Chapter 10
Linkages Between Formal Institutions, ICT Adoption, and Inclusive Human Development in Sub-Saharan Africa

Antonio Rodrìguez Andrés, Voxi Amavilah, and Simplice Asongu

Abstract This study empirically assesses the effects of formal institutions on ICT adoption in 49 African countries over the years 2000–2012. It deploys 2SLS and FE regression models (a) to estimate the determinants of 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 effects and regulations the largest negative effects. However, while formal institutions generally affect ICT adoption positively, population and economic growth tend to constrain ICT adoption more in low-income countries than middle-income countries. The results further demonstrate that the effects of ICT adoption on development are comparable to those of domestic credit and foreign direct investment. Ceteris paribus, one may conclude that external factors like foreign aid are more limiting to inclusive development than internal factors. This suggests that developing countries, African countries in this specific case, 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

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A.R. Andrés (✉)
School of Business, Universidad del Norte, Barranquilla, Colombia
e-mail: antoniorodriguez@uninorte.edu.co

V. Amavilah
Estrella Mountain College, Phoenix, AZ, USA
e-mail: amavilah@msn.com

S. Asongu
African Governance and Development Institute, Yaoundé, Cameroon

Department of Economics, University of South Africa,
P. O. Box 392 UNISA 0003, Pretoria, South Africa.
e-mail: asongusimplice@yahoo.com

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10.1 Introduction

In recent years, there has been a major change in thinking about the appropriate role of telecommunications as growth and development enhancers. For instance, it has been stated that the adoption with diffusion of information and communication technologies (ICTs) promotes growth, and growth promotes ICT adoption and diffusion [1–12]. Billón et al. [13]'s study of the patterns and factors affecting ICT adoption[1] found that economic growth, education, and government effectiveness explain high ICT adoption rates positively in developed countries, while in developing countries the age of the urban population and Internet costs affect ICT adoption rates negatively. Kiessling [14] associated ICT adoption in 82 developed and developing countries with economic, financial, and political institutions, as well as with per capita income and education, discovering 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 [14] remain few, and even fewer of them address the role of formal institutions in ICT adoption. In this limited sense, [15] are correct that existing models "are not very useful to explain the breadth of technology adoption across countries. Indeed, aggregate diffusion models 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). In addition, such models have neglected the "wildfire phenomenon" in the spread of innovations outlined in [16, 17]; (cf. [18–21]). Furthermore, formal comparisons of the relative influences of institutional quality indicators on ICT within developing countries are also missing from existing literature (for instance, [22, 23]).

In this chapter, first, we assess the effects of formal institutions on ICT adoption across 49 African countries. Second, we analyze how ICT adoption affects development in African countries. We concentrate on the two technologies, because among ICTs newer technologies and/or new uses of old technologies have had stronger impacts than others.

We link ICT adoption rates to the quality of formal institutions as predictors under control. Once we have estimated the factors determining ICT adoption, we examine how ICT adoption catalyzes development. Our approach departs from previous studies (cf. [13, 24]) in that its underlying hypothesis is that cross-country differences in institutional quality, and hence in ICT adoption, enhance or limit inclusive development, where formal institutions are measured by the World Bank indicators of governance.

The chapter is organized as follows: Sect. 10.2 describes the empirical model. We characterize key variables and data in Sect. 10.3. Section 10.4 implements the model and presents the results, while Sect. 10.5 concludes the exercise.

[1] Wherever 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.

10.2 Empirical Model

To examine the impact of formal institutions on ICT adoption, we estimate the following regression:

$$\text{ICT}_i = \alpha_0^* + \alpha_i^* \text{EconGrowth}_i + \beta_i^* \text{Institutions}_i + \gamma_i^* \text{Controls}_i + \lambda_i + \nu_i \quad (10.1)$$

where ICT represents the average ICT adoption, measured as cellular (mobile) phone and Internet penetration rates, and EconGrowth is economic growth predicted to promote ICT adoption, a relationship well-documented in the development literature [5, 6, 10, 11, 12]. Institutions are formal institutions, Controls include the educational attainment of the population, expected to affect ICT adoption positively, $\alpha_0^*, \alpha_i^*, \beta_i^*, \gamma_I^*$ are parameters to be estimated, λ are the country-fixed effects, and ν is the error term. A short theoretical underpinning of the model is available upon request.

Finally, ICT adoption catalyzes development, where development is characterized as structural change in the economy that is accompanied by measurable improvement in the quality of life of the people. Many times such improvements are measured as positive changes in 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. In this study we take development to be inequality-adjusted HDI and estimate it as:

$$\text{Development}_i \equiv \text{IHDI}_i = \delta_{0i} + \delta_{1i} \text{ICT}_i^* + \delta_{2i} Z_i + \varepsilon_i \quad (10.2)$$

where δ are coefficients to be estimated, ICT_i^* is estimated from (10.1), Z are the determinants of development not already included in (10.1), and ε is the classical error term. There is a lot on Eq. (10.2) in the literature, see, e.g., [25–29]), and so on.

10.3 Key Variables and Data

10.3.1 Dependent Variables for ICT Adoption (ICT)

Unlike [24] who measure ICT adoption as investment per worker of computer produced domestically and/or imported, here dependent variables are measured as the rates of adoption of mobile phones and Internet per 100 people, i.e., penetration rates. The use of these dependent variables is consistent with recent African knowledge economy literature [30].

10.3.2 Determinants of ICT Adoption

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

Institutions and Institutional Quality Our key explanatory variable is governance. 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 [31] study, and the World Bank.[2] The World Bank indicators capture different aspects of governance as 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. 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, and 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. Despite data aggregation problems, one of the advantages of aggregate indicators is that they are more informative about broad notions 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. Although they lack sufficient random variations over time, aggregate indicators used in isolation measure different aspects of the impact of formal institutions on ICT adoption. Poor institutions, for instance, would influence aggregate economic growth by delaying productivity improvements. Productivity is an important channel for the effects of institutions on ICT adoption and hence on economic growth and development.

Other Variables Previous research has used many other explanatory variables. [13], for example, argued that disparities in ICT adoption depend on GDP per capita, population aged 15–64 years old, fraction of GDP that comes from the service sector, foreign trade as a percentage of GDP, population density, urban population size, educational level measured as years of schooling, government effectiveness, income level of the country, dummies for the dominant market structure, and language.

Caselli and Coleman II [24] associated adoption of personal computers with income per worker, and investment per worker is 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 were the shares of GDP originating from agriculture and manufacturing, government spending as a percentage of GDP, manufactured imports from OECD as well as non-OECD countries, country's structure of property rights, and dummy for language. A notable omission here is human capital.

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

Kiessling [14]'s examination of the adoption of cellular telephony, Internet, and PC stresses economic, financial, and political institutions, arguing that good economic institutions attract foreign interactions (investment, trade, aid) and are effective tools in devising effective anti-diversion and anticorruption policies. Among macro-economic variables, [14] also included changes in the general price level (CPI). The latter are warranted because cross-country comparison based on common prices is better than those made based on exchange rates; many developing countries have more than one exchange rate running parallel.

Regarding financial institutions the argument is that they 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 rates of return on private investment, availability of private credit as a sign of the existence of a vibrant entrepreneurial activity, and effective demand for ICTs.[3] Among political institutions, [14] used "an index of political regime characteristics – Polity 2" (p. 39), freedom of press, rule of law, and round off his specification by including education, and income.[4]

10.3.3 Development Dependent Variables

The literature on the link between ICT adoption and development is huge (see, [32–37]). The term of development is one of those things that nearly everyone knows, but no one knows how to measure precisely. Some experts 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. Others measure development as the Human Development Index (HDI). The HDI encompasses real GDP, health (life expectancy), and education (years of schooling). It also has an additional advantage that it can be adjusted for inequalities of income, wealth, poverty, gender, and so on, thereby yielding IHDI. One of IHDI weaknesses is that it is still an index and therefore lacks sufficient variations and may cause some statistical problems in small sample regressions (cf. [38]). IHDI is our preferred option for this study, nonetheless.

10.3.4 Key Determinants of Development

The determinants of development are just as many and complex as development itself. Below are those we considered.

Estimated ICT (ICT*) Among key predictors of inclusive development, we emphasize the role of ICT adoption as estimated in Eq. (10.1). This is just another

[3] Note that the existence of entrepreneurs with access to private credit is a key driver of capital formation in a Schumpeterian model – Eq. (10.2) above.

[4] For a description of how the Polity 2 index is calculated, we refer the interested reader to [14]), p. 39ff.

way of acknowledging the importance of formal institutions in development acting through ICT adoption (cf. [38–43]).

Other Development Determinants (Z) From the vast literature, the usual determinants of development would include: geography, foreign trade, foreign aid, foreign direct investment (FDI), remittances, and so on (see, e.g., [44–46]). However, we assume African countries to be geographically homogenous, so that the effects of geographical factors are constant. Even as we do so, we know that development can be measured by its narrower quality-of-life representations like health, participatory democracy, education, privacy and security, innovations, employment, economic performance, and poverty reduction. In such cases determinants of development can be varied. For instance, in [47]), development is represented by "high growth entrepreneurship," which is driven by trade-related intellectual property rights (TRIPS). As the model available as Supplement 1 shows, the results reported in here place a Baumolian-Schmpumpterian emphasis on the entrepreneur as a driver of dynamic development. In fact, according to Schumpeter [53], Becker et al. [54], and Bazhal [55], in a Schumpeterian economy, technological knowledge such as ICT depends on the profit made possible by the risk-taking entrepreneur. The entrepreneur succeeds profitably under an enabling social setting implied by the country's level of development (see, [47], pp. 6–7). An implication of such an approach is that the effects on development of ICT adoption are weak or negative; it does not necessarily imply that adoption rates are low; it could be that entrepreneurship and/or the social organization are somehow reluctant to change.[5] We know that [47]) used real interest rate as a proxy for the cost of capital. However, due to the lack of reliable data on African capital markets, here we use domestic credit as an indicator of the local banking sector and a source of capital for the entrepreneur. The lack of credit constrains the entrepreneur, and without profits ICT adoption is not possible, and without ICT adoption growth and inclusive development are stunted.

10.3.5 Data

To establish a sample of 49 African countries listed at the bottom of Table 10.1, 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. Variable definitions, data, and data relating to ICT adoption (Eq. 10.1) and inclusive development

[5] We refer the interested reader to Willian J. Baumol's *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism*. Princeton/Oxford: Princeton University Press, 2002. However, this great work was not fundamental to our work and therefore we do not include it in our list of cited work.

(Eq. 10.2) are available as supplementary material. Here note again that ICT adoption is measured as Internet penetration rates and mobile penetration rates. Inclusive development is represented by inequality-adjusted HDI (IHDI). The IHDI adjusts HDI for inequality by accounting for the manner in which such achievements are distributed within the population controlling for the mean values of achievements for inequality, where 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 the African context, as elsewhere in developing countries, control variables for the human development equation would encompass: development assistance, private domestic credit, remittances, and foreign direct investment. The choice of these variables is consistent with recent literature on inclusive development/growth [44–46].

10.4 Empirical Strategy and Results

Our strategy involves estimating Eqs. (10.1 and 10.2). The first regression in both cases is for the entire sample of 49 countries. The second regression focuses on 28 low-income countries, the third on 21 middle-income countries. We use two related estimators: 2SLS and IV FE, corrected for an unknown and unobserved form of heteroscedasticity.

Tables 10.1, 10.2, 10.3, 10.4, and 10.5 present the results. Specifically, Table 10.1 shows 2SLS effects of formal institutions on mobile phone penetration across the full sample of 49 African countries (Panel A) and across the subsamples of 28 low-income (Panel B) and 21 middle-income (Panel C) countries. For all countries formal institutions promote ICT adoption, with the government effectiveness contributing most positively. 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 are not sufficiently tailored toward enhancing ICT adoption. Moreover, the positive effects of corruption control and political governance are not significant for ICT adoption in low-income and middle-income countries, respectively.

Regarding control variables, economic growth and population growth have disadvantaged ICT adoption in this group of countries. The result is reasonable, because if population grows faster than real GDP, then per capita real 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 segments of the population, then ICT adoption would not increase. Such a narrative would be consistent with the position that the rich in Africa, as elsewhere, prefer the quality of children to the quantity of children. Therefore the wealthy have fewer children than the poor [48]. Hence, population growth is mostly traceable to the poor segments of the population. 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 [49]. In fact, a World Bank report has revealed that extreme

Table 10.1 Mobile phone penetration and governance, Eq. (10.1), 2SLS

	Dependent variable: mobile phone penetration					
	Political governance		Economic governance		Institutional governance	
	Political stability/ nonviolence	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Panel A: full sample						
Constant	26.505***	25.298***	27.077***	24.833***	26.146***	20.469**
	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)	(0.012)
Political stability(IV)	6.256***	–	–	–	–	–
	(0.000)					
Voice and 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	−0.581**	−0.573**	−0.663***	−0.505**	−0.492**
	(0.107)	(0.022)	(0.023)	(0.008)	(0.046)	(0.048)
Trade openness	0.105**	0.141***	0.146***	0.156***	0.132***	0.153***
	(0.016)	(0.000)	(0.001)	(0.001)	(0.003)	(0.000)
Population growth	−7.197***	−6.584***	−6.485***	−5.079**	−6.473***	−5.517**
	(0.001)	(0.002)	(0.005)	(0.016)	(0.003)	(0.010)
Primary school enrolment	0.148***	0.144***	0.145***	0.150***	0.156***	0.172***
	(0.002)	(0.006)	(0.006)	(0.004)	(0.002)	(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	5.354	7.781	5.641	5.062	−2.922
	(0.743)	(0.526)	(0.377)	(0.548)	(0.601)	(0.729)
Governance (IV)	5.547***	6.872***	10.803***	8.872***	7.577**	3.742
	(0.001)	(0.005)	(0.000)	(0.004)	(0.025)	(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*	40.600*	39.309*	38.280*	42.641*	33.900***
	(0.053)	(0.080)	(0.079)	(0.094)	(0.062)	(0.141)
Governance (IV)	5.791	2.915	−0.982*	10.629**	8.660*	12.334***
	(0.127)	(0.468)	(0.051)	(0.039)	(0.054)	(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/nonviolence, voice and accountability, regulation quality, government effectiveness, rule of law, and corruption control). For instance, in column 2 of Panel B, governance (IV) represents political stability, while in the last column, governance (IV) denotes corruption control

Table 10.2 Internet penetration and governance, Eq. (10.1), 2SLS

	Dependent variable: Internet penetration					
	Political governance		Economic governance		Institutional governance	
	Political stability/ nonviolence	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Panel A: full sample						
Constant	11.095***	10.665***	9.825***	10.304***	11.144***	9.319***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Political stability (IV)	1.780***	–	–	–	–	–
	(0.000)					
Voice and 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	0.018	0.037	0.007	0.037	0.043
	(0.321)	(0.794)	(0.609)	(0.913)	(0.585)	(0.531)
Trade openness	−0.008	0.001	−0.001	0.003	−0.001	0.005
	(0.348)	(0.840)	(0.912)	(0.760)	(0.895)	(0.608)
Population Growth	−3.074***	−2.888***	−3.234***	−2.739***	−2.865***	−2.626***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Primary school enrolment	0.019**	0.018**	0.028***	0.022**	0.020**	0.026***
	(0.026)	(0.048)	(0.003)	(0.011)	(0.020)	(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	−0.112	0.787	1.071	1.491	0.182
	(0.749)	(0.931)	(0.506)	(0.408)	(0.253)	(0.885)
Governance (IV)	0.724***	0.433	1.179**	1.385***	1.477***	1.090*
	(0.001)	(0.244)	(0.022)	(0.001)	(0.001)	(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***	14.432**	14.585**	14.063**	14.424**	13.0119**
	(0.002)	(0.011)	(0.019)	(0.022)	(0.012)	(0.035)
Governance (IV)	1.744	1.474	−3.640***	−0.326	0.044	1.671
	(0.144)	(0.195)	(0.007)	(0.864)	(0.809)	(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/nonviolence, voice and accountability, regulation quality, government effectiveness, rule of law, and corruption control). For instance, in column 2 of Panel B, governance (IV) represents political stability, while in the last column, governance (IV) denotes corruption control.

Table 10.3 Mobile phone penetration and governance, Eq. (10.1), IV FE

	Dependent variable: mobile phone penetration					
	Political governance		Economic governance		Institutional governance	
	Political stability/ nonviolence	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Panel A: full sample						
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 and 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/nonviolence, voice and accountability, regulation quality, government effectiveness, rule of law, and corruption control)

poverty has been decreasing in all regions of the world with the exception of Africa where 45% of countries were substantially offtrack from achieving extreme poverty reduction targets [50]. While population and economic growth have restricted ICT adoption, openness to trade and human capital accumulation has had positive effects.

By 2SLS formal institutions also promote ICT adoption measured as Internet penetration rate (Table 10.2). As with cellular (mobile) phone penetration rate, the quality of regulation is inversely correlated with ICT adoption in middle-income countries. Unlike in the full sample, population growth, trade, political stability, and rule of law affect ICT adoption negatively when the sample is disaggregated by income levels. Still, formal institutions generally improve ICT adoption in these countries, although improvements vary by income levels. It is apparent from the results that ICT adoption in Sub-Sahara Africa (SSA) is driven by formal institutions more in low-income countries than middle-income countries. Put in standard economic theory, given formal institutions, the marginal product of ICT adoption increases at an increasing rate in low-income countries, but diminishing returns to ICT adoption appear to set in at middle-income level. Consequently, while both groups of countries gain from ICT adoption, for development the benefits of ICT adoption are greater for poor than for rich countries.

Country Classification by Income Level

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-Bissau, 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)

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 in Tables 10.3 and 10.4. Ceteris paribus, government effectiveness and population growth restrict ICT adoption, all else have positive effects. By income levels the IV FE estimator yields negative institutional effects on ICT adoption except for the corruption indicator. For all 49 countries, corruption, regulation, trade, and population growth assist ICT adoption, and all else have negative effects, although statistically insignificant in most cases. 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 effectiveness in middle-income countries. The negative effects may be traceable to the fact that formal institutions are a necessary but not a sufficient condition for ICT adoption

Table 10.4 Internet penetration and governance, Eq. (10.1), IVFE

	Dependent variable: mobile phone penetration					
	Political governance		Economic governance		Institutional governance	
	Political stability/ nonviolence	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Panel A: full sample						
Constant	−1.883	−3.517	−0.998	−4.387	−3.003	−0.535
	(0.552)	(0.306)	(0.767)	(0.233)	(0.406)	(0.866)
Political stability (IV)	0.719	–	–	–	–	–
	(0.357)					
Voice and 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	−0.078	−0.083	−0.075	−0.084	−0.090*
	(0.107)	(0.144)	(0.120)	(0.163)	(0.116)	(0.090)
Trade openness	0.019	0.020	0.019	0.017	0.020	0.024
	(0.298)	(0.290)	(0.304)	(0.362)	(0.296)	(0.199)
Population growth	1.236	1.365*	1.247	1.479*	1.343*	0.913
	(0.104)	(0.073)	(0.100)	(0.058)	(0.081)	(0.235)

(continued)

Table 10.4 (continued)

	Dependent variable: mobile phone penetration					
	Political governance		Economic governance		Institutional governance	
	Political stability/ nonviolence	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Primary school enrolment	0.028	0.031	0.026	0.034	0.030	0.032
	(0.235)	(0.187)	(0.258)	(0.151)	(0.205)	(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	2.097	−3.274	−6.129**	−5.484*	−0.216
	(0.604)	(0.408)	(0.215)	(0.032)	(0.051)	(0.931)
Governance (IV)	0.996**	0.003	−0.558	−2.027*	−1.799	1.702*
	(0.042)	(0.923)	(0.616)	(0.058)	(0.105)	(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	4.188	−0.965	2.796	2.589	−3.807
	(0.782)	(0.725)	(0.935)	(0.817)	(0.828)	(0.757)
Governance (IV)	−1.084	−5.439	9.844**	−0.364	2.788	5.678*
	(0.724)	(0.261)	(0.049)	(0.938)	(0.589)	(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/nonviolence, voice and accountability, regulation quality, government effectiveness, rule of law, and corruption control)

Table 10.5 ICT and inclusive development, Eq. (10.2), 2SLS, IV FE

	Dependent variable: inequality adjusted human development index							
	Two-stage least squares				Instrumental variable fixed effects			
Panel A: full sample								
Constant	0.403***	0.402***	0.422***	0.415***	0.436***	0.434***	0.430***	0.427***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mobile phone penetration (IV)	0.001***	0.001***	–	–	0.0005***	0.0006***	–	–
	(0.000)	(0.000)			(0.000)	(0.000)		
Internet penetration (IV)	–	–	0.007***	0.007***	–	–	0.002***	0.002***
			(0.000)	(0.000)			(0.000)	(0.000)
Foreign aid	−0.001***	−0.001***	−0.002***	−0.002***	−0.0001*	−0.0001	0.002***	−0.0002
	(0.000)	(0.001)	(0.003)	(0.005)	(0.088)	(0.200)	(0.000)	(0.160)
Private domestic credit	0.001***	0.001***	0.001***	0.001***	−0.00003	0.00009	(0.102)	0.0009**
	(0.002)	(0.001)	(0.000)	(0.000)	(0.925)	(0.799)	0.0006*	(0.020)
Remittances	–	−0.00009	–	−0.0002	–	0.0003	(0.053)	0.0001
		(0.739)		(0.349)		(0.338)	–	(0.792)
Foreign direct investment	–	0.001	–	0.001**	–	0.0005**		0.0005**
		(0.138)		(0.029)		(0.025)	–	(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***	0.389***	0.381***	0.390***	0.377***	−68.20***	0.370***	0.369***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Mobile phone penetration (IV)	0.001***	0.001***	–	–	0.0007***	−12.576	–	–
	(0.000)	(0.000)			(0.000)	(0.102)		

Internet penetration (IV)	–	–	0.010***	0.010***	–	–	0.005***	0.005***
			(0.000)	(0.000)			(0.000)	(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***	0.472***	0.514***	0.492***	0.531***	0.511***	0.523***	0.501***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mobile phone penetration (IV)	0.001***	0.001***	–	–	0.0004***	0.0004***	–	–
	(0.000)	(0.000)			(0.000)	(0.000)		
Internet penetration (IV)	–	–	0.005***	0.005***	–	–	0.001**	0.001**
			(0.000)	(0.000)			(0.019)	(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

when country-specific effects are considered. It is also important to note that the findings in Tables 10.1 and 10.2 hold only when we control for simultaneity, while those in Tables 10.3 and 10.4 stem from controlling for both simultaneity and unobserved heterogeneity. A broad implication here is that while formal institutions could enhance the adoption of ICT in SSA, policy makers still need to take into account country-specific institutional arrangements in determining ICT adoption outcomes. A corollary explanation is that the weight of countries with negatively skewed government quality variables significantly influences the outcome of all countries, leading to unexpected signs of the estimated coefficients. Consequently, while the significance of such results may be questionable from the statistical viewpoint, the results are nonetheless important from the economic perspective. They suggest that formal institutions are critical to ICT adoption, in both positive and negative ways.

The findings in Table 10.5 are about the effects of ICT adoption on inclusive development estimated by the 2SLS (columns 2–5) and by the IV FE (columns 6–9) methods. In the full sample, ICT adoption strongly affects 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 [51]) 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 [44, 45, 52]. Clearly, ICT adoption increases inclusive development, and the propensity to do so is higher in low-income countries than in middle-income countries. Just as clearly, the evidence shows that holding ICT adoption constant, there is competition between domestic factors and forces tending to increase development and external factors and forces pulling in the opposite direction.

10.5 Conclusion

We have argued in the chapter that ICT adoption is a catalyst for inclusive development of developing countries. We 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 adoption 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 unambiguously clear that ICT adoption has strong and statistically

significant effects on inclusive development on average. However, the results indicate that 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 the external factors like foreign aid rather than internal factors like the availability of credit which hinder inclusive development in these countries. Again, average ICT adoption rate is higher in low-income countries than middle-income countries, which seems to suggest an inverted-U relationship between ICT adoption rate and income level (Eq. 10.1). According to Eq. (10.2), although their average ICT adoption rate is lower, middle-income countries gain more from ICT adoption for their inclusive development than low-income countries. This result might arise due to the nature of the formal institutions in these countries, as well as the analysis of ICT disparities that can be influenced by other variables limiting 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 modeling and estimation techniques.

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Supplementary Material for the Editor

Supplement 1: The Theory Behind the Model

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

$$Y_i = \left(A_i^{\alpha_i} S_i^{\beta_i} X_i^{\gamma_i}\right) \exp\left(\mu_i\right) \tag{10.3}$$

where, Y_i is the real GDP of the ith economy, in Schumpeter's terminology A_i (technology, including ICT) and S_i (socioeconomic setting, including institutions) are "evolution components", X_i are "growth components", including conventional factors of production, and all variables are dated ([53]; cf. [54, 55]). Central to growth among X_i is capital accumulation, which over time depends on investment (I) equal to savings in a steady state. Savings come from profit (π) made possible by technological change and the socioeconomic setting surrounding it. The evolution of the

socioeconomic environment is a function of resources, technology, and level of development, i.e.:

$$\frac{dK_{it}}{dt} = k\left[\frac{dI_{it}}{dt} = f\left(\pi_i\left(A_i,S_i\right)\right)\right], \frac{dS_{it}}{dt} = s\left(X_i,,A_i,,S_i\right), \pi = \text{profit}. \tag{10.4}$$

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) are 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 Eq. (10.1) is characterized by the Schumpeter-Kondratiev waves (cycles), such that A_i over time is sinusoid, i.e.:

$$A_i\left(t\right) = A_0 \exp\left(\varphi t + \cos\left(bt + \psi\right)\right)$$

and $\partial A / \partial t = A_0\left(\varphi - b\right)\sin\left(bt + \psi\right)\exp\left(\varphi t + \cos\left(bt + \psi\right)\right)$, which is consistent with [15] Eqs. (10.3 and 10.4 (p. 6)), but we do not pursue this line of thought further. Instead, from Eq. (10.1) we solve for A_i as:

$$A_i = Y_i^{1/\alpha_i} S_i^{-\beta_i/\alpha_i} X_i^{-\gamma_{i/\alpha_i}}. \tag{10.5}$$

Dividing both sides of Eq. (10.3) Equation 10.5 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:

$$\dot{\mathrm{A}}_i = \alpha_i^* y_i + \beta_i^* \dot{s}_i + \gamma_i^* \dot{x}_i + \mu_i \tag{10.6}$$

$$\dot{\mathrm{A}} = \log\left(\frac{A_i}{X_i^*}\right) = ICT_i; \alpha_i^* = \frac{1}{\alpha}; \dot{y}_i = \text{economic growth};$$

where $\beta_i^* = \dfrac{\beta_i}{\alpha_i}; \dot{s}_i = \log\left(\dfrac{S_i}{X_i^*}\right) = \text{economic setting}\left(\text{governance}\right);$

$$\gamma_i^* = \frac{\gamma_i}{\alpha_i}; \dot{x}_i = \frac{X_i}{X_i^*} = \text{primary } \textit{and} \text{ other drivers};$$

$\textit{and } \mu_i = \text{the random classical error term.}$

This all shows that in the main document, the ICT equation is the equivalent of 10.(6) Eq. (10.4) above, and the development equation is Eq. (10.1) 10.3.

Supplement 2: A Note on Country Classification by Income Level

The World Bank classifies countries 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. The classification is arbitrary. No particular line of reasoning is given for why the cutoff point between "developed" and "developing" is set at $12,735. There is no reason to believe that a country just below the cutoff line cannot be more "developed" than a country just above it. For instance, Equatorial Guinea has a higher average income level than both China and South Africa, but its industrial base and technological structure are miles far behind. This is one of the reasons we modified the World Bank and grouped 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.

Supplement 3: 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 and 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 effectiveness	GE	"Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments' commitments to such policies"	WGI

(continued)

Variables	Signs	Definitions	Sources
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 (annual %)	WDI
Education	PSE	Primary school enrolment (% of gross)	WDI

WGI World Governance Indicators, *WDI* World Development Indicators, *GDP* gross domestic product

Supplement 4: 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 and 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

Supplement 5: 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 and 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

Supplement 6: 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

Supplement 7: IHDI Summary Statistics

	Mean	SD	Min	Max	Obs
Inequality-adjusted 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

Supplement 8: 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

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