259	0.158	0.228	Trade
								1.000	-0.172	-0.331	-0.414	-0.581	Popg
									1.000	0.288	0.224	0.181	PSE
										1.000	0.690	0.479	Mobile
											1.000	0.695	Internet
												1.000	Telephone

PolS: Political Stability. VA: Voice & Accountability. GE: Government Effectiveness. RQ: Regulation Quality. CC: Corruption-Control. RL: Rule of Law. GDPg : GDP per capita growth rate. Popg: Population growth. PSE: Primary School Enrolment. Mobile: Mobile Phone Penetration. Internet: Internet Penetration. Telephone: Telephone Penetration.

Appendix 3.1: IHDI Variable Definitions and Data Sources

Variables	Signs	Definitions	Sources
Inclusive development	IHDI	Inequality Adjusted Human Development Index	UNDP
Mobile Phone	Mobile	Mobile phone subscriptions (per 100 people)	WDI
Internet	Internet	Internet subscriptions (per 100 people)	WDI
Telephone	Telephone	Telephone subscriptions (per 100 people)	WDI
Foreign Aid	Aid	Total Official Development Assistance (% of GDP)	WDI
Private Credit	Credit	Private credit by deposit banks and other financial institutions (% of GDP)	WDI
Remittance	Remit	Remittance inflows (% of GDP)	WDI
Foreign investment	FDI	Foreign Direct Investment net inflows (% of GDP)	WDI

UNDP: United Nations Development Program. WDI: World Development Indicators. GDP: Gross Domestic Product.

Appendix 3.2.IHDI Summary Statistics

	Mean	SD	Min	Max	Obs
Inequality Adj. Human Development	0.721	3.505	0.129	0.768	485
Mobile Phone Penetration	23.379	28.004	0.000	147.202	572
Internet Penetration	4.152	6.450	0.005	43.605	566
Telephone Penetration	3.039	5.810	0.005	32.455	565
Foreign Aid	11.687	14.193	-0.253	181.187	606
Private Domestic Credit	18.551	22.472	0.550	149.78	507
Remittances	3.977	8.031	0.000	64.100	434
Net Foreign Direct Investment Inflows	5.332	8.737	-6.043	91.007	603

SD: Standard deviation. Min: Minimum. Max: Maximum. Obs: Observations. Adj: Adjusted.

Appendix 3.3.IHDI Correlation Matrix (Uniform sample size: 324)

Foreign aid	Credit	Remittances	FDI	Mobile	Internet	Telephone	IHDI	
1.000	-0.173	-0.037	0.411	-0.165	-0.196	-0.223	-0.382	Foreign aid
	1.000	-0.084	-0.065	0.514	0.511	0.614	0.529	Credit
		1.000	0.115	-0.050	-0.035	-0.062	-0.027	Remittances
			1.000	0.111	0.072	-0.029	-0.001	FDI
				1.000	0.749	0.504	0.626	Mobile
					1.000	0.669	0.649	Internet
						1.000	0.747	Telephone
							1.000	IHDI

Credit: Private domestic credit. FDI: Foreign Direct Investment. Mobile: Mobile Phone Penetration. Internet: Internet Penetration. Telephone: Telephone Penetration. IHDI: Inequality Adjusted Human Development Index.

References

Acemoglu, D., & Robinson, J., (2008). The role of institutions in growth and development, in D. Brady and M. Spence (eds) Leadership and Growth. Washington, DC: World Bank.

Acemoglu, D, Johnson, S, & Robinson, J., (2001). "The colonial orignis of comaparative development: An empirical investigation", *American Economic Review*, 91(5), pp. 1369-1401.

Amavilah, V. H. S., (2007). "Innovations spread more like wildfire than like infections" [May]. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=99950 (Accessed: 09/08/2016).

Amavilah, V. H. S., (2008). "Inhibited (Exhibited) spread of innovations". Available at https://mpra.ub.uni-muenchen.de/8993/.(Accessed: 09/08/2016).

Anand, R., Mishra, S., & Spatafora, N., (2012), "Structural Transformation and the Sophistication of Production," *IMF Working Paper* No. 12/59, Washington.

Asongu, S. A., & Nwachukwu, J. C., (2016a). "Mobile phones in the diffusion of knowledge and persistence in inclusive human development in Sub-Saharan Africa", *Information Development*, DOI: 10.1177/0266666916655189.

Asongu, S. A., & Nwachukwu, J. C., (2016b). "The Mobile Phone in the Diffusion of Knowledge for Institutional Quality in Sub-Saharan Africa", *World Development*, 86(October), pp. 133–147.

Asongu, S. A., & Nwachukwu, J. C., (2016c). "The role of governance in mobile phones for inclusive human development in Sub-Saharan Africa", *Technovation*, 55-56(September-October), pp. 1-13.

Asongu, S. A., (2013). "How would population growth affect investment in the future? Asymmetric panel causality evidence for Africa", *African Development Review*, 25(1), pp. 14-29.

Asongu, S. A., (2014). "The Questionable Economics of Development Assistance in Africa: Hot-Fresh Evidence, 1996–2010", *The Review of Black Political Economy*, 41(4), pp. 455-480.

Bazhal, I., (2016). "The Theory of Economic Development of J.A. Schumpeter: Key Features" MPRA Paper 69883, University Library of Munich, Germany, revised 25 Feb 2016. Available at https://ideas.repec.org/p/pra/mprapa/69883.html. (Accessed: 09/08/2016).

Becker, M. C., Eblinger, H. U., Hedtke, U., & Knudsen, T., (2005). "Development: Josep A. Schumpeter", *Journal of Economic Literature*, XLII(1), pp. 108-111.

Beliamoune-Lutz, (2003). "An analysis of the determinants and effects of ICT diffusion in developing countries", *Information Technology for Development*, 10(2), pp. 151-169.

Bellock, R., & Dimitrova, D., (2003). "An explanatory model of inter-country internet diffusion". *Telecommunications Policy*, 27(3-4), pp. 237-252.

Billon, M., Marco, R., & Lera-Lopez, F., (2009). "Disparities in ICT adoption: A multidimensional approach to study the cross-country digital divide", *Telecommunications Policy*, 33, pp. 596-610.

Binder, M., & Georgiadis, G., (2011). "Determinants of Human Development: Capturing the Role of Institutions". *CESIFO Working Paper* No. 3397.

Brynjolfsson, E., & Hitt, L., (2003). "Computing productivity: firm-level evidence". *Review of Economics and Statistics*, 85(4), pp. 793-808.

Caselli, F., & Coleman II. W., (2001). "Cross-country technology diffusion: The case of computers", *American Economic Review*, 91(2), pp. 328-335.

Chinn, M., & Fairlie, R. (2007). "The determinants of the global digital divide: a cross country analysis of computer and Internet penetration". *Oxford Economic Papers*, 59(1), pp. 16-44.

Dasgupta, S.; Lall, S., & Wheeler, D., (2005). "Policy reform, economic growth and the digital divide". *Oxford Development Studies*, 33(2), pp. 229-243.

Dekimpe, M.K., Parker, P.M., & Sarvary, M. (2000). "Globalization: Modeling Technology Adoption Timing across countries". *Technological Forecasting and Social Change*, 63, pp. 125-145.

Detschew, S., (2007). "Impact of ICT in the Developing Countries on the Economic Growth: Implications Derived from Theory and Empiricism". Diploma Thesis, Technical University of Ilmenau.

Fosu, A. K., (2015). "Growth, Inequality and Poverty in Sub-Saharan Africa: Recent Progress in a Global Context", *Oxford Development Studies*, 43(1), pp. 44-59.

Geroski, P. A., (2000). "Models of technology diffusion", *Research Policy*, 29(4/5), pp. 603-625.

Gholami, R., Higón, D. A., Hanafizedh, P., & Emrouznejad, A., (2010). "Is ICT the key to development?", *Journal of Global Information Management*, 18(1), pp. 66-83.

Harggitai, E. (1999). "Weaving the Western Web: Explaining differences in Internet connectivity among OECD countries", *Telecommunications Policy*, 23(10-11), pp. 701-718.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010). "The worldwide governance indicators: Methodology and analytical Issues". *World Bank Policy Research Working Paper* No. 5430.

Kiessling, J., (2007). “Institutions and ICT Technology Adoption”. Department of Economics, Stockholm University.

Kiiski, S., & Pohjola, M., (2002). “Cross-country diffusion of the Internet”, *Information Economics and Policy*, 14(2), pp.297-310.

Livramento, I M H, & Foray, D (2007). “Does IPR protection affect high growth entrepreneurship? A cross-country empirical examination”. Available at http://www.epip.eu/conferences/epip02/files/EPIP_ihdf.pdf (Accessed: 09/08/2016).

Mlachila, M., Tapsoba, R., & Tapsoba, S. J. A., (2014). “A Quality of Growth Index for Developing Countries: A Proposal”, *IMF Working Paper* No. 14/172, Washington.

Norris, P., (2001). Digital Divide?: Civic Engagement, Information Poverty and the Internet Worldwide, Cambridge University Press, Cambridge.

Oxley, J., & Yeung, B., (2001). “E-commerce and readiness institutional environment and international competitiveness”, *Journal of International Business Studies*, 32(4), pp. 705-723.

Papaioannou, S. K., & Dimelis, S. P. (2007). « Information technology as a factor of economic development: Evidence from developed and Developing countries”. *Economics of Innovation and New Technology*, 16(3), pp. 179-194.

Quibria, M.; Ahmed, S.; Tschang, T., & Reyes-Macasaquit, M. (2003). “Digital divide: determinants and policies with special reference to Asia”, *Journal of Asian Economics*, 13(6), pp. 811-825.

Robison, K., & Crenshaw, E. (2002). “Post-industrial transformations and cyber-space: A cross national analysis of internet development”. *Social Science Research*, 31(3), pp. 334-363.

Rodrik, D., (2000). “Institutions for high-quality growth: What they are, how to acquire them”. *NBER Working Paper* No. W7540, Cambridge.

Rodrik, D., (2001). “The global governance of trade as if development really matter”. Report submitted to UNDP.

Rodrik, D., Subramanian, A. & Trebbi, F., (2004). “Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development”, *Journal of Economic Growth,* 9(2), pp. 131-165.

Rogers, E. M. (1995). Diffusion of innovations. N.Y: The Free Press.

Schumpeter, J. A., (2005[1991]). “Development”, *Journal of Economic Literature*, XLII(1), pp. 112-120.

Seo, H. J., Lee, Y.S., & Oh, J.H. (2009). “Does ICT investment widen the growth gap”. *Telecommunications Policy*, 3 pp. 422-431.

Steinmueller, W. (2001). “ICTs and the possibilities of leapfrogging by developing countries”. *International Labour Review*, 140(2), pp. 193-210.

Tchamyou, V. S., (2015). “The role of knowledge economy in African business”, *African Governance and Development Institute Working Paper* No. 15/049, Yaoundé.

UNCTAD (2006). "Using ICT to achieve growth and development". http://unctad.org/en/docs/c3em29d2_en.pdf. (Accessed: 09/08/2016).

UNCTAD (2011). "Measuring the impacts of ICT for development3. http://unctad.org/en/Docs/dtlstict2011d1_en.pdf. (Accessed: 09/08/2016).

UNDP (2008). "The role of ICTs in achieving the Millennium Development Goals". http://hdr.undp.org/en/content/role-information-communication-technologies-icts-achieving-millennium-development-goals (Accessed: 09/08/2016).

UNDP (2010). ICT4D and the Human Development and Capability Approach: The potentials of ICT. http://hdr.undp.org/en/content/ict4d-and-human-development-and-capability-approach (Accessed: 09/08/2016).

Wallsten, S., (2005). "Regulation and internet use in developing countries". Economic Development and Cultural Change, 53(2), pp. 501-523.

Wejnert, B., (2002). "Integrating models of diffusion of innovations: A conceptual framework". *Annual Reviews of Sociology*, 28, pp. 297-326.

World Bank (2009). "Information Communications Technologies for Development (blog)". http://live.worldbank.org/information-communications-technology-development (Accessed: 09/08/2016).

World Bank (2012). "ICT for Greater Development Impact 2012-2015". http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/WBG_ICT_Strategy-2012.pdf (Accessed: 09/08/2016).

Young, H. P., (2005). "The spread of innovations by social learning", Working Paper (February 17, 2006 Version). Available at: http://www.econ.jhu.edu/People/Young/Spread28march.pdf. (Accessed: 09/08/2016).

Young, H. P., (2004). "Innovation diffusion and population heterogeneity", Preliminary Draft, Johns Hopkins University (October 20, 2006 Version). Available at: http://www.econ.princeton.edu/seminars/SEMINARS/Fall06Seminars/young.pdf (Accessed: 09/08/2016).

Young, H. P., (2007). "Innovation diffusions in heterogeneous populations". *Discussion Paper Series*, No. 303. Department of Economics, University of Oxford. Available at: http://www.economics.ox.ac.uk/Research/wp/pdf/paper303.pdf. (Accessed: 09/08/2016).