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January 2019

A G D I Working Paper

WP/19/004

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Forthcoming: Information Development

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[1] This working paper also appears in the Development Bank of Nigeria Working Paper Series.

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Abstract

This paper develops a framework (a) to examine whether or not the African business environment hinders or promotes the knowledge economy (KE), (b) to determine how the KE affects economic performance, and (c) how economic performance relates to the inequality-adjusted human socioeconomic development (IHDI) of 53 African countries during the 1996-2010 time period. We estimate the linkages with three related equations. The results support a strong correlation between the dynamics of starting and doing business and variations in KE. The results also show that there exists a weak link between KE and economic performance. Nonetheless, KE-influenced performance plays a more important role in socioeconomic development than some of the conventional control variables like foreign direct investment (FDI), foreign aid, and even private investment.

1. Introduction

This study investigates linkages between business dynamics and the KE, between KE and the economic performance, and the implications for inequality-adjusted human development (IHDI) in African countries. By business dynamics we mean the environment that influences starting, running (operating) a business. We define the "KE" as an economy based on knowledge (Powell & Snellman, 2004; Brinkley, 2006). Such an economy has four pillars: (i) an economic incentive and institutional regime, (ii) educated and skilled workers, (iii) a modern and adequate information infrastructure, and (iv) an efficient innovation system (see Chen & Dahlman, 2005). The pillars distinguish a KE from a simple "knowledge" (or technology). For instance, although the Safaricom (Mpesa) mobile money transfer technology has shaped growth and development in Kenya where it is widely used, it is not a KE; it is only an aspect of the KE. Also in this paper economic performance refers to changes (positive or negative) in GDP. IHDI goes beyond simple GDP changes, and we represent it with changes in IHDI to control for how achievements are distributed within the population (see Noorbakhsh, 1998; Asongu & le Roux, 2017).

The analysis is important for a number of reasons. First, level business dynamics influence the value of the firm, and the latter affects sustainable (long-term) performance of the KE (Ernst & Young, 2013; Leke, Lund, Roxburgh, & van Wamelen, 2010; Anyanwu, 2012; Kuada, 2009). This contribution is in line with the United NationsSustainable Development Goals (UN, 2013, p. 7-13).

Second, the performance of KE affects the competitiveness of nations, with implications for economic performance (Kowal & Roztocki, 2013; Roztocki & Weistroffer, 2016). We *deliberately* utilize the notion of inclusive development to suggest that our analysis goes beyond assessing the conventional growth-development nexus. GDP growth, albeit necessary, is not a sufficient indicator of human development, because '*output may be growing, and yet the mass of the people may be becoming poorer*' (Lewis, 1955, emphasis added). This sufficiency condition has been recently rediscovered by Piketty's (2014) '*Capital in the 21st Century*' in developed countries, and by a growing stream of literature on developing nations (Kalwij & Verschoor, 2007; Thorbecke, 2013; Fosu, 2009, 2014; Singh, 2014)..

Third, the study enhances current understanding of the determinants of the KE in African countries by extending the literature on the institutional drivers of innovation (Oluwatobi, Efobi, Olurinola, & Alege, 2015), on business research (Sigué, 2011),on entrepreneurship (Brixiova, Ncube, Bicaba, 2014) needed to alleviate poverty (Kuada, 2011), on the role of the KE in African business (Tchamyou, 2017), and on the reverse relationship between entrepreneurship and the KE (Asongu and Tchamyou, 2016).

Finally, the novelty of this study is that we approach the issues in a three-stage model in which business dynamics affect the KE, the KE affects economic performance, and the latter has important implications for IHDI. The model is estimated, and then tested with five interrelated hypotheses. The intuition of the inquiry builds on evidence that the use of information technology pillar of the KE, for instance, activates various strands of knowledge within complex human connections that can ultimately lead to reduction in the digital divide (Qureshi, Kamal, & Keen, 2009). This positioning of the inquiry also extends another recent stream of literature on the relevance of information technology dimension of the KE in improving economic and human development (Levendis & Lee, 2013; Qureshi, 2013a); welfare externalities (Carmody, 2013; Qureshi, 2013b,c), entrepreneurship and inclusive development (Asongu & Boateng, 2018; Gosavi, 2018; Humbani & Wiese, 2018; Muthinja & Chipeta, 2018), living standards (Chavula, 2013), financial sector development (Tchamyou & Asongu, 2017) and equal income distribution (Tchamyou, 2019a, 2019b; Tchamyou, Erreygers, Cassimon & 2019).

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 outlines methodological issues. Section 4 presents and discusses the results. Section 5 stresses the implications of the findings, while Section 6draws conclusions from the study implications.

2. Literature Review

The general literature on the effects of the business environment on the competitiveness of firms is notable, and Porter (1990, 1998) has traced it back to Adam Smith's concepts of division of labor, comparative advantage, and specialization(Smith, 1937[1776], Stigler, 1957).Other interpretations include Richardson (1969), Krugman (2008; 1995), Barnes & Ledebur (1998), and Neven & Dröge (2001). Despite previous efforts, the general theory of the business climate

is a lot more complex than the optimal location theory of the firm as businesses do not always set up in their lowest cost or highest profit locations. For example, N'da (2012) demonstrated that the cost of doing business in Sub-Saharan African countries (SSACs) depends on many indicators of the quality of the business environment, all of which suggest the importance of the transparency of business dynamics to trade, foreign direct investment (FDI), and foreign aid, hence to the KE (see World Bank Doing Business reports).The WB and the International Finance Corporation's (IFC) *Doing Business in the East African Community*(2013) reveals that only 10 SSACs rank among the top 100 of 185 countries in which it is easy to do business (http://www.doingbusiness.org). Eifert, Gelb, & Ramachandan (2005) found evidence that the business climate determine the competitiveness and external economies of African manufacturing sectors, so that "Africa is high-cost relative to its income and productivity" Consequently, Bannock and Darro (undated) raised seven key points to justify "donor support for business environment reform in Africa" (p.1), and called for intense engagement and creation of institutions and instruments that link governments, donors, private sector stakeholders and development agencies to the business environment. Also, Spring, Rolfe, & Odera (2013) studied the Sub-Sahara Africa (SSA) business environment by major regions, revealing influential economic factors and forces like economic growth, trade, infrastructure, and FDI.

Although the business environment and its effects on business activity have origins in standard economic theory, recent economic literature on the topic is thin. Among the few Fosu, Mlambo, & Oshikoya (2001) concluded that "despite more than a decade of reform in many African countries, investment and growth rates are still far below the levels required for sustainable development" (p.1). Mlambo & Oshikoya (2001) examined macroeconomic factors and forces affecting investment and discovered that the business climate has had enormous influence on private investment. They concluded that the business climate "matters for investment" and that it has "had a negative impact on private investment recovery" (p.1). These studies are relevant, because they illustrate that by influencing investment (both domestic and FDI) business dynamics affect economic performance of the general economy of which KE is a part.

Further research shows the effects of business dynamics on investment. For instance, Gunning & Mengistae (2001) surveyed microeconomic evidence on manufacturing investment in Africa

during the 1990s. Besides uncovering that market processes have selected the survival of efficient firms in African countries as strongly as they did elsewhere, their research also indicates that the low real rates of investment are likely more due to the politically risky business environment than anything else. Devarajan, Easterly, & Pack (2001) disagree with Gunning and Mengistae's assessment, because their cross-country data and micro data from Tanzania indicate that the low marginal impacts of investment on growth in Africa suggest too much, not too little, investment. Our own interpretation is that the returns on foreign investment and the return of investment (replacement cost in the Tobin-q framework) in SSACs are more competitive than often suggested. This interpretation is consistent with Fafchamps's (2001) finding that, although network and other externalities of business dynamics a tendency to lock market participants into inefficient and unequal long-term relationships, with respect to revenue in the mobile technologies sectors in Africa, while higher operators' tariffs may be attributable to noncompetitive business dynamics surrounding mobile technologies compared to other regions in the world, simultaneously over the 2003-2008 years the Herfindahl index suggests that African mobile markets have become more competitive than before and thereby increasing the market penetration rate. Consequently variable network cost per traffic minute for 14 African mobile operators have fallen (Gutierrez, Lee, & Virto, 2009; Noumba Um, Gille, Rudelle, & Simon, 2004; Esselaar, Gillwald, & Stork, 2007; Gillwald & Stork, 2008). All these cannot be explained by a negative business climate.

As stated previously a KE has four pillars, and each pillar has its own environment that intersects with other pillar's environments and with the KE (see Chen & Dahlman, 2005).Any business environment that affects the pillars affects the foundation of the KE itself. Changes in any of its pillars are changes in the KE itself. Sheba's (1998) argument is understandable that "major hindrances to the provision of information in Africa" are results of the policy failure (neglect) to acknowledge the interdependence between information and development. In fact, Alemna (1999) has gone further in asserting that the inaction by African governments to implement ICT policies has impeded the "harnessing" of new technologies needed for "Africa's transition to the 21st Century" (Mchombu, 2007). The rationale, again, is that KE is a function of investment in the four pillars; any business climate that interferes with such investment also interferes with the KE. Moreover, we know from Stan & Garnsey (2006), for instance, that knowledge facilitates

entrepreneurship, and the latter leads to knowledge growth that stimulates the KE in turn (Tchamyou, 2017). Zakić, Jovanović, & Stamatović (2008) have discussed external and internal factors that determine product and process innovations. Andrés, Asongu, & Amavilah (2015) estimated the impact through governance of formal institutions on the KE in African and Middle East and North African (henceforth, MENA) countries, and they found that formal institutions are necessary, but not strong enough, determinants of KE. Furthermore, Amavilah, Asongu, and Andrés (2017) estimate economically significant effects on the KE of globalization-related peace and stability acting through governance, with the peace and stability induced by trade-related globalization have stronger effects on governance, and hence on the KE, than peace and stability resulting from FDI-related stability associated with globalization represented as financial flows.

The importance of the relationship between the KE and the general economy depends on the intensity of the knowledge underlying the KE itself. If KE is taken to be a technology, changing that relationship is changing production and consumption possibilities and hence national well-being. This paper takes additional steps to describe the links between the KE and the surrounding business context, between the KE and economic performance (growth or decline), and between economic performance and IHDI. As growth economic performance improves production possibilities, but improved possibilities do not always mean well-being as there are examples of growth that is accompanied by inequality and poverty. In fact, Kuznets's (1955, 1971) work inspired a strand of literature that predicted an inverted-U relationship between inequality and growth. However, in the years 1990-2010 economic growth coincided with both inequality and poverty in SSACs – despite Young's (2012), and Pinkovskiy & Sala-i-Martin ' (2014) enthusiasm. Over the same time period OECD, MENA, and South Asian countries have seen inequality rise with weak growth. Latin American and South East Asian countries have experienced high growth and high inequality in the 1980-2000s followed by significant reductions in inequality even as recent years growth in those regions has been anemic, implying that growth can be both enriching and "immiserizing" (Bhagwati, 1958).

Our current interest is not just in output growth, but in inclusive growth, growth that has sustainable development and freedom as its objectives according to the UN and Sen (1999; 1983), respectively. For example, Kjøller-Hansen & Sperling (2013) quantify this type of growth

"by setting up five distinct criteria for inclusive growth in relation to productive employment" (pp.10-15), and use household data to evaluate the experiences of Albania, Burkina Faso, Egypt, Romania, and Tajikistan, discovering that countries' experiences differed remarkably. Using Zambian data Ianchovichina & Lundstrom (2009) developed a related framework in which growth is meaningful only if it reduces poverty and inequality, and does so in a sustained and sustainable manner. All these studies agree that to be inclusive, growth has to advance human progress meaningfully and in measurable ways. For this reason Ianchovichina & Lundstrom (2009) and Kjøller-Hansen & Sperling (2013) provide practical formulas for characterizing income from employment of resources that individual persons or countries need to meet the Euler or Keynes-Ramsey conditions for inclusiveness. We modify Ianchovichina & Lundstrom's (2009) insight by saying if sustainable growth is sustained inclusive growth, then IHDI is a better indicator of well-being (standard of living) than per capita GDP, because IHDI accounts for the "loss of human development due to economic inequality" (Human Development Reports, HDR, 2014, p.4; cf..Sen, 1997; 1999; 1983; Anand & Sen, 1994). Thus, the coefficient of IHDI measures the intensity of such inequality, and the data reveals that SSACs have the highest IHDI in health; South Asia, and the Arab States have the highest IHDI in education; and Latin American and the Caribbean have the highest IHDI in income. We are aware that a more appropriate measure to use is the poverty-adjusted HDI, also called the "multidimensional poverty index" (MPI). However, for the lack of complete data we use IHDI in spite of its weaknesses.

3. Methodology

Our methodology has four stylized components to which we turn next: The model, testable hypotheses, variable and data characterization, and the estimation technique.

3.1 The Model

Rationalizing Lucas and Moll (2014), assume that a representative economy has two interactive sub-economies: the *KE* (y_1), and the general economy (y_2). Suppose y_1 depends on business dynamics (z) as well as control variables (x_1), such that

$$y_1 = a_1 + \alpha_1 z + \beta_1 x_1 + \mu_1, \tag{1}$$

where the intercept a_1 represents the state of technology current to the KE, α_1 is the marginal effect of business dynamics (z) on KE, β_1 is the influence on KE of the control variables (x_1), and μ_1 is the error term associated with KE. If the link between y_1 and y_2 is weak or nonexistent, then y_2 would depend only on its own factors (x_2) and forces (a_2), and y_1, if anything, is an unexplained part of a_2. However, any interaction between y_1 and y_2 leads to

$$y_2 = a_2 + \alpha_1' y_1 + \beta_2 x_2 + \mu_2, \tag{2}$$

where a_2 is the economy-wide technological constant, α_1' is the marginal effect of the KE on economic performance, β_2 is the marginal effect of non-KE variables on economic performance, and μ_2 is the error term associated with economic performance. Equation 2 represents the performance equation and its Euler or Keynes-Ramsey conditions.

Eqs. (1) and (2) are standard growth equations (Solow, 1956; 1957; Swan, 1956; 2002; Lucas, 1988; 1993; Romer, 1990; Aghion & Howitt, 1992; Mankiw, Romer, & Weil, 1992; Barro,1991). One of our contributions is in reformulating (1)-(3) as a Sen's capabilities model to interpretation of $y_3 \equiv IHDI$ as a better indicator of national well-being -- not GDP growth alone. The reasoning is that y_3 is determined by (a) the by life-expectancy at birth, (b) the knowledge available to the economy, and (c) a "decent standard of living," represented by per capita income. The sum of the inequality adjusted longevity and health and education equals human capital, H. Given H per capita $= h = y_1$, one can show that $y_3 = \gamma_1 h + \gamma_2 y_2 = \gamma_1 y_1 + \gamma_2 y_2$, $\gamma_1 + \gamma_2 = 1$ being the shares (weights) of y_1 and y_2 in y_3, such that

$$y_3 = a_3 + \alpha_2' y_2 + \beta_3 x_3 + \mu_3, \tag{3}$$

where again, $y_3 \equiv IHDI$, a_3 is a development-specific constant, α_3' is the marginal effect of economic performance on inclusive development, β_3 is the effect of other influences on development, and μ_3 stands for random variations around the development process.

3.2Testable Hypotheses

Eqs. (1)-(3) suggest that the entire estimation process reduces to testing the following five testable hypotheses (see also Figure 1):

Hypothesis 1: *Education* (Educatex) from starting and doing business is associated with growth which influences the quality of development (IHDI).

Hypothesis 2: *ICT* from starting and doing business is associated with economic growth which influences the quality of inclusive development (IHDI).

Hypothesis 3: *Innovation* (Innovex = STJA) from starting and doing business is associated with growth, which influences the quality of development (IHDI).

Hypothesis 4: *Economic incentives* (Creditex) from starting and doing business are associated with growth, which influences the quality of development (IHDI).

Hypothesis 5: *Institutional regime* (Instireg) from starting and doing business is associated with growth which influences the quality of development (IHDI).

3.3 Variables, Data, and Principal Component Analysis (PCA)

We investigate a group of 53 African countries listed in Panel B of Table 1 over the 1996-2010 period. The choice of the study time-span was motivated by the need to compare the findings with the extant literature that has employed a similar sample and periodicity (Amavilah, Andrés, and Asongu, 2017; Tchamyou, 2017; Asongu & Tchamyou, 2016).However, since available data is of limited scope and accuracy, we use the World Bank's World Development Indicators (WDI) data primarily.[2] Such a choice comes with a trade-off between consistency and small-size sample properties.

Table 1 also describes the variables of particular interest to this study. The first row of Panel A displays the representations of KE. The second and third rows list two indicators of business

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[2] The interested reader can find the data on the following site of the World Bank.http://data.worldbank.org/data-catalog/world-development-indicators.

dynamics: Starting and doing (operating) business, noting that both operating and starting business have more than one component. The fourth row of the table outlines control and other variables. One of the benefits of these variables and data is that they allow us to examine the links between business dynamics and the KE, and between the KE and economic performance and then the implications of both for inclusive development.

Table 1: Descriptive statistics and list of countries

Panel A: Descriptive Statistics						
		Mean	S.D.	Min	Max	Obs.
Knowledge Economy	Educatex (Education)	-0.075	1.329	-2.116	5.562	320
	ICTex (Information & Infrastructure)	0.008	1.480	-1.018	8.475	765
	Creditex (Economic Incentive)	-0.083	0.893	-4.889	2.041	383
	Instireg (Institutional Regime)	0.105	2.075	-5.399	5.233	598
	Scientific and Technical Journal Articles(log)	1.235	0.906	-1.000	3.464	717
	Trademarks(log)	6.973	1.567	0.000	10.463	276
	Patents(log)	5.161	2.077	1.386	9.026	121
Starting Business	Time to Start-up (log)	3.624	0.812	1.098	5.556	386
	Cost of Start-up (log)	4.354	1.312	0.741	8.760	386
	New business density	1.032	1.962	0.002	10.085	111
	Newly registered businesses (log)	7.965	1.878	2.639	11.084	111
Doing(operating) Business	Cost of Export (log)	7.282	0.517	6.137	8.683	305
	Trade Barriers (Tariff)	11.474	5.611	0.000	39.010	347
	Trade (log)	4.239	0.476	2.882	5.617	719
	ICT Goods Exports	0.788	1.979	0.000	20.944	391
	ICT Service Exports	6.098	5.792	0.017	45.265	277
	High-Technology Exports	4.640	7.192	0.000	83.640	455
	Contract Enforcement (log)	6.434	0.383	5.438	7.447	383
	Registration of Property (log)	4.175	0.756	2.197	5.983	346
	Investor Protection: Disclosure	4.774	1.976	0.000	8.000	293
Control & Other variables	Growth	4.763	7.293	-31.300	106.28	759
	Inclusive Human Development	1.351	6.341	0.127	47.486	551
	Net Official Development Assistance(NODA)	10.811	12.774	-0.251	148.30	704
	Inflation	57.556	955.55	-100.00	24411	673
	Trade	77.853	39.698	17.859	275.23	719
	Private Investment	12.979	9.400	-2.437	112.35	658
	Public Investment	7.449	4.500	0.000	39.984	655
	Foreign Direct Investment	4.221	8.451	-8.629	145.20	557

Panel B: List of 53 African Countries

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Chad, Central African Republic, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Rwanda, Sao Tomé & Principe, Seychelles, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

Notes :S.D.: Standard Deviation. Min: Minimum. Max: Maximum. Obs: Number of observations.

The "starting" and "operating" indicators of business dynamics are not affected by multicollinearity and overparameterization issues (Tchamyou, 2017; Asongu & Tchamyou,

2016; Asongu & Tchamyou, 2019a, 2019b). However, since (1)-(3) likely face heteroskedasticity and multicollinearity, we apply the principal component analysis (PCA) to minimize the risks posed by overparameterization and multiple correlations (Miller & van der Meulen Rodgers, 2008). The Principal Component Analysis (henceforth, PCA) reduces highly correlated variables into a smaller set of uncorrelated principal components (PCs) that retain substantial information in the original dataset as suggested by an eigenvalue that is one or greater than one (Jolliffe, 2002, Fomby, Hill, & Johnson, 1984). Table 2 shows eigenvalues ranging from 1.31 for the Economic Incentive (*Creditex*) variable to 4.64 for the Institutional Regime (*Instireg*) variable. Among the principals we also include logSTJA to proxy for Innovation (*Innovex≡logSTJA*) because of limited degrees of freedom in the other components, where, logSTJA is the natural logarithm of STJA, and STJA is Scientific & Technical Journal Articles. A number of studies in the KE literature have used the STJA as a proxy for innovation (Chavula, 2010; Tchamyou, 2017). Besides Creditex and Instireg variables, Table 2 also reveals the first PCs for education (*Educatex)*, information and communications technologies (*ICTex), Innovex, Creditex*, and *Instireg* correspond consistently to eigenvalues that are greater than one.

Table 2: Principal Component Analysis (PCA) for KE Indicators

KE dimensions		Component Matrix (Loadings)						% of Variation	Eigen Value	Indexes
Education	School Enrollment	PSE 0.438		SSE 0.657		TSE 0.614		65.80	1.975	Educatex
Information &communication technologies	ICTs	Internet 0.614		Mobile 0.584		Telephone 0.531		73.00	2.190	ICTex
Innovation Systems	Innovation	STJA 0.567		Trademarks 0.572		Patents 0.592		91.70	2.753	Innovex
Economic Incentives &	Economic Incentive	Private Credit -0.707			Interest rate Spread 0.707			65.60	1.313	Creditex
Institutional regimes	Institutional index	VA 0.383	PS 0.374	RQ 0.403	GE 0.429	RL 0.443	CC 0.413	77.30	4.642	Instireg

Notes: P.C: Principal Component. PSE: Primary School Enrollment. SSE: Secondary School Enrollment. TSE: Tertiary School Enrollment. PC: Principal Component. ICTs: Information and Communication Technologies. Educatex is the first principal component of primary, secondary and tertiary school enrollments. ICTex: First principal component of mobile, telephone and internet subscriptions. STJA: Scientific and Technical Journal Articles. Innovex: first principal component of STJA, trademarks and patents (resident plus nonresident). VA: Voice & Accountability. RL: Rule of Law. R.Q: Regulation Quality. GE: Government Effectiveness. PS: Political Stability. CC: Control of Corruption. Instireg (Institutional regime): First PC of VA, PS, RQ, GE, RL& CC. Creditex: First principal component of private domestic credit and interest rate spread.

Previous research has documented three concerns that may arise when regressors are obtained

from prior estimations: (i) efficiency, (ii) consistency, and (iii) validity in terms of inferences at higher stages of estimations (Pagan, 1984, p. 242; Asongu and Nwachukwu, 2016a; 2016b).The literature suggests that whereas multiple-stage estimations are consistent and efficient, only a few may provide inferences that are valid (Bai& Ng, 2006, McKenzie & McAleer, 1997), Oxley & McAleer, 1993, Westerlund & Urbain, 2013a). To minimize the lack of validity, we have employed principal components (PCs) following Westerlund & Urbain (2015, 2013b), who have provided an account for the interpretation of PC augmented factors. Although we are unable to do it here because of data limitations, previous empirical work like Stock & Watson (2002), Pesaran (2006), Bai (2003,2009), and Greenaway-McGrevy, Han, & Sul (2012) have shown that it is possible to adopt normal inferences with PCA derived variables, so long as the estimated values converge to their real values at the rate $\sqrt{NT}$, with T representing the time series and N the number of cross-sections.

3.4 Estimation Technique

We assume that there is cross correlation of residuals, and estimate the model in three stages we describe next..

Stage 1: The KE (y_1)depends on the dynamics of starting business, the dynamics of doing business, controls, and some random error. The dynamics of doing business include trade dynamics, technological dynamics, and dynamics of property rights. This first-stage builds upon Asongu & Tchmayou's (2016) notion of 'the effect of entrepreneurship on the KE'.

Stage 2: Economic performance -- growth or decline -- y_2 is a function of estimated y_1, controls and other relevant variables, and random chances. This stage entails two sets of equations: Performance related to the KE from starting a business, and performance emanating from doing business.

Stage 3: To test for the implications of economic performance for well-being, we argue that inclusive development (IHDI =y_3) is related to estimated y_2 in addition to other variables and controls and the error term. This stage involves two sets of equations: One for$y_3$that is influenced by y_2 from starting business, and the other for $y_3$from y_2 from doing business.

Over time the three stages suggest the following reduced form specifications:

$$y_{1t} = a_1 + \alpha_1 z_1 + \beta_1 x_{1t} + \eta_{1i} + \xi_{1t} + \mu_{1t,}$$

$$y_{2t} = a_2 + \alpha_1' \dot{y}_{1t} + \beta_2 x_{2t} + \eta_{2i} + \xi_{2t} + \mu_{2t}^*, \alpha_1' = \alpha_1 + \beta_1, \tag{4}$$

$$y_{3t} = a_3 + \alpha_2' \dot{y}_{2t} + \beta_3 x_{3t} + \eta_{3i} + \xi_{3t} + \mu_{3t}^*, \alpha_2' = \alpha_1' + \beta_2$$

where $\dot{y}$ is estimated y from the preceding stage, η_i and ξ_i are time- and country-specific effects, and μ_i are error terms of an unknown structure *a priori* but suspected of being heteroskadastic and autocorellated (HEC) and estimated as such.

One possible estimation technique for (4) is simultaneous equation. We do not use the simultaneous setting, because it does not permit us to check for the validity of the instruments after the first-stage and second-stage regressions (cf. Young, 2017); the sequential setting does and it is also consistent with our formulation of testable hypotheses.

4   Results and Discussion

Tables 3-6 present estimation results by stage.[3] For instance, Table 3A reveals that overall the dynamics of starting business explain more than a quarter of all variations in the KE. However, variations differ across KE dimensions, being the lowest for the Creditex variable, and the highest for the logSTJA = Innovex variable. *Ceteris paribus*, in the light of the coefficients of determinations (i.e. adjusted R²), the dynamics of doing (operating) business explains 36% to 42% of all changes in the KE. Among these, doing business dynamics explain the Educatex dimension of the KE the least. These results are reasonable and reflect country heterogeneity. Nigeria, for example, has a far more educated population than South Africa, even though the latter has a far more advanced financial and technological infrastructure than the former.

In Table 3B the results show that doing business explain over 40% of the variations in the KE, or an average of 46% across all dimensions. Respectively, starting business dynamics are the first,

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[3]Appendix to additional variable definitions and data manipulations is available separately.

second, and third strongest explainers of the Educatex, ICTex, and logSTJA pillars of the KE, and weakest for Creditex. Accordingly, the strengths of doing business on KE indicators are nearly uniform at about 45%. Overall, KE from starting a business is on average higher than the corresponding KE from doing business. It makes sense that starting a business would have larger effects on the KE than running a business; starting a business generates learning (knowledge) whether the business succeeds or fails, whereas doing business is beneficial only when the business succeeds.

The results in Table 4 report the estimation (Panel A) and the testing of the strength (PanelB) of the estimated KE on economic performance. Average KE from starting and running business accounts for 81% and 80% of all fluctuations in economic performance, respectively. In this case, however, specific KE from starting and doing business is high only for the Innovex (logSTJA) dimension of the KE. For others, the adjusted R-squared and Fisher statistics are low. Even so, a relationship exists, because average KE is responsible for up to 83% of variations in economic performance.

Table 6 shows the results from the third-stage estimation. Here KE-associated economic performance affects inclusive development (IHDI) strongly. The effects on IHDI of performance based on the KE from starting business without and with time effects (Panel A) are positive, except in the cases of ICTex, Creditex, and Instireg when time effects are included. The included variables explain up to 70% of variations when time effects are not considered, and up to 89% when time effects are considered.

Table 3: KE from starting and doing business (First-stage)

Panel A: Instrumentation (Dependent variable: KE dynamics. Independent variables: Business dynamics).

	KE from starting business					KE from doing business				
	Educatex	ICTex	logSTJA	Creditex	Instireg	Educatex	ICTex	Innovex	Creditex	Instireg
Adjusted R²	0.634	0.641	0.667	0.397	0.484	0.364	0.414	0.415	0.419	0.406
Fisher	30.060***	49.258***	55.634***	12.073***	25.190***	4.661***	10.82***	10.17***	6.235***	10.317***
Observations	68	109	110	68	104	52	112	104	59	110
Countries	17	20	20	14	19	23	32	32	20	31

Panel B: Testing the strength of instruments (Dependent variable: KE dynamics. Independent variables: Instrument KE dynamics)

Instrument	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adjusted R²	0.988	0.900	0.676	0.425	0.499	0.453	0.451	0.456	0.490	0.444
Fisher	5821.4***	977.3***	228.89***	50.59***	103.81***	43.36***	92.44***	87.35***	56,86***	88,259***
Observations	68	109	110	68	104	52	112	104	59	110
Countries	17	20	20	14	19	23	32	32	20	31

Notes: *,**,***: significant levels at 10%, 5% and 1% respectively. Educatex is the first principal component of primary, secondary and tertiary school enrollments. ICTex: First principal component of mobile, telephone and internet subscriptions. STJA: Scientific and Technical Journal Articles. Innovex: first principal component of STJA, trademarks and patents (resident plus nonresident). VA: Voice & Accountability. RL: Rule of Law. R.Q: Regulation Quality. GE: Government Effectiveness. PS: Political Stability. CC: Control of Corruption. Instireg (Institutional regime): First PC of VA, PS, RQ, GE, RL& CC. Creditex: First principal component of private domestic credit and interest rate spread. KE: Knowledge Economy. (): P values in parentheses.

Table 4: Growth related to KE from starting and doing business (Second-stage)

Panel A: Instrumentation (Dependent variable: GDP growth. Independent variables: Instrumented KE dynamics)

	KE from starting business						KE from doing business					
	Educatex	ICTex	Innovex	Creditex	Instireg	KE	Educatex	ICTex	Innovex	Creditex	Instireg	KE
Adjusted R²	0.047	0.154	0.731	0.233	0.304	0.806	0.077	0.302	0.638	0.179	0.171	0.797
Fisher	3.337*	19.69***	297.07***	2.427***	45.16***	26.592***	4.196**	48.09***	180.19***	12.653***	22.54***	18.13***
Observations	68	109	110	68	104	32	51	112	103	59	110	23
Countries	17	20	20	14	19	10	23	32	32	20	31	13

Panel B: Testing the strength of instruments (Dependent variable GDP growth. Independent variables: Instrumented GDP growth)

	KE from starting business						KE from doing business					
	Educatex	ICTex	Innovex	Creditex	Instireg	KE	Educatex	ICTex	Innovex	Creditex	Instireg	KE
Instrument	1.000	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***	1.000***
	(0.174)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.020)	(0.020)	(0.000)	(0.000)	(0.000)	(0.000)
Adjusted R²	0.047	0.154	0.731	0.233	0.304	0.831	0.077	0.302	0.638	0.179	0.171	0.834
Fisher	3.337*	19.69***	297.07***	21.42***	45.168***	152.65***	4.196**	48.09***	180.19***	12.653***	22.54***	110.8***
Observations	68	109	110	68	104	32	51	112	103	59	110	23
Countries	17	20	20	14	19	10	23	32	32	20	31	13

Notes: *,**,***: significant levels at 10%, 5% and 1% respectively. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex: first principal component of mobile, telephone and internet subscriptions. STJA: Scientific and Technical Journal Articles. Innovex: first principal component of STJA, trademarks and patents (resident plus nonresident). VA: Voice & Accountability. RL: Rule of Law. R.Q: Regulation Quality. GE: Government Effectiveness. PS: Political Stability. CC: Control of Corruption. Instireg (Institutional regime): First PC of VA, PS, RQ, GE, RL& CC. Creditex: first principal component of private domestic credit and interest rate spread. KE: Knowledge Economy. (): P values in parentheses.

Table 5: Descriptive statistics of instrumented variables (Growth related to KE from business dynamics)

	Panel A: KE from Starting Business						**Panel B: KE from Doing Business**				
	Mean	S.D	Min	Max	Obs.		Mean	S.D	Min	Max	Obs.
IVGrEduSB	0.446	1.352	-2.362	3.082	68	IVGrEduDB	0.774	1.539	-2.128	6.384	51
IVGrICTSB	1.252	2.016	-2.512	8.353	109	IVGrICTDB	2.162	2.288	-4.566	8.130	112
IVGrSTJASB	4.979	1.450	1.231	7.356	110	IVGrSTJADB	4.279	1.381	0.304	6.869	103
IVGrCredSB	5.745	1.477	3.162	9.024	68	IVGrCredDB	1.460	2.052	-3.106	5.687	59
IVGrInstSB	2.322	2.378	-1.703	11.504	104	IVGrInstDB	1.444	1.882	-3.721	5.072	110
IVGrKESB	6.302	1.801	3.474	9.662	32	IVGrKEDB	5.327	2.181	2.057	9.485	23

IVGrEduSB: Growth related to Education from Starting Business. IVGrICTSB: Growth related to ICT from Starting Business. IVGrSJTASB: Growth related to STJA from Starting Business. IVGrCredSB: Growth related to Economic Incentives from Starting Business. IVGrInstSB: Growth related to Institutional regime from Starting Business. IVGrKESB: Growth related to KE from Starting Business. IVGrEduDB: Growth related to Education from Doing Business. IVGrICTDB: Growth related to ICT from Doing Business. IVGrSJTADB: Growth related to STJA from Doing Business. IVGrCredDB: Growth related to Economic Incentives from Doing Business. IVGrInstDB: Growth related to Institutional regime from Doing Business.IVGrKEDB: Growth related to KE from Doing Business. S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obs: Observations.

Table 6: Inclusive development from Growth related to the KE from starting and doing business (Third stage)

Dependent variable: Inequality-adjusted Human Development Index (IHDI)

Panel A: KE from starting business

	Education		ICT		STJA		Economic Incentives		Institutional Regime		Knowledge Economy	
Constant	0.493***	0.534***	0.499***	0.531***	0.449***	0.490***	0.545***	0.527***	0.494***	0.531***	0.486***	0.484***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IVGrEduSB	0.012***	0.005**	---	---	---	---	---	---	---	---	---	---
	(0.000)	(0.013)										
IVGrICTSB	---	---	0.006**	-0.0002	---	---	---	---	---	---	---	---
			(0.014)	(0.893)								
IVGrSTJASB	---	---	---	---	0.010**	0.007***	---	---	---	---	---	---
					(0.046)	(0.000)						
IVGrCredSB	---	---	---	---	---	---	-0.004	0.003	---	---	---	---
							(0.442)	(0.201)				
IVGrInstSB	---	---	---	---	---	---	---	---	0.005*	-0.0006	---	---
									(0.055)	(0.619)		
IVGrKESB	---	---	---	---	---	---	---	---	---	---	0.003*	0.005***
											(0.055)	(0.003)
NODA	-0.002**	-0.0008	-0.002***	-0.001**	-0.002***	-0.0007**	-0.002***	-0.001***	-0.002***	-0.001***	-0.003**	-0.003***
	(0.020)	(0.196)	(0.000)	(0.011)	(0.000)	(0.032)	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)	(0.000)
Inflation	0.0007***	0.0003***	0.0005***	0.0004***	0.0006***	0.0003***	0.0008***	0.0007***	0.0006***	0.0004***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Private Invt.	---	---	0.0004	-0.0002	0.0005	-0.0004*	0.0004*	-0.0001	0.0005	-0.0002	0.0005***	0.001***
			(0.190)	(0.258)	(0.174)	(0.096)	(0.087)	(0.592)	(0.147)	(0.269)	(0.002)	(0.005)
Public Invt.	---	---	0.001*	0.0005	0.001*	0.00006	0.0008**	0.0003	0.001*	0.0005	0.0009	0.001*
			(0.065)	(0.302)	(0.079)	(0.876)	(0.035)	(0.419)	(0.059)	(0.300)	(0.216)	(0.082)
Time effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Adjusted R²	0.551	0.848	0.635	0.853	0.599	0.881	0.688	0.890	0.619	0.854	0.842	0.865
Fisher	554.17***	1148.7***	720.27***	1275.7***	671.64***	1618.8***	951.26***	1712.4***	707.81***	1320.6***	785.61***	682.19***
Observations	61	61	68	68	69	69	47	47	69	69	28	28
Countries	17	17	14	14	14	14	10	10	14	14	9	9

Panel B: KE from doing business

	Education		ICT		STJA		Economic Incentives		Institutional Regime		Knowledge Economy	
Constant	0.479***	0.563***	0.493***	0.508***	0.436***	0.513***	0.548***	0.553***	0.503***	0.507***	0.558***	0.400***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)
IVGrEduSB	0.004	0.003***	---	---	---	---	---	---	---	---	---	---
	(0.152)	(0.000)										
IVGrICTSB	---	---	-0.001	-0.001	---	---	---	---	---	---	---	---
			(0.723)	(0.376)								
IVGrSTJASB	---	---	---	---	0.008***	-0.0009	---	---	---	---	---	---

19

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
							(0.003)	(0.334)				
IVGrCredSB	---	---	---	---	---	---	**0.003****	-0.0002	---	---	---	---
							(0.049)	(0.581)				
IVGrInstSB	---	---	---	---	---	---	---	---	**0.007****	0.0007	---	---
									(0.011)	(0.541)		
IVGrKESB	---	---	---	---	---	---	---	---	---	---	-0.0008	**0.011****
											(0.807)	**(0.058)**
NODA	0.001	**-0.002****	0.0002	**-0.0005*****	0.0001	**-0.0005*****	0.0001	-0.0005	0.000	**-0.0005*****	0.0005	-0.001
	(0.271)	**(0.033)**	(0.600)	**(0.009)**	(0.801)	**(0.007)**	(0.866)	(0.134)	(0.846)	**(0.000)**	(0.290)	(0.235)
Inflation	**0.0005*****	0.0001	**0.0003****	**0.0001***	**0.0002****	**0.0001****	**0.0005***	**0.0003***	0.0002	**0.0001***	**0.0009*****	**0.0009****
	(0.000)	(0.139)	**(0.021)**	**(0.054)**	**(0.027)**	**(0.039)**	**(0.054)**	**(0.060)**	(0.033)	**(0.068)**	**(0.000)**	**(0.015)**
Private Invt.	**0.002*****	-0.0005	**0.001*****	0.000	**0.0009*****	0.000	**0.0008****	0.0001	**0.0009*****	0.000	**0.001*****	**0.001***
	(0.000)	(0.178)	**(0.005)**	(0.712)	**(0.009)**	(0.707)	**(0.026)**	(0.180)	**(0.005)**	(0.740)	**(0.002)**	**(0.082)**
Public Invt.	**0.003*****	0.0009	**0.001*****	**0.0004****	**0.001****	**0.0005****	**0.001***	**0.0005****	**0.001****	**0.0005****	**0.002****	**0.003*****
	(0.000)	(0.110)	**(0.007)**	**(0.028)**	**(0.017)**	**(0.026)**	**(0.069)**	**(0.016)**	**(0.010)**	**(0.027)**	**(0.021)**	**(0.008)**
Time effects	No	Yes	No	Yes	No	No	No	Yes	No	Yes	No	Yes
Adjusted R²	0.446	0.937	0.255	0.856	0.333	0.857	0.496	0.878	0.344	0.858	0.930	0.964
Fisher	**301.33*****	**1610.2*****	**543.68*****	**2238.3*****	**625.27*****	**2330.7*****	**703.81*****	**1955.1*****	**636.17*****	**2335.08*****	**1465.2*****	**1281.7*****
Observations	37	37	71	71	73	73	41	41	73	73	21	21
Countries	17	17	22	22	22	22	14	14	22	22	11	11

Notes: *,**,***: significance levels of 10%, 5% and 1% respectively. NODA: Net Official Development Assistance. FDI: Foreign Direct Investment. Priv. Invt: Private Investment. Pub.Invt: Public Investment. IVGrEduSB: Growth related to Education from Starting Business. IVGrICTSB: Growth related to ICT from Starting Business. IVGrSJTASB: Growth related to STJA from Starting Business. IVGrCredSB: Growth related to Economic Incentives from Starting Business. IVGrInstSB: Growth related to Institutional regime from Starting Business. IVGrKESB: Growth related to KE from Starting Business. IVGrEduDB: Growth related to Education from Doing Business. IVGrICTDB: Growth related to ICT from Doing Business. IVGrSJTADB: Growth related to STJA from Doing Business. IVGrCredDB: Growth related to Economic Incentives from Doing Business. IVGrInstDB: Growth related to Institutional regime from Doing Business. IVGrKEDB: Growth related to KE from Doing Business. (): P values in parentheses.

The effects on the inclusive development of growth associated with the KE from doing business without and with time effects are less impressive (Table 6, Panel B). In fact, they are negative for ICT without and with time effects, negative for Creditex and Innovex = STJA, and for average KE with time effects. Excluding time effects, a one percent increase in growth enhanced by the KE from starting business improves inclusive development by 1.3%, and only by half a percent when time effects are included. Inclusive development increases by 1.1% for every one percent increase in growth related to KE from doing business. These estimates are more important than the effects of foreign aid (NODA), which are negative across the board, and they compare well to the effects of private investment as well.

The key control variables have the expected signs and agree with previous research. For instance, Asongu (2013a) has established from the African literature on inclusive growth that low and stable inflation is pro-poor, because high inflation has strong disequalizing income-distribution effects (Albanesi, 2007) and low inflation has strong equalizing income-distribution effects (Bulir, 1998; López, 2004). Low inflation is better for the poor, because it exerts a lower depreciation on the purchasing power of their income. The negative effect of foreign aid on IHDI is consistent with a recent study on quality of performance in developing countries (Mlachila, Tapsoba, & Sampawende, 2014, Asongu, 2014a). The positive effect of investment (public and private) on IHDI conforms with intuition and the predictions of economic theory. An added insight here is that public investment appears to exert a stronger effect on IHDI than private investment.

The main purpose of this paper is to study the relationships (a) between the business environment and the KE, (b) between the KE so determined and economic performance, and consequently (c) between economic performance and inclusive development. We represent the business environment with the dynamics of starting and doing business in those countries. Economic performance is measured conventionally as the growth rate of real GDP and IHDI represents inclusive development. The effects of business dynamics on the KE are both nonzero and strong as measured by the adjusted R-squares and exact F statistic are reasonable.

At the second stage of the estimation, the results indicate a weak link between the KE and

economic performance. Both adjusted R-squares and the F-statistic are low, but the magnitudes of the instruments are reasonable. We suspect that the weakness could be due to the synergic effect from the combined dimensions of the KE on economic performance, because relative to individual KE components the growth-enhancing effect from the KE is substantial. This is nota new conjecture. The KE literature demonstrates that South Korea's growth-enhancing benefits from the KE have been based on a strategy that incorporates all the dimensions of the KE (Suh & Chen, 2007; Lee, 2009). Another plausible explanation is that the low adjusted R-squares simply indicate missing relevant variables, which is not unreasonable given the large constant terms. Such an explanation is also likely because parameter signs are generally consistent with both economic tuition and intuition, and the weak effect on performance is no better or worse than the "Africa dummy" found to be either low or negative in many growth regressions (Temple, 1999; Temple& Johnson, 1998). Hence, despite the low level of statistical significance of individual parameters, we insist that the results are indicative of the economic significance and relevance.

Regarding the third-stage, the stated hypotheses have been validated (accepted or not rejected). For example: *Education* from starting and doing business is associated with growth, which in turn influences development (*Hypothesis 1*); *ICT* from starting and doing business is associated with growth which influences the quality of development (*Hypothesis 2*); *Innovation* from starting and doing business is associated with growth which influences the quality of development (*Hypothesis 3*); *Economic incentives* from starting and doing business are associated with growth, which influences the quality of development (*Hypothesis 4*); and *Institutional regime* from starting and doing business is associated with growth which influences the quality of development (*Hypothesis 5*).Obviously not all associations are statistically significant, but most coefficients have correct arithmetic signs. Still a key policy conclusion is that categorical statements that the African business environment is bad for inclusive development, worse for economic growth, and crippling (worst) for the KE are not entirely correct.

5. Implications

The results also show that the African business environment influences the quality of education,

which has growth-enhancing benefits that ultimately improve development. This finding is consistent with the general African entrepreneurship and poverty reduction literature (Singh, et. al., 2011; Gerba, 2012; Oseifuah, 2010; Ita, Singh, & Adelosa, 2014; Mensah & Benedict, 2010). Two other related perspectives hold that the production value of knowledge (education), and positive human capital externalities from learning on the African continent, which are strongly influenced by the positive business environment, also have growth-enhancing effects on inclusive development (Amavilah, 2009; Wantchekon, et. al., 2015). Therefore, boosting the education dimension of the KE requires: improving knowledge infrastructure, fighting the brain drain, improving the nexus between technological science and industry, updating academic curricula, and providing greater support for research and development (R&D). These all would enable the continent to reap the educational benefits accruing from an increasingly vibrant business environment. The reinvigoration of learning should not be restricted to general formal education like vocational & technical training; governments could adopt lifelong learning strategies such as 'work place trainings' in order to keep workers abreast of the challenges of the business environment. The KE depends on technological change, which is a function of human capital accumulation. Billon et. al. (2017) have found that internet use affects economic growth positively, but educational inequality lowers internet use, irrespective of country income levels.

Second, the results also confirm that ICT and African business environment have been related over the past decade. Asongu (2013b), for instance, shows that the positive correlation between ICT and the informal financial sector has led to substantial growth-enhancing benefits of inclusive development, implying that the vitality of the informal sector depends on the business environment as well (Demombynes & Thegeya, 2012; Jonathan & Camilo, 2008; Asongu, 2015). This means that investment in ICT infrastructure would go a long way toward improving both growth and inclusive development. While business constraints are already pushing most African governments into the direction of adopting such an initiative, implementing pro-poor growth investment priorities would still be critical to overall policy success. Like Tchamyou (2017), we urge for ICT-friendly measures in collaboration with other soundly integrated policies that take into account industrialization, a regulatory and competitive policy, and a vibrant computing-literacy and numeracy policy. Since there is already a growing consensus that liberalization of the ICT sector in Africa has had considerable pro-poor benefits (Asongu, 2015), further actions

could consolidate the insights from Korea's success story. According to Suh & Chen (2007), in Korea policies favoring ICTs have been motivated along three main axes: An industrial policy requiring sound R&D and venture capital, a 'competitive & regulatory' policy entailing privatization and market liberalization, and an 'active policy of information' requiring the setting-up of electronic governance mechanisms and building of advanced ICT infrastructure. Korea's KE strategy has taken research center stage in China as demonstrated by Hu (2018) and Zhang (2018) and African countries might want to take heed.

Third, the positive effect of business dynamics on innovation in terms of STJA provides insights on the need to invest in the production of scientific knowledge in African countries that are lagging behind other regions of the world. Chavula (2010, p. 20) has found an insignificant positive relationship between STJA and growth in Africa. In this paper we have provided a new clarification of STJA could be enhanced through less tight Intellectual Property Rights (IPRs) regimes such as software piracy (Asongu, 2014b; Asongu, 2014c). In other words, software piracy would boost scientific publications, partly because it is pro-poor.

Bold policy initiatives are essential to encouraging science and technology in institutions of higher learning that are consistent with Africa's level of development. Policies favouring reverse engineering might be worthwhile, because the technology in the sampled countries is more imitative and adaptive than anything else. This line of policy recommendations agrees with the underlying factors of the East Asian Miracle (Andrés et al., 2015). However, following Romer (1993), Lewis (1955), and Amavilah (2005) it is worth noting that the technology that matters to long-run economic growth is not only a function of resources alone; it is also determined by the *interactions* and *intra-actions* among resources. For example, huge investments in educational and or research structures along with mediocre investments in teachers, students, and researchers, are likely less productive than small investments in "objects," "ideas," and the surrounding environment. This perspective is consistent with Schultz's (1981) call for 'investment in people,' and Lucas's (1993) conclusion that the Asian growth miracle was really just a man-made miracle. It is also in line with Lewis's (1955[1965]) insistence that"E*conomic growth depends upon technological knowledge about things and living creatures, and also upon social knowledge about man and his relations with his fellowmen. The former is often*

emphasized in this context, but the latter is just as important since growth depends as much upon such matters as learning how to administer large scale organizations, or creating institutions which favor economizing effort, as it does upon breeding new seeds or learning how to build bigger dams" (p. 164, italics added).

Fourth, it is natural to expect an improving business environment to stimulate economic incentives by means of credit facilities which ultimately engender growth and inclusive human development. However, documented surplus liquidity issues constrain financial allocation efficiency in Africa, and the resulting inefficiency is not a good channel to mitigating inequality (Saxegaard, 2006; Asongu, 2013a). Capital requirements in Small & Medium Size Enterprises (SMEs) should be adequately addressed, because pro-poor externalities from SMEs are likely larger than those from MNCs.

Fifth, the finding related to the hypothesis on the institutional regime pillar of the KE clearly articulates the imperative of good institutions in the KE for economic performance and implications for inclusive development. This also supports a clarification by Amavilah et al. (2017) of Andrés et al. (2015) on the positive role of institutions in KE-related development when more factors are taken into account. Oluwatobi et al. (2015) have established that government effectiveness and regulation quality are the most relevant for growth enhancing innovations, a finding in line with the role of institutions in the inclusive development of Africa as stressed in Fosu (2013a,b), Musila & Sigué (2010, 2011), and Mlachila et al. (2014). Improvement of the institutional regime component of KE should be made in conjunction with other economic policies discussed above.

Sixth, it is important to point out that incidental to the main purpose of this study, the results also reveal other interesting insights relating to control and other variables. For example, foreign aid (NODA) is inversely related to inclusive development. Such a result is familiar to the aid-growth debate, foreign aid to many African countries has often been crisis-driven. A recent case in point is the recent effort against the Ebola virus outbreak in three West African countries. Such aid has been helpful for the survival of citizens in recipient countries. It is less effective in promoting growth and reducing poverty in the long term. This observation might be one of the pieces of

evidence in Moyo's (2009) for declaring that aid dead.

The net effects on inclusive development of investment are positive. However, while the effects of public investment on inclusive development are positive, those of private investment are negative, especially with respect to ICT, STJA, Creditex and Instireg. One may conclude that public policy is misguided for overstressing foreign aid and FDI, even though greater benefits lie in supporting the local business environment. Thus, this research has provided an empirical framework on which policy makers can substantiate policy initiatives that aim at stimulating inclusive development, through the following path: business dynamics →KE→ growth → inclusive development. While we acknowledge the likelihood of sequential reverse causation, the contributions of this paper are strong enough to stand on their own for now, and leave the issue of endogeneity to a separate effort.

The findings established in the first path (business dynamics → KE) are broadly consistent with Tchamyou (2017), who has investigated the role of the KE in promoting the African business environment (KE → Business dynamics). The result of the second path (KE→ growth) is in line with Asongu & Tchamyou (2016), who found that such a path stimulates to economic prosperity. The third path (growth → inclusive development), although not new in the literature (see, e.g., Odhiambo, 2009; 2011),is distinct in that the influence of growth is contingent on the previously established paths (business dynamics → KE→ growth). Overall, the evidence also falls within the framework of theory-building, because applied econometrics should not be exclusively limited to the acceptance and rejection of existing theory. We have shown that arguments which are founded on solid intuition and prior theoretical exposition on similar linkages can provide the basis for results that have both statistical significance and economic relevance. In that case we agree with Colander (2017) that "economists should stop doing it with models (and start doing it with heuristics)."

5. Conclusions

This paper has developed an empirically-relevant framework to examine linkages between business dynamics and KE, between KE and economic performance, and the implications for inclusive human development (IHDI) in 53 African countries during the period 1996-2010. The

framework provides a guide to policymaking and further research. We implement the framework by building a three-stage model and rationalizing it as five interrelated hypotheses. Estimation results indicate that the dynamics of starting and doing business explain a large part of variations in the KE. The link between the KE and economic performance exists, but it is weak, and we provide plausible reasons for such a result. We conclude that despite the weak association between the KE and economic growth, KE-influenced economic performance plays a very important role in inclusive development. In fact, growth of this kind has stronger effects on poverty reduction than some of the conventional controls in this study, such as FDI, foreign aid, and even private investment.

There is clearly room for further research to improve the results, but just as clearly practical policy is best served by not neglecting the relationships examined here. Even so, we still conclude that this paper provides a firm foundation for improving policymaking and further research. We acknowledge that the use of simultaneous techniques and confronting reverse causation may provide more insights. However, the motivation of the study has not been about causal allegations; we have been more concerned with establishing the presence of linkages between business dynamics and the KE, between the KE and economic performance, and the implications for inclusive human development. Dealing with the endogeneity issues is another interesting area for future research.

Finally, we conclude that other efforts are needed to concentrate on improving the extant literature by assessing whether the established linkages withstand empirical scrutiny from country-specific examinations. Country-specific inquiries will provide room for more targeted policy strategies. The employment of the more comprehensive pillars of the KE proposed by Brockmann & Roztocki (2017) is another worthwhile future extension that would permit comparison between the four components of the World Bank's Knowledge Economy Index and the Brockmann & Roztocki's (2017) scheme which includes the following six pillars: Innovation Capability, Leadership, Human Capital, Information Technology Resources, Financial Resources, and Innovation Climate.

Furthermore, there are apparent issues of missing observations which invite a cautious interpretation of the attendant policy implications. However, there is nothing the research could do to address the issue of constraints in data availability at the time of the study. It would therefore be worthwhile for future research adopting the same methodological outline, to tailor adopted estimation techniques such that the issues scant data and relatively larger variances are taken on board. Although, looking into the underlying issues is out of the scope, one can certainly work with missing values to a certain extent and PCA is very sensitive to small changes in the dataset (Beckers and Risen, 2003).

References

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction.*Econometrica* 60(2), 323–351.

Albanesi, S. (2007).Inflation and inequality.*Journal of Monetary Economics*, 54(4), 1088–1114.

Alemna, A.A. (1999). The impact of new information technology on Africa, *Information Development*, 15(3), 167–170.

Amavilah, V.H.S. (2009). Knowledge of African countries: Production and value of doctoral dissertations.*Applied Economics*, 41 (8), 977–989.

Amavilah, V.H.S. (2005). "Resource Intra-Actions And Inter-Actions: Implications For Technological Change And Economic Growth," GE, Growth, Math methods 0508004, University Library of Munich, Germany.

Amavilah, V.H.S. (2003).Resource intra-actions and interactions: Implication for economic growth. Available at http://128.118.178.162/eps/ge/papers/0508/0508004.pdf.

Amavilah, V.H.S., Asongu, S.A., & Andrés, A.R. (2014). Globalization, peace & stability, governance and knowledge economy.*African Governance and Development Institute Working Paper* No. 14/012.

Amavilah, V.H.S., Asongu, S.A., & Andrés, A R. (2017). Effects of globalization on peace and stability: Implications for governance and the knowledge economy of African countries.*Technological Forecasting and Social Change*, 122, 91–103.

Anand, S., & Sen, A.K. (1994). Human development index: Methodology and measurement. Human Development Report Office. Occasional paper. New York.

Andrés, A.R., Asongu, S.A., &Amavilah, V.H.S. (2015). The impact of formal institutions on knowledge economy.*Journal of the Knowledge Economy*, 6(4), 1034–1062.

Anyanwu, J.C. (2012). Developing knowledge for the economic advancement of Africa.*International Journal of Academic Research in Economics and Management Sciences*, 1(2), 73–111.

Asongu, S.A. (2013a). Investment and inequality in Africa: Which financial channels are good for the poor?.*The African Finance Journal*, 15(2), 43–65.

Asongu, S.A. (2013b). How has mobile phone penetration stimulated financial development in Africa?. *Journal of African Business*, 14(1), 7–18.

Asongu, S.A. (2014a). The questionable economics of development assistance in Africa: Hot-fresh evidence, 1996-2010.*The Review of Black Political Economy*, 41(4), 455–480.

Asongu, S.A. (2014b).Software piracy and scientific publications: Knowledge economy evidence from Africa.*African Development Review*, 26(4), 572–583.

Asongu, S.A. (2014c). Software piracy, inequality and the poor: Evidence from Africa. *Journal of Economic Studies*, 41(4), 526–553.

Asongu, S.A. (2015). The impact of mobile phone penetration on African inequality.*International Journal of Social Economics*, 42(8), 706–716.

Asongu, S. A., & Boateng, A., (2018). Introduction to Special Issue: Mobile Technologies and Inclusive Development in Africa, *Journal of African Business*, 19(3), 297-301.

Asongu, S.A., & le Roux, S. (2017). Enhancing ICT for inclusive human development in Sub-Saharan Africa.*Technological Forecasting and Social Change*, 118(May), 44–54.

Asongu, S.A., & Nwachukwu, J.C. (2016a). Revolution empirics: predicting the Arab Spring.*Empirical Economics,* 51(2), 439–482.

Asongu, S.A., & Nwachukwu, J.C. (2016b). The role of lifelong learning in political stability and non-violence: Evidence from Africa.*Journal of Economic Studies*, 43(1), 141–164.

Asongu, S.A., & Tchamyou, S.A. (2016). The effect of entrepreneurship on knowledge economy in Africa.*Journal of Entrepreneurship in Emerging Economies*, 8(1), 101–131.

Asongu, S. A., & Tchamyou, V. S., (2019a). Human Capital, Knowledge Creation, Knowledge Diffusion, Institutions and Economic Incentives: South Korea Versus Africa, Contemporary *Social Science*. DOI: 10.1080/21582041.2018.1457170.

Asongu, S. A., & Tchamyou, V. S., (2019b). Foreign Aid, Education and Lifelong Learning in

Africa. *Journal of the Knowledge Economy*. DOI: 10.1007/s13132-017-0449-1.

Bai, J., & Ng, S. (2006). Confidence intervals for diffusion index forecasts and inference for factor-augmented regression.*Econometrica*, 74(4), 1133–1150.

Bai, J. (2003). Inferential theory for factor models of large dimensions. *Econometrica*, 71 (1),135–173.

Bai, J. (2009). Panel data models with interactive fixed effects. *Econometrica*, 77(4), 1229–1279.

Bannock, G., & Darroll, C. (2007) Donor support for business environment reform in Africa: A review of key issues. Donor Committee for Enterprise Development, Business Environment Working Group, African Consultative Conference, African overview Parper. Available at http://www.businessenvironment.org/dyn/be/docs/160/Bannock-Daroll.pdf.Accessed on 7/5/2018.

Barnes, W.R., & Ledebur, L.C. (1998).*The New Regional Economies: The U.S. Common Market and the Global Economy*. Thousand Oaks: Sage Publications.

Barro, R.J. (1991). Economic growth in a cross section of countries.*Quarterly Journal of Economics*, CVI (2), 407–443.

Beckers, J. M., & Rixen, M., (2003). EOF Calculations and Data Filling from Incomplete Oceanographic Datasets, *Journal of Atmospheric and Ocean Technology*, 20, 1839-1856.

Bhagwati, J. (1958). Immiserizing growth: A geometrical note.*Review of Economic Studies*, 25 (June), 201–205.

Billon, M., Crespo, J., Lera-López, F. (2017).Educational inequalities: Do they affect the relationship between Internet use and economic growth? *Information Development*. Available at https://doi.org/10.1177/0266666917720968.

Brinkley, I. (2006) Defining the knowledge economy. Knowledge Economiy Programme Report. The Knowledge Foundation

Brixiova, Z., Ncube, M., & Bicaba, Z. (2014). Skills and youth entrepreneurship in Africa: Analysis with evidence from Swaziland. William Davidson Institute Working Paper No. 1077. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2445001.

Brockmann, C., & Roztocki, N. (2017). The six pillars of knowledge economics. Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS 2017), 4444–4453. Available at http://scholarspace.manoa.hawaii.edu/handle/10125/41701 (Accessed: 29/04/2017).

Bulir, A. (1998). Income inequality: Does inflation matter?.*IMF Working Paper* No. 98/7, Washington.

Carmody, P.(2013). A knowledge economy or an information society in Africa? Thintegration and the mobile phone revolution. *Information Technology for Development*, 19(1), 24-39.

Chavula, H. K. (2013). Telecommunications development and economic growth in Africa. *Information Technology for Development*, 19(1), 5-23.

Chavula, H. K. (2010). The role of knowledge in economic growth. The African perspective. ICT, Science and Technology Division (ISTD),United Nations Economic Commission for Africa (UNECA), 1–26.

Chen, D., & Dahlman, C.J. (2005). The knowledge economy, the KAM methodology and World Bank operations. World Bank Institute Working Paper, No. 37256, Washington, DC. Available at https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=841625.

Colander, D. (2017). Economists should stop doing it with models (and start doing it with heuristics).*Eastern Economic Journal*, 43(4), 729-733.

Demombynes, G., &Thegeya, A. (2012). Kenya's mobile revolution and the promise of mobile savings. *World Bank Policy Research Working Paper*, No. 5988, Washington.

Devarajan, S., Easterly, W., & Pack, H. (2001). Is investment in Africa too high or too low? Macro-and micro-evidence.*Journal of African Economies,* 10 (2), 81–108.

Eifert, B., Gelb, A., & Ramachandran, V. (2005). Business environment and comparative advantage in Africa: Evidence from the investment climate data. Working Paper No. 56, Center for Global Development, Washington, DC.

Ernst & Young (2013). Doing business in Africa: From strategy to execution. Growing Beyond http://www.ey.com/Publication/vwLUAssets/Doing_business_in_Africa_-_From_strategy_to_execution/$FILE/130130%20SGF%20Thought%20Leadership%20email%20version.pdf (Accessed: 29/11/2014).

Esselaar, B., Gillwald, A., & Stork, C. (2007). Towards an Africa e-index: Telecommunications sector performance in 16 African countries. Research ICT Africa, www.researchICTafrica.net.

Fafchamps, M. (2001).Networks, communities and markets in Sub-Saharan Africa: Implications for firm growth and investment.*Journal of African Economies,* 10 (2), 109–142.

Fomby, T.B., Johnson, S.R., & Hill, R.C. (1984).*Advanced Econometric Methods*. New York: Springer-Verlag. Chapter 13, 283-306.

Fosu, A., Mlambo, K., &Oshikoya, T.W.(2001). Business environment and investment in Africa: An overview.*Journal of African Economies,* 10 (2), 1–11.

Fosu, A.K. (2009). Inequality and the impact of growth on poverty: Comparative evidence for

Sub-Saharan Africa.*Journal of Development Studies*, 45(5), 726–745.

Fosu, A.K. (2013a). Growth of African economies: Productivity, policy syndromes and the importance of institutions.*Journal of African Economies*, 22(4), 523–551.

Fosu, A.K. (2013b). Institutions and African economies: An overview.*Journal of African Economies*, 22(4), 491–498.

Fosu, A.K. (2014). Growth, inequality and poverty in Sub-Saharan Africa: Recent progress in a global context.*CSAE Working Paper Series* 2014-17, Oxford.

Gerba, D.T. (2012). Impact of entrepreneurship education on entrepreneurial intentions of business and engineering students in Ethiopia.*African Journal of Economic and Management Studies*, 3(2), 258–277.

Gillwald, A., & Stork, C. (2008). Towards evidence-based ICT policy and regulation: ICT access and usage in Africa. Volume 1. Policy Paper Two, Research ICT Africa, available at https://www.researchictafrica.net/publications/Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_1/RIA%20Policy%20Paper%20Vol%201%20Paper%202%20-%20ICT%20Access%20and%20Usage%20in%20Africa%202008.pdf

Gosavi, A., (2018). Can mobile money help firms mitigate the problem of access to finance in Eastern sub-Saharan Africa, *Journal of African Business*. 18(4), 343-360.

Greenaway-McGrevy, R., Han, C., &Sul, D. (2012).Asymptotic distribution of factor augmented estimators for panel regression. *Journal of Econometrics*, 169 (1), 48–53.

Gunning, J.W., & Mengistae, T. (2001). Determinants of African manufacturing investment: The microeconomic evidence.*Journal of African Economies,* 10 (2), 48–80.

Gutierrez, L. H., Lee, S., &Virto, L.R. (2009). Market concentration and performance in mobile markets in Africa and Latin America.OECD Development Center (mimeo).

Hu, Z. (2018). The study of international trade effect of the infrastructure construction under the One belt and One Road. WAEI Conference Paper (June 26-30), Vancouver, BS.

Humbani, M., & Wiese, M., (2018). A Cashless Society for All: Determining Consumers' Readiness to Adopt Mobile Payment Services, *Journal of African Business*, 18(4), 409-429..

Ianchovichina, E., & Lundstrom, S. (2009). Inclusive growth analytics: Framework and application. *Policy Research Working Paper* No. 4851. The World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/4047/WPS4851.pdf?sequence=1 (Accessed: 27/11/2014).

Ita, J.J., Singh P., &Adelosa, S. (2014). Factors that influence entrepreneurial intentions among

undergraduates of South-South and Southeast Nigeria. Oxford Brookes University. http://dx.doi.org/10.2139/ssrn.2506268(Accessed: 08/12/2014).

Jolliffe, I. T. (2002).*Principal Component Analysis* (2ndEd.), New York: Springer-Verlag.

Jonathan, D., & Camilo, T. (2008). Mobile banking and economic development: Linking adoption, impact and use. *Asian Journal of Communication*, 18(4), 318–322.

Kalwij, A., &Verschoor, A. (2007). Not by growth alone: The role of the distribution of income in regional diversity in poverty reduction.*European Economic Review*, 51(4), 805–829.

Kjøller-Hansen, A.O., & Sperling, L.L. (2013).Measuring inclusive growth experiences: Five criteria for productive employment. Paper submitted for a presentation at UNU WIDER's Annual Conference held in Helsinki on 21-23 September 2013. Available at http://www1.wider.unu.edu/inclusivegrowth/sites/default/files/IGA/Lindbjerg%20Sperling.pdf (Accessed 8/15/2014).

Kowal, J., & Roztocki, N. (2013). Information and communication technology management for global competitiveness and economic growth in emerging economies.*The Electronic Journal of Information Systems in Developing Countries*, 57, 1–12. http://www.ejisdc.org/ojs2/index.php/ejisdc/issue/view/117 (Accessed: 29/04/2017).

Kuada, J. (2009). Gender, social networks, and entrepreneurship in Ghana.*Journal of African Business*, 10(1), 85–103.

Kuada, J. (2011). Understanding growth options and challenges in African economies.*African Journal of Economic and Management Studies*, 2(1), 5–8.

Kuznets, S. (1955).Economic growth and income inequality.*American Economic Review*,45 (March), 1–28

Kuznets, S. (1971).*Economic Growth of Nations: Total Output and Production Structure*. Belknap Press/Harvard University Press: Cambridge (Mass).

Krugman, P.M. (2008). The increasing returns revolution in trade and geography. http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2008/krugman_lecture.pdf (Accessed 8/11/2014).

Krugman, P.M. (1995).*Development, Geography, and Economic Theory*. Cambridge: MIT Press.

Lee, K. (2009). How can Korea be a role model for catch-up development? A 'capability- based' view. UN-WIDER Research Paper No. 2009/34, Helsinki.

Leke, A., Lund, S., Roxburgh, C., & Van Wamelen, A. (2010). What's driving Africa's growth?. McKinsey & Company report. http://www.mckinsey.com/insights/economic_studies/whats_driving_africas_growth (Accessed: 29/11/2014).

Levendis, J., & Lee, S.H. (2013). On the endogeneity of telecommunications and economic growth: evidence from Asia. *Information Technology for Development*, 19(1), 62-85.

Lewis, A. (1955). *Theory of Economic Growth*. Milton Park: Routledge.

Lopez, J.H. (2004). Pro-growth, pro-poor: Is there a trade-off?. World Bank Policy Research Working Paper 3378. World Bank, Washington DC.

Lucas, R. (1988). On the mechanics of economic development. *Journal of Monetary Economics,* 22(1), 2–42.

Lucas, R. (1993). Making a miracle.*Econometrica*, 61(2), 251–272.

Lucas, R., & Moll, B. (2014). Knowledge growth and the allocation of time.*Journal of Political Economy*, 122(1),1–51.

Majerova, I. (2012). Comparison of old and new methodology of human capital and poverty indexes: A case of the least developed countries. The*Journal ofEconomics Studies and Research*, available at http://www.ibimapublishing.com/journals/JESR/2012/290025/290025.pdf.

Mankiw, N.G., Romer, D., & Weil, D. (1992). A contribution to the empirics of economic growth.*Quarterly Journal of Economics,* 107(2), 407–437.

Mchombu, K.J. (2007). Harnessing knowledge management for Africa's transition to the 21st Century. *Information Development*, 23(1), 25-42.

McKenzie, C., & McAleer, M. (1997). On efficient estimation and correct inference in models with generated regressors: A general approach. *Japanese Economic Review*, 48(4), 368–389.

Mensah, S.N., & Benedict, E. (2010). Entrepreneurship training and poverty alleviation: Empowering the poor in the Eastern Free State of South Africa. *African Journal of Economic and Management Studies*, 1(2), 138–163.

Miller, J.E.,&Van der Meulen Rodgers, Y. (2008). Economic importance and statistical significance: Guidelines for communicating empirical research.*Feminist Economics*, 14(2), 117–149.

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.

Mlambo, K., &Oshikoya, T.W. (2001). Macroeconomic factors and investment in Africa.*Journal of African Economies,* 10 (2), 12–47.

Moyo, D. (2009) *Dead Aid: Why aid is not working and how there is a better way for Africa.* Vancouver/Toronto: Douglas & McIntyre, D & M Publishers Inc.

Musila, J.W.,&Sigué,S.P. (2010). Corruption and international trade: An empirical investigation of African countries.*The World Economy*, 33(1), 129–146.

Musila, J.W.,&Sigué, S.P. (2011). Accelerating foreign direct investment flow to Africa: from policy statements to successful strategies. *Managerial Finance*, 32(7), 577–593.

Muthinja, M. M., & Chipeta, C., (2018). What Drives Financial Innovations in Kenya's Commercial Banks? An Empirical Study on Firm and Macro-Level Drivers of Branchless Banking, *Journal of African Business*, 18(4), 385-408.

N'da, K.C. (2012). The cost of doing business in Sub-Saharan Africa.*Bridges Africa.International Center for Trade and Sustainable Development*, 1(6): http://www.ictsd.org/bridges-news/bridges-africa/news/the-cost-of-doing-business-in-sub-saharan-africa (Accessed 8/15/2014).

Nelson, R.R. (1996). *The Sources of Economic Growth*. Cambridge (Mass): Harvard University Press.

Neven, D.,& Dröge, C.L.M. (2001). A diamond for the poor? Assessing Porter's diamond model for the analysis of agro-food clusters in developing countries. http://www.agrifood.info/Agrifood/members/Congress/Congress2001Papers/Symposium/Neven.pdf (Accessed 8/.15.2014).

Noorbakhsh, F. (1998).A modified human development index.*World Development*, 26(3), 517–528.

Noumba Um, P., Gille, L., Rudelle, C., & Simon, L. (2004). A model for calculating interconnection costs in telecommunications. World Bank. Washington DC. Available at http://documents.worldbank.org/curated/en/993401468779995571/pdf/280390PAPER0Model0for0calculating0costs.pdf (Accessed: 25/09/2017).

Odhiambo, N.M. (2009). Finance-growth-poverty nexus in South Africa: A dynamic causality linkage.*Journal of Behavioral and Experimental Economics*, 38(2), 320–325.

Odhiambo, N.M. (2011). Growth, employment and poverty in South Africa: In search of a trickle-down effect.*Journal of Income Distribution*, 20(1), 49–62.

Oluwatobi, S., Efobi, U., Olurinola, I., &Alege, P. (2014). Innovation in Africa: Why institutions matter?.*South African Journal of Economics*, 83(3), 390–410.

Open Working Group on Sustainable Development Goals (OWG) (2013). Statistical note for the issue brief on: Sustained and inclusive economic growth and infrastructure development and industrialization (draft, 22 November).(Accessed: 27/11/2014).

Oseifuah, E.K. (2010). Financial literacy and youth entrepreneurship in South Africa.*African*

Journal of Economic and Management Studies, 1(2), 164–182.

Oxley, L.,&McAleer, M. (1993). Econometric issues in macroeconomic models with generated regressors. *Journal of Economic Surveys*, 7(1), 1–40.

Pagan, A. (1984).Econometric issues in the analysis of regressions with generated regressors.*International Economic Review*, 25(1), 221–247.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74 (4), 967–1012.

Piketty, T. (2014). *Capital in the Twenty First Century*. Harvard University Press.

Pinkovskiy, M., & Sala-i-Martin, X. (2014). Africa is on time.*Journal of Economic Growth*, 19(3), 311–338.

Porter, M.E. (1990).*The Competitive Advantage of Nations*. New York: Free Press.

Porter, M.E. (1998). The Adam Smith Address: Location, Clusters, and the "New" Microeconomics of Competition. *Business Economics*, 33(1),7–13. http://www.econ.nyu.edu/dept/courses/niemira/980107.pdf (Accessed 8/11/2014).

Powell, W., & Snellman, K., (2004) "The knowledge economy." Annual Review of Sociology 30(Febraury): 199-220.

Qureshi, S., Kamal, M., & Keen, P. (2009). Knowledge Networking to overcome the Digital Divide. In: King W. (eds) *Knowledge Management and Organizational Learning*. *Annals ofInformation Systems*, Vol. 4. Springer, Boston, MA

Qureshi, S. (2013a). What is the role of mobile phones in bringing about growth? *Information Technology for Development*, 19(1), 1-4.

Qureshi, S. (2013b). Networks of change, shifting power from institutions to people: how are innovations in the use of information and communication technology transforming development? *Information Technology for Development*, 19(2), 97-99.

Qureshi, S. (2013c). Information and Communication Technologies in the Midst of Global Change: How do we Know When Development Takes Place? *Information Technology for Development*, 19(3), 189-192.

Richardson, H.W. (1969).*Regional Economics: Location Theory, Urban Structure, and Regional Change*. New York: Praeger Publishers. Chapters 1-5.

Romer, P.M. (1993). Idea gaps and object gaps in economic development.*Journal of Monetary Economics*,32(3), 543–573.

Romer, P.M. (1990). Endogenous technological change.*Journal of Political Economy*, 98(5),S71–S102.

Roztocki, N., & Weistroffer, H.R. (2016). Conceptualizing and researching the adoption of ICT and the impact on socioeconomic development.*Information Technology for Development*, 22(4), 541–549.

Saxegaard, M. (2006). Excess liquidity and effectiveness of monetary policy: Evidence from sub-Saharan Africa.*IMF Working Paper* No. 06/115, Washington.

Schultz, T.W.(1981).*Investing in People: The Economics of Population Quality*. Berkeley: University of California Press.

Sen, A. (1983). Development: Which way now?.*The Economic Journal*, 93(372), 745–762.

Sen, A. (1997). Editorial: Human capital and human capability. *World Development*, 25(2), 1959–1961.

Sen, A. (1999). The possibility of social choice. American Economic Review, 89(3), 349–378.

Sheba, M.S.(1998). Information for development in Africa. *Information Development*, 14(3), 152-154.

Sigué, S.P. (2011). Strengthening the position of a premier outlet for African business research.*Journal of African Business*, 12(1), 1–7.

Singh, P. (2014). Austerity, welfare state and eco-socialism: With special reference to the United Kingdom.*Economic and Political Weekly*, XLIX(39), 111–118.

Singh, S., Simpson, R., Mordi, C., &Okafor, C. (2011). Motivation to become an entrepreneur: A study of Nigerian women's decisions.*African Journal of Economic and Management Studies*, 2(2), 202–219.

Smith, A. 1937[1776]. *An Inquiry into the Nature and causes of the Wealth of Nations*. Edwin Canna (ed) and Max Lerner (introducer). New York: modern Library. Book 1, Chapters 1-3.

Spring, A., Rolfe, R.,&Odera, L. (2013). *Sub-Saharan Africa Business Environment Report: 2012-13 – Business Information at a Ready Glance*. http://warrington.ufl.edu/centers/ciber/docs/SABER_2012-2013.pdf (Accessed 8/15/214).

Solow, R.M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics,* 70(1), 65–94.

Solow, R.M. (1957). Technical change and the aggregate production function.*Review of Economics and Statistics,* 39(3), 312–320.

Stan, E., & Garnsey, E. (2006). Entrepreneurship and the knowledge economy. Centre for Centre for Technology Management (CMT) Working Paper, No 2007/04. Available at SSRN: https://ssrn.com/abstract=1923098 .

Stigler, G.J. (1957).*Adam Smith: Selections from the Wealth of Nations*. New York: Wiley-Blackwell.

Stock, J.H.,& Watson, M.W.(2002). Forecasting using principal components from a large number of predictors. *Journal of the American Statistical Association*, 97(460), 1167–1179.

Suh, J., & Chen, D. H. C. (2007).Korea as a knowledge economy. Evolutionary process and lessons learned. Korea Development Institute,
https://www.usp.ac.fj/worldbank2009/frame/Documents/Publications_regional/409300PAPER0
KR101OFFICIAL0USE0ONLY1.pdf (Accessed: 19/03/2014).

Swan, T.W. (1956). Economic growth and capital accumulation.*Economic Record,* 32(2), 334–361.

Swan, T.W.(2002). Economic growth.*Economic Record*, 78(243), 375–380.

Tchamyou, V. S., (2017). The role of knowledge economy in African business. *Journal of the Knowledge Economy*, 8(4), 1189–1228.

Tchamyou, V. S., (2019a).The Role of Information Sharing in Modulating the Effect of Financial Access on Inequality. *Journal of African Business*: Forthcoming.

Tchamyou, V. S., (2019b). Education, Lifelong learning, Inequality and Financial access: Evidence from African countries. *Contemporary Social Science*.
DOI: 10.1080/21582041.2018.1433314.

Tchamyou, S. V., & Asongu, S. A., (2017). Information Sharing and Financial Sector Development in Africa, *Journal of African Business*, 18(1), 24-49.

Tchamyou, V.S., Erreygers, G., & Cassimon, D., (2019). Inequality, ICT and Financial Access in Africa, *Technological Forecasting and Social Change*, 139(February), 169-184.

Temple, J. (1999). The new growth evidence.*Journal of Economic Literature*, XXXVII(1), 112–156.

Temple, J.,& Johnson, P. (1998). Social capability and economic growth.*Quarterly Journal of Economics*, CXIII (3), 965–990.

Thorbecke, E.(2013). The interrelationship linking growth, inequality and poverty in Sub-Saharan Africa.*Journal of African Economies*, 33(1), 15–48.

United Nations (Various). TST Issue Brief: Sustained and Inclusive Economic Growth,

Infrastructure Development, and Industrialization. http://sustainabledevelopment.un.org/content/documents/2078Draft%20Issue%20Brief_Sustaine d%20and%20Inclusive%20Economic%20Growth_Final_16Oct.pdf. (Accessed: 27/11/2014).

United Nations (Various). Sustained and Inclusive Economic Growth, Infrastructure Development, and Industrialization. Also see http://sustainabledevelopment.un.org/index.php?page=view&type=9502&menu=1565&nr=7. (Accessed: 27/11/2014).

United Nations Development Programme, Various, Human Development Reports.Technical Notes. hdr.undp.org/default/files.hdr14_technical_notes-1.pdf.

United Nations (2013). A New Global Partnership: Eradicate Poverty and Transform Economies Through Sustainable Development. The Report of the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda.
http://www.un.org/sg/management/pdf/HLP_P2015_Report.pdf (Accessed: 29/11/2014).

United Nations Development Programme or UNDP (various) Human
Reports. http://www.hdr.undp.org/.

Wantchekon, L., Klašnja, M., &Novta, N. (2015).Education and human capital externalities: Evidence from Colonial Benin.*Quarterly Journal of Economics*, 130(2), 703–757.

Westerlund, J., & Urbain, J-P. (2013a).On the estimation and inference in factor-augmented panel regressions with correlated loadings.*Economics Letters*, 119(3),247–250.

Westerlund, J., & Urbain, J-P. (2013b).On the implementation and use of factor-augmented regressions in panel data.*Journal of Asian Economics*, 28(October), 3–11.

Westerlund, J., &Urbain, J-P. (2015).Cross-sectional averages versus principal components.*Journal of Econometrics*, 185(2), 372–377.

World Bank (WB) and International Finance Corporation (IFC) (2013).*Doing business in the East African Community 2013*. Available at http://www.doingbusiness.org/reports/regional-reports/east-african-community (Accessed 8/15/2014).

World Bank (WB), *Measuring knowledge in the World's Economies.*Washington, D.C. http://siteresources.worldbank.org/INTUNIKAM/Resources/KAM_v4.pdf; also see www.worldbank.org/kam.

Young, A. (2012). The African growth miracle.*Journal of Political Economy*, 120 (4), 696–739.

Young, A., (2017) "Consistency without Inference: Instrumental Variables in Practical Application." Unpublished Manuscript.
 http://personal.lse.ac.uk/YoungA/ConsistencyWithoutInference.pdf.

Zakić, N., Jovanović, A., &Stamotović, M. (2008).External and internal factors affecting the

product and business process innovations.FACTA UNIVERSITATIS. Series: *Economics and Organization*, 5(1), 17–29.

Zhang, X., & Zhang, R. (2018). Road infrastructure, market integration, and productivity: Evidence from China's manufacturing sector. WAEI Conference Paper (June 26-30), Vancouver, BS.

APPENDIX

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Appendix Table 1: Variables, definitions, and data sources

Variables	Signs	Definitions of variables	Sources
Panel A: Dimensions in Knowledge Economy (KE)			
A1: Education			
Primary School Enrolment	PSE	School enrolment, primary (% of gross)	World Bank (WDI)
Secondary School Enrolment	SSE	School enrolment, secondary (% of gross)	World Bank (WDI)
Tertiary School Enrolment	TSE	School enrolment, tertiary (% of gross)	World Bank (WDI)
Education in KE	Educatex	First PC of PSE, SSE & TSE	PCA
A2: Information & Infrastructure			
Internet Users	Internet	Internet users (per 100 people)	World Bank (WDI)
Mobile Cellular Subscriptions	Mobile	Mobile subscriptions (per 100 people)	World Bank (WDI)
Telephone lines	Tel	Telephone lines (per 100 people)	World Bank (WDI)
Information &Communication Technology (ICT) in KE	ICTex	First PC of Internet, Mobile & Tel	PCA
A3: Economic Incentive & Institutional Regime			
Financial Activity (Credit)	Pcrbof	Private domestic credit from banks and other financial institutions	World Bank (FDSD)
Interest Rate Spreads	IRS	Lending rate minus deposit rate (%)	World Bank (WDI)
Economic Incentive in KE	Creditex	First PC of Pcrbof and IRS	PCA
Corruption-Control	CC	"Control of Corruption (estimate): Captures perceptions of the extent to	World Bank (WDI)

		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".	
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".	World Bank (WDI)
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".	World Bank (WDI)
Political Stability/ No violence	PS	"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".	World Bank (WDI)
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".	World Bank (WDI)
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".	World Bank (WDI)
Institutional Regime in KE	Instireg	First PC of CC, RL, RQ, PS, GE & VA	PCA
A4: Innovation			
Scientific & Technical Publications	STJA	Number of Scientific & Technical Journal Articles	World Bank (WDI)
Trademark Applications	Trademark	Total Trademark Applications	World Bank (WDI)
Patent Applications	Patent	Total Residents + Nonresident Patent Applications	World Bank (WDI)
Innovation in KE	Innovex	First PC of Trademarks and Patents	World Bank (WDI)
Panel B: Business Indicators			
B1: Starting Business			
Time to Start-up	Timestart	Log of Time required to start a business (days)	World Bank (WDI)

41

Cost of Start-up	Coststart	Log of Cost of business start-up procedures (% of GNI per capita)	World Bank (WDI)
New business density	Newbisden	New business density (new registrations per 1,000 people ages 15-64)	World Bank (WDI)
Newly registered businesses	Newbisreg	Log of New businesses registered (number)	World Bank (WDI)

B2: Doing Business

B2a: Trade

Cost of Export	Costexp.	Log of Cost to export (US$ per container)	World Bank (WDI)
Trade Barriers	Tariff	Tariff rate, applied, weighted mean, all products (%)	World Bank (WDI)
Trade Openness	Trade	Export plus Import of Commodities (% of GDP)	World Bank (WDI)

B2b: Technology Exports

ICT Goods Exports	ICTgoods:	ICT goods exports (% of total goods exports)	World Bank (WDI)
ICT Service Exports	ICTser	ICT service exports (% of service exports, BoP)	World Bank (WDI)
High-Technology Exports	Hightecexp	High-technology exports (% of manufactured exports)	World Bank (WDI)

B2c: Property Rights

Contract Enforcement	Contenfor	Log of Time required to enforce a contract (days)	World Bank (WDI)
Registration of Property	Regprop	Log of Time required to register property (days)	World Bank (WDI)
Investor Protection	Bisdiclos	Business extent of disclosure index (0=less disclosure to 10=more disclosure). It measures the extent to which investors are protected through disclosure of ownership information	World Bank (WDI)

B3: Closing Business

Insolvency Resolution[4]	Insolv	Time to resolve insolvency (years). The number of years from the filling of insolvency in court until the resolution of distressed assets.	World Bank (WDI)

Panel C: Control& Other Variables

Inclusive Human Development	IHDI	Inequality Adjusted Human Development Index	World Bank (WDI)
Economic Prosperity	GDPg	GDP Growth Rate (annual %)	World Bank (WDI)

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[4]Although the dynamics of closing business (Insolvency Resolution) would clearly affect KE, it is not included in empirical estimations, because issues in degrees of freedom.

Foreign Aid	NODA	Net Official Development Assistance (% of GDP)	World Bank (WDI)
Inflation	Infl.	Consumer Price Index (annual %)	World Bank (WDI)
Foreign Investment	FDI	Gross Foreign Direct Investment (% of GDP)	World Bank (WDI)
Public Investment	Pub Ivt.	Gross Public Investment (% of GDP)	World Bank (WDI)
Private Investment	Priv. Ivt.	Gross Private Investment (% of GDP)	World Bank (WDI)

WDI: World Bank Development Indicators. GNI: Gross National Income. BoP: Balance of Payment. GDP: Gross Domestic Product. PC: Principal Component. PCA: Principal Component Analysis. Log: logarithm. Educatex is the first principal component of primary, secondary and tertiary school enrolments. ICTex: first principal component of mobile, telephone and internet subscriptions. Creditex: First PC of Private domestic credit and interest rate spread. P.C: Principal Component. VA: Voice & Accountability. RL: Rule of Law. R.Q: Regulation Quality. GE: Government Effectiveness. PS: Political Stability. CC: Control of Corruption. Instireg (Institutional regime): First PC of VA, PS, RQ, GE, RL & CC.

Appendix Table 2: Correlation matrix of Growth related to KE from business dynamics

Panel A: Growth related to KE from Starting Business

	Control Variables					Starting Business						IHDI	
NODA	Inflation	FDI	PrivInvt.	Pub. Invt	IVGrEduSB	IVGrICTSB	IVGrSTJASB	IVGrCredSB	IVGrInstSB	IVGrKESB			
1.000	-0.004	0.165	-0.222	0.195	-0.749	-0.633	-0.457	0.835	-0.612	0.852	-0.072	NODA
	1.000	0.011	-0.042	-0.072	-0.017	-0.046	0.105	0.290	-0.049	0.226	-0.009	Inflation
		1.000	0.635	0.074	0.183	0.074	0.154	0.164	0.060	0.294	-0.042	FDI
			1.000	-0.037	0.443	0.350	0.132	-0.302	0.336	-0.453	0.025	Priv. Invt.
				1.000	-0.125	-0.162	0.041	0.263	-0.198	0.190	-0.151	Pub. Invt.
					1.000	0.913	0.583	-0.972	0.859	-0.930	0.880	IVGrEduSB
						1.000	0.331	-0.801	0.986	-0.703	0.784	IVGrICTSB
							1.000	-0.447	0.228	-0.168	0.400	IVGrSTJASB
								1.000	-0.735	0.864	-0.721	IVGrCredSB
									1.000	-0.622	0.757	IVGrInstSB
										1.000	-0.743	IVGrKESB
											1.000	IHDI

Panel B: Growth related to KE from Doing Business

	Control Variables					Doing Business						IHDI	
NODA	Inflation	FDI	PrivInvt.	Pub. Invt	IVGrEduDB	IVGrICTDB	IVGrSTJADB	IVGrCredDB	IVGrInstDB	IVGrKEDB			
1.000	-0.004	0.165	-0.222	0.195	-0.525	-0.450	-0.218	-0.340	-0.485	0.608	-0.072	NODA
	1.000	0.011	-0.042	-0.072	-0.089	-0.208	0.042	-0.124	-0.006	0.325	-0.009	Inflation
		1.000	0.635	0.074	0.146	0.399	-0.260	-0.106	0.100	-0.166	-0.042	FDI
			1.000	-0.037	0.329	0.421	0.073	0.180	0.266	-0.086	0.025	Priv. Invt.
				1.000	-0.301	-0.174	0.024	-0.105	-0.108	0.230	-0.151	Pub. Invt.
					1.000	0.0737	0.143	0.545	0.817	-0.651	0.778	IVGrEduDB
						1.000	0.086	0.506	0.764	-0.694	0.600	IVGrICTDB
							1.000	0.596	0.409	0.146	0.286	IVGrSTJADB
								1.000	0.780	-0.327	0.536	IVGrCredDB
									1.000	-0.736	0.637	IVGrInstDB
										1.000	-0.652	IVGrKEDB
											1.000	IHDI

NODA: Net Official Development Assistance. FDI: Foreign Direct Investment. Priv. Invt: Private Investment. Pub.Invt: Public Investment. IVGrEduSB: Growth related to Education from Starting Business. IVGrICTSB: Growth related to ICT from Starting Business. IVGrSJTASB: Growth related to STJA from Starting Business. IVGrCredSB: Growth related to Economic Incentives from Starting Business. IVGrInstSB: Growth related to Institutional regime from Starting Business. IVGrKESB: Growth related to KE from Starting Business. IVGrEduDB: Growth related to Education from Doing Business. IVGrICTDB: Growth related to ICT from Doing Business. IVGrSJTADB: Growth related to STJA from Doing Business. IVGrCredDB: Growth related to Economic Incentives from Doing Business. IVGrInstDB: Growth related to Institutional regime from Doing Business. IVGrKEDB: Growth related to KE from Doing Business. IHDI: Inequality Adjusted Human Development Index