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Abstract

Purpose - The paper assesses how entrepreneurship affects knowledge economy (KE) in Africa.

Design/methodology/approach – Entrepreneurship is measured by indicators of starting, doing and ending business. The four dimensions of the World Bank's index of KE are employed. Instrumental variable panel fixed effects are applied on a sampled of 53 African countries for the period 1996-2010.

Findings –The following are some findings. First, creating an enabling environment for starting business can substantially boost most dimensions of KE. Second, doing business through mechanisms of trade globalisation has positive effects from sectors that are not ICT and High-tech oriented. Third, the time required to end business has negative effects on KE.

Practical implications – Our findings confirm the narrative that the technology in African countries at the moment may be more imitative and adaptive for reverse-engineering in ICTs and high-tech products. Given the massive consumption of ICT and high-tech commodities in Africa, the continent has to start thinking of how to participate in the global value chain of producing what it consumes.

Originality/value – This paper has a twofold motivation. First, given the ambitions of African countries of moving towards knowledge based economies, the line of inquiry is timely. Second, investigating the nexus may have substantial poverty mitigation and sustainable development implications. These entail *inter alia*: the development of technology with value-added services; enhancement of existing agricultural practices; promotion of conditions that are essential for competitiveness and adjustment of globalization challenges.

JEL Classification: L59; O10; O30; O20; O55
Keywords: Entrepreneurship; Knowledge Economy; Development; Africa

1. Introduction

It is now abundantly apparent that for countries to be integrated into and competitive within the global arena, they have to adapt to the rules of competition that are consistent with globalisation: a phenomenon that has become an ineluctable process, whose challenges can be neglected only at the expense of the wealth of nations (Tchamyou, 2014; Asongu, 2015a). Competition in the 21st century is fundamentally centred on knowledge economy (KE). Unfortunately, recent evidence suggests KE in the African continent has been decreasing since the year 2000 (Asongu, 2015b).

The 2014 African Economic Conference on "Knowledge and Innovation for Africa's Transformation" has clearly articulated, *inter alia*: the imperative of investing in innovations and technology that are centered on people, for Africa's development and the importance of knowledge economy in shaping Africa's future. This is broadly consistent with the recent stream of research on entrepreneurship (Brixiova et al., 2015) and innovation (Oluwatobi et al., 2014) for the continent's emergence from poverty (Kuada, 2011a) and stylized facts on doing business challenges on the continent (Ernst & Young, 2013; Leke et al., 2010). We discuss recent African KE and entrepreneurship literature motivating the present line of inquiry in three main strands: need for entrepreneurship and investment, business strategies for achieving sustainable progress and KE on the continent.

First, on entrepreneurship, in line with Tchamyou (2014), doing business in Africa is extremely risky (Alagidede, 2008; Asongu, 2012). Doing business indicators of the World Bank do not fully reflect the African situation in terms of the impact of labour regulation (Paul et al., 2010). This is in accordance with an earlier position by Eifert et al. (2008) that the performance of African firms is undervalued by these indicators. The study is based on 7000 companies in 17 countries with data for the period 2002-2003. This finding does not overlook the current challenges of entrepreneurship in the continent (Taplin & Synman, 2004) which have culminated in, among others: studies encouraging more entrepreneurial lessons in undergraduate university programs (Gerba, 2012); a growing body of work on female entrepreneurial motivation (Singh et al., 2011) to bridge the substantially documented gender gap in doing business (Kuada, 2009); the fundamental roles of community and family relationships in the decision to become an entrepreneur (Khavul et al., 2009) and the effects of macroeconomic pressures on doing business in the continent (Kuada, 2011b)[1].

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[1] Other recently documented issues include, among others, the need for higher intra-trade intensity to synchronization of business cycles across the continent (Tapsoba, 2010); more socially responsible investments (Bardy et al., 2012); the need for more investment (Rolfe & Woodward, 2004) and good understanding of factors affecting investment

With the post-2015 development agenda approaching, the second strand entails an evolving body of African business literature on strategies needed to achieving development that is sustainable. Sustainable development relationships from a plethora of business fields have been documented by Rugimbana (2010) who has also provided interesting strategies for the future. The long-term impact of training in entrepreneurship is more rewarding than short-term government hand-outs which for the most part culminate in violent protests and unanticipated ramifications (Mensah & Benedict, 2010). The authors conclude that entrepreneurial facilities as well as training enable small corporations with avenues of ameliorating their livelihoods and ultimately emerging from poverty. This is consistent with conclusions of Oseifuah (2010) and Brixiova et al. (2015) on the need to train more African youths in order to address long-term unemployment concerns that can only be handled by massive engagement of the private sector (Asongu, 2013a). Above all, the role of KE in sustainable development is an indispensible dimension in the 21st century (Tchamyou 2014), especially to the African continent that has been witnessing a declining KE potential (Anyanwu, 2012b).

We devote some space to engaging the relationship between entrepreneurship and economic development. Entrepreneurship has been substantially documented to be a source of poverty mitigation (Bruton et al., 2015; Si et al., 2015). This narrative is consistent with social entrepreneurship (Alvarez et al., 2015) as well as institutional entrepreneurship (George et al., 2015) which are both favorable with, *inter alia*: (i) conducive politico-economic institutions (Autio & Fu, 2015) and (ii) microfinance institutions following social-welfare logic as opposed to the profitability logic (Im & Sun, 2015).

In the third strand, recent KE literature in Africa has established that formal institutions may not be a necessary condition for the enhancement of the phenomenon (Andrés et al., 2014). A tendency that has been relaxed in a latter study by the same authors using more macroeconomic indicators (Amavilah et al., 2014). The need for more investment in education to enhance doctoral productivity (Amavilah, 2009) and relaxing of intellectual property rights (IPRs) to improve scientific publications (Asongu, 2014). The literature is broadly consistent on the need to invest more in KE for African development in order catch-up with failures in industrialization (AfDB, 2007; Chavula, 2010).

The paper unites the three strands above by assessing the role of entrepreneurship on KE. It examines the impact of starting business, doing business and ending business on the four

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location decisions (Bartels et al., 2009, 2014; Anyanwu, 2007, 2012a; Amendolagine et al., 2013; Kinda, 2010; Tuomi, 2011; Yin & Vaschetto, 2011; Kolstad & Wiig, 2011; De Maria, 2010; Darley, 2012; Asiedu, 2002, 2006; Asiedu & Lien, 2011).

dimensions of KE identified by the World Bank, notably: education, innovation, information and communication technology (ICT) and economic incentives and institutional regime. By uniting these streams, it has a twofold contribution to existing literature. First, given the ambitions of African countries of moving towards knowledge-based economies, the line of inquiry is timely. Second, investigating the nexus may have substantial poverty mitigation and sustainable development implications. These entail inter alia: the development of technology with value-added services; enhancement of existing agricultural practices; conditions that are essential for competitiveness and adjustment of globalization challenges.

In light of the above, the research question assessed by this inquiry is: how does entrepreneurship influence KE in Africa? Instrumental variable panel fixed effects are applied on a sample of 53 African countries for the period 1996-2010. Three main findings are established. First, creating an enabling environment for starting business can substantially boost most dimensions of KE. Second, doing business through mechanisms of trade globalisation has positive effects from sectors that are not ICT and High-tech oriented. Third, the time required to end business has negative effects on KE.

The rest of the study is organized as follows. Section 2 presents stylized facts, theoretical highlights and the relevant knowledge economy literature. Section 3 discusses the data and methodology. The empirical analysis is covered in Section 4, while Section 5 concludes.

2. Stylized facts, theoretical underpinnings and knowledge economy in Africa
2.1 Stylized facts and theoretical underpinnings

In accordance with recent literature (Such & Chen, 2007; Tchamyou, 2014; Asongu, 2015ab), over the past decades, there has been a considerable soar in the production and dissemination of knowledge. This tendency can be traceable to the proliferation of ICTs which have facilitated electronic networking and consolidated computing strength. In essence, modern ICTs are becoming more and more affordable, hence, easing efficiency in the diffusion of existing and new knowledge. Within this framework, some benefits include: (i) the possibility of scholars from various locations to collaborate and enhance scientific productivity and (ii) the production of novel knowledge and technology. To put these facts into perspective, between 1981 and 2005, the number of patents and trademarks granted in the United States of America (USA) witnessed a rise by more than 120%, hence, illustrating an increasing pace in the creation of new knowledge and technologies. Comparatively, during the same periodic interval, patents delivered outside of the USA increased from 39% to 48%. It is also important to note that, competition during the same interval has increased in the world economy. The pace and magnitude of this competition has

been facilitated by the creation and diffusion ICTs and knowledge. As substantiated by Suh and Chen (2007), the size of global trade as a proportion of GDP (which is a proxy for globalization and global competition) increased from 24% in 1960 to 47% in 2003.

In light of the above, it is therefore reasonable to infer that entrepreneurship has increased KE. The stylized facts are consistent with Kim (1997) and Kim and Kim (2014) on the entrepreneurship-driven KE in South Korea. This intuition which serves as theoretical basis for this line of inquiry is also broadly in accordance with entrepreneurship literature, notably: Bruton et al. (2008, 2010) and Bruton & Ahlstrom (2003, 2006). For instance according to Bruton et al. (2008), entrepreneurship has played a key role in emerging countries' increasing orientation towards market orientation, KE and economic development.

2.2 Knowledge economy in Africa

In accordance with Tchamyou (2014) and Asongu (2015ab), the KE literature on Africa can be engaged in eleven principal strands, namely: general narratives, education, innovation, economic incentives and institutional regimes, ICTs, research and development (R&D), intellectual capital and economic development, indigenous knowledge systems, IPRs, spatiality in the production of knowledge and KE in the transformation of space.

General narratives about KE in Africa in first strand are consistent with the perspective that compared to other regions of the world; KE is lower on the continent. For instance, Anyanwu (2012b) has shown that the knowledge economy index (KEI) of the continent has dropped during the period 2000-2009. Rooney (2005) had earlier established from dominant discourses that Africa is limited in technocracy and understanding of KE. The relationship between KE and growth has been examined by Lin (2006) who has articulated the relevance of rethinking the KE-growth nexus and incorporating some previously missing dimensions, like the importance of knowledge in facilitating environmental conservations, wealth and equality.

Education in the second strand can be emphasized with the following interesting findings: (i) the lagging position of Africa in the information highway (Ford, 2007); (ii) the low production/value of doctoral dissertations in Africa (Amavilah, 2009); (iii) need for more quality education, essential for the stimulation of growth (Chavula, 2010); (iv) the imperative of education in preserving cultural integrity, ending illiteracy and diversifying the economy (Weber, 2011) and (v) the importance of education in stimulating positive human capital externalities (Wantchekon et al., 2004).

In the third strand on innovation: Anyanwu (2012b) has emphasized the need for more innovation on the continent; Oyelaran-Oyeyinka and Gehl (2007) have articulated that policy makers on the continent need to take the phenomenon more seriously because it is the main source of productivity and economic growth, while Carisle et al. (2013) have examined the innovation-tourism nexus to establish that institutions are important in networking, transfer of knowledge and preservation of best practices.

Concerning 'institutional regime and economic incentives' in the four strand, valuable insights into lessons from other developing nations and best practices have been provided by Cogburn (2003) who has attempted to clarify the transition in regimes of international telecommunications. Letiche (2006) has employed Behavioral economics to elucidate the success of economic transition and disclosed an examination of developing nations with varying determining factors like traditions and customs. The relevance of formal institutions in KE has been examined by Andrés et al. (2014) to establish that based on the instrumentality of IPRs, formal institutions are a necessary but not a sufficient condition for KE in Africa. The same authors had previously concluded that corruption-control is the best institutional weapon in the fight against software piracy (Andrés & Asongu, 2013a). The absence of financial incentives or credit unavailability is also a major constraint in the African business environment owing to substantially documented issues of surplus liquidity (Saxegaard, 2006; Asongu & De Moor, 2015ab).

Consistent with Asongu (2015ab), ICTs in the fifth strand are essential for mitigating poverty and boosting economic prosperity. According to the discourse, novel income-generating avenues are created with ICTs. Moreover, ICTs also enable access to new services and markets, enhance government and ameliorate efficiency. This narrative is consistent with Chavula (2010) and Butcher (2011).

With regard to 'indigenous knowledge systems' in the sixth strand, Roseroka (2008) has investigated mechanisms by which: comparative advantages of oral knowledge can be emphasized and indigenous knowledge space preserved. Lwoga et al. (2010), upon applying knowledge management frameworks to indigenous KE have concluded that knowledge management could be used to manage indigenous KE after controlling for specific features.

In the seventh stream on 'intellectual capital and economic development', Wagiciengo and Balal (2012) are focused on the disclosure of information and lifelong learning. They establish that the disclosure of intellectual capital is growing in companies across Africa. In the same light, the nexus between international lifelong-learning policies and development assistance in Africa is unappealing because international priorities in development have

negatively affected government choices towards domestic lifelong learning policies (Preece, 2013).

R&D is the focus of the eighth strand. Within this framework, Sumberg (2005) has assessed the growing international architecture of agricultural research and concluded that African research realities are not in harmony with global research systems. German and Stroud (2007) have undertaken a study to improve the applications and understanding of R&D in order to present lessons, types and implications of learning approaches. In the same vein, the need for more emphasis on R&D in the drive towards African KE has been consistently articulated by the literature in the area, notably: African Development Bank (2007), Chavula (2010) and Anyanwu (2012b).

In the tenth strand, we find literature that has focused on spatiality in the production of knowledge. Within this framework, Bidwell et al. (2011) have examined how technology can be adapted to heritages and needs of the rural population, in order to elucidate how the information can be temporarily and spatially managed by the rural community. Variations in bioprospecting have been provided by Neimark (2012) on Madagascar.

We discuss IPRs in the tenth stream. Here, Zerbe (2005) has investigated the legislation of the African Union for the protection of indigenous knowledge and found that, it is consistent with the needs and requirements of nations on the continent as it provides some balance between the rights of indigenes and those of monopoly breeders. Lor and Britz (2005) have investigated trends in knowledge and corresponding impacts on the flow of international information to provide three principal pillars that elucidate such flows, namely: common good, human rights and social justice. Myburgh (2011) reviews legal processes for the protection of knowledge related to plant in order to present the views of an IPRs lawyer on variations in the protection of plant-based traditional knowledge. Asongu (2013b) and Andrés and Asongu (2013b, 2016) have provided timelines for global IPRs protection initiatives while Asongu (2013c) has modeled the future of African KE. In an earlier inquiry, Andrés and Asongu (2013a) had established that corruption-control is the most relevant weapon in the battle against software piracy, contingent on the enforcement of IPRs. Within the same stream of contingency in IPRs, Andrés et al. (2014) have shown that formal institutions are not enough for the development of KE in Africa.

The last strand engages KE in space transformation. Here, Maswera et al. (2008) have assessed the rate of adoption of electronic (e)-commerce in the tourism industry to conclude that, whereas there are websites of information in Africa, they are substantially lacking in interactive e-transaction facilities.

We steer clear of above literature by assessing the impact of entrepreneurship on KE in Africa. The contributions of the inquiry to the literature have already been discussed in the introduction.

3. Data and methodology

3.1 Data

The study assesses a balanced panel of 53 African nations with World Bank Development indicators for the period 1996-2010[2]. The start year is constrained by governance data which is available only from 1996. The end year is 2010 to enable comparison with the literature motivating the study that is based on the same periodicity. The choices of the KE, entrepreneurship and control variables defined in Table 1 are broadly consistent with the underlying literature (Tchamyou 2014; Andres et al., 2014). The KE dependent variables entail the four components of the World Bank's KE index: education, innovation, economic incentives and institutional regime and ICTs. The principal component analysis (PCA) approach used to mitigate potential overparameterization and multicollinearity issues is discussed in Section 3.2.1. The entrepreneurship indicators are classified in terms of: starting business, doing business and ending business. For brevity, the definitions of these variables are found in Table 1.

The control variables which are in line with the underlying KE literature (Andrés et al., 2014; Amavilah et al., 2014) entail: *population growth, inflation, government expenditure, financial size, financial efficiency* and *economic prosperity*. The expected signs on KE depend on the dimensions of KE investigated. Apart from inflation, the other control variables should generally stimulate KE (see Amavilah et al., 2014, p. 24). However, the expected signs still remain dynamic because the KE indicators have distinct features. The control variables are defined in Table 1.

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[2] It is important to note that: (i) missing observations and (ii) variables included in the specifications; ultimately influence the number of observations in the regression output.

Table 1: Variable definitions

Variables	Signs	Variable definitions	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 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".	World Bank (WDI)
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	World Bank (WDI)

		governments commitments to such policies".	
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)
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)
		"Business extent of disclosure index (0=less disclosure to 10=more disclosure). It	

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Investor Protection	Bisdiclos	measures the extent to which investors are protected through disclosure of ownership information"	World Bank (WDI)
B3: Closing Business			
Insolvency Resolution	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 Variables			
Government Expenditure	Gov. Exp.	"Government final consumption expenditure (% of GDP)"	World Bank (WDI)
Inflation	Infl.	"Consumer Price Index (annual %)"	World Bank (WDI)
Economic Prosperity	GDPg	"GDP Growth Rate (annual %)"	World Bank (WDI)
Financial Size	Dbacba	"Deposit bank assets on Total assets"	World Bank (WDI)
Financial Efficiency	BcBd	"Bank Credit on Bank Deposits"	World Bank (WDI)
Population Growth	Popg	"Population growth (% 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. FDSD: Financial Development and Structure Database".

3. 2 Exploratory analysis

3.2.1 Principal component analysis (PCA)

Following Andres et al. (2014) and Amavilah et al. (2014), the KE dimensions are reduced by PCA to mitigate potential concerns of information redundancy among indicators of various components. Table 2 which is in line with Tchamyou (2014) shows that the first principal component (PC) of each KE dimension is enough to proxy of a given KE dynamic because it respects the Kaiser (1974) and Joliffe (2002) criterion for the selection of first PCs: an eigenvalue superior to one. For instance, *ICTex* which is the ICT index represents about 73% of common information in *internet*, *mobile* and *telephone*.

Table 2: PCA for KE Indicators

Knowledge Economy dimensions		Component Matrix (Loadings)						First PC	Eigen Value	Indexes
Education	School Enrolment	PSE 0.438		SSE 0.657		TSE 0.614		0.658	1.975	Educatex
Information & Infrastructure	ICTs	Internet 0.614		Mobile 0.584		Telephone 0.531		0.730	2.190	ICTex
Innovation System	Innovation	STJA 0.567		Trademarks 0.572		Patents 0.592		0.917	2.753	Innovex
Economic Incentive &	Economic Incentive	Private Credit -0.707			Interest rate Spread 0.707			0.656	1.313	Creditex
Institutional regime	Institutional index	VA 0.383	PS 0.374	RQ 0.403	GE 0.429	RL 0.443	CC 0.413	0.773	4.642	Instireg

"P.C: Principal Component. PSE: Primary School Enrolment. SSE: Secondary School Enrolment. TSE: Tertiary School Enrolment. PC: Principal Component. ICTs: Information and Communication Technologies. 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".

3.2.2 Summary statistics and correlation analysis

The summary statistics of the variables presented in Table 3 has helped the exposition in a threefold manner. First, the variables are quite comparable. Second, there is a substantial degree of variation which implies that significant relationships should be expected. Third, given the low degrees of freedom in the *trademark and patent applications* variables, instead of *innovex* from Table 2 above, we use Scientific and Technical Journals Articles (STJA) as a proxy for innovation. This assumption is consistent with recent literature (Chavula, 2010; Tchamyou, 2014).

Table 3: Summary statistics and Presentation of Countries

		Mean	S.D	Min	Max	Obs.
	Panel A: Summary Statistics					
	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
Knowledge	Instireg (Institutional Regime)	0.105	2.075	-5.399	5.233	598
Economy	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
	Patentes(log)	5.161	2.077	1.386	9.026	121
	Time to Start-up (log)	3.624	0.812	1.098	5.556	386
Starting	Cost of Start-up (log)	4.354	1.312	0.741	8.760	386
Business	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
	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 Openness (log)	4.239	0.476	2.882	5.617	719

Doing Business	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
Closing Business	Insolvency Resolution	3.337	1.452	1.300	8.000	330
Control variables	Inflation	57.556	955.55	-100.00	24411	673
	Government Expenditure	4.392	12.908	-57.815	90.544	468
	Economic Prosperity	4.763	7.293	-31.300	106.28	759
	Financsial Size	0.70273	0.25169	0.017332	1.6093	693
	Financial Efficiency	0.75523	0.42385	0.13754	2.6066	567
	Population Growth	2.3565	1.0059	-1.0811	10.043	795

Panel B: Presentation of Countries (53)

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.

S.D: Standard Deviation. Min: Minimum. Max: Maximum. Obs: Observations

The objective of the correlation matrix in Table 4 is to mitigate issues of multicollinearity and over-parameterization. Based on the analysis, the issues are not of serious nature to bias estimated results.

Table 4: Correlation Matrix

Knowledge Economy (KE)					Starting Business				Business Indicators — Doing Business — Trade			Technology Exports			Property Rights			Closing Business	Control Variables						
Educatex	ICTex	Creditex	Instireg	STJA	Time Start	Cost Start	Bis den	Bis num	Cexp	Tariff	T.O	ICTg	ICTs	HT	C.En	P.R	BDis	Insolv.	Infl-ation	Gov. Exp.	GDP g	Fin. Eff.	Fin. Size	Pop. g.	
1.00	0.69	-0.54	0.44	0.36	-0.20	-0.74	0.47	0.65	-0.46	0.09	0.36	0.32	-0.42	-0.07	0.05	0.09	-0.34	-0.54	-0.089	0.04	0.003	-0.04	0.39	-0.50	Edctex
	1.00	-0.55	0.44	0.20	-0.26	-0.61	0.63	0.54	-0.42	-0.09	0.34	0.26	-0.15	-0.006	0.03	-0.15	0.04	-0.30	0.002	-0.02	-0.05	0.07	0.39	-0.44	ICTex
		1.00	-0.61	-0.48	0.25	0.59	-0.30	-0.52	0.35	0.19	0.032	-0.18	0.13	-0.01	0.03	0.27	-0.38	0.32	0.15	0.04	0.13	-0.63	-0.44	0.36	Credtx
			1.00	0.31	-0.25	-0.69	0.61	0.48	-0.36	-0.15	0.20	0.25	-0.27	-0.10	-0.03	-0.06	0.03	-0.37	-0.09	0.05	0.03	0.24	0.51	-0.30	Instireg
				1.00	-0.37	-0.47	-0.22	0.68	-0.11	-0.10	-0.25	0.08	-0.18	-0.08	-0.07	-0.07	0.25	-0.46	0.01	0.09	-0.13	0.26	0.27	-0.17	STJA
					1.00	0.39	-0.05	-0.09	0.12	0.08	0.27	-0.12	0.02	0.02	0.22	-0.03	-0.03	0.31	0.07	-0.03	-0.03	-0.21	-0.08	0.00	T.Start
						1.00	-0.50	-0.64	0.24	0.26	-0.16	-0.26	0.44	0.07	0.03	0.31	-0.05	0.45	0.10	-0.10	0.04	-0.24	-0.48	0.49	C.Start
							1.00	0.25	-0.29	-0.34	0.56	0.49	-0.28	0.21	0.33	0.03	0.15	-0.16	-0.11	-0.05	-0.22	0.05	0.25	-0.54	Bis den
								1.00	-0.44	-0.23	0.25	0.29	-0.64	-0.24	0.10	-0.18	0.007	-0.52	0.09	0.04	0.02	0.23	0.34	-0.61	Bis.N
									1.00	-0.08	-0.17	-0.19	0.15	0.15	-0.12	-0.15	0.002	0.15	0.03	0.14	-0.004	-0.06	-0.29	0.25	Cexp
										1.00	0.09	0.03	0.03	-0.02	0.17	0.05	-0.15	0.20	0.02	-0.09	-0.03	-0.15	-0.19	-0.19	Tariff
											1.00	0.21	-0.09	-0.02	0.20	-0.06	-0.03	0.001	0.03	-0.05	0.09	-0.13	0.24	-0.26	T.O
												1.00	-0.002	0.13	-0.03	0.16	-0.13	-0.30	-0.01	-0.008	0.05	0.01	0.17	-0.25	ICTg
													1.00	0.21	-0.05	0.05	-0.02	0.34	-0.09	-0.03	-0.15	-0.06	-0.22	0.38	ICTs
														1.00	-0.04	0.14	-0.05	0.11	-0.14	-0.04	0.05	0.08	0.01	0.08	HT
															1.00	0.05	0.04	0.17	-0.07	-0.04	0.04	-0.15	0.06	-0.04	C.En
																1.00	0.02	0.08	-0.06	-0.06	0.09	-0.17	-0.02	0.21	P.R
																	1.00	0.09	0.10	-0.09	-0.20	0.21	0.02	-0.07	BDis
																		1.00	0.001	-0.09	0.07	-0.09	-0.16	0.29	Insolv.
																			1.00	-0.13	-0.06	-0.07	-0.05	-0.10	Infl.
																				1.00	0.10	-0.01	0.07	0.01	Gov.E.
																					1.00	-0.07	-0.07	0.34	GDPg
																						1.00	0.26	-0.07	Fin.Eff
																							1.00	-0.32	Fin.Siz
																								1.00	Pop.g

Educatex: Education. ICTex: Information & Communication Technology. Creditex: Economic Incentives. Instireg: Institutional Regime. STJA: Scientific & Technical Journal Articles. Time Start: Time to Start a Business. Cost Start: Cost of Starting a Business. Bisden: Business density. Bisnum: Business number. Cexp: Cost of exports. Tariff: Trade Barriers. T.O: Trade Openness. ICTg: ICT goods exports. ICTs: ICT service exports. HT: High-tech exports. C. En: Contract Enforcement. P.R: Property Registration Time. Dis: Business Extent Disclosure. Insolv: Insolvency. Gov. Exp: Government Expenditure. GDPg: Gross Domestic Product growth rate. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth.

3.3 Estimation technique

Consistent with Tchamyou (2014), the estimation approach controls for potential endogeneity between KE and entrepreneurship. It follows the Ivashina (2009, p. 301) approach of regressing the entrepreneurship variables on their first lags and using the saved fitted values as loadings for main equation regressions at the second-stage. The following stages embody the following estimation process.

First-stage regression:

$$E_{it} = \gamma_0 + \gamma_1 (Instruments)_{it} + \gamma_j X_{it} + \upsilon_{it} \tag{1}$$

Second-stage regression:

$$KE_{it} = \beta_0 + \beta_1 (StartBis)_{it} + \beta_2 (DoingBis)_{it} + \beta_3 (EndingBis)_{it} + \beta_j X_{it} + \xi_t + \mu_{it} \tag{2}$$

Where *KE* denotes: institutional regime (*Instireg*), ICTs (*ICTex*), innovation (*STJA*), education (*Educatex*) and economic incentives (*Creditex*). *E* represents entrepreneurship indicators, notably: *starting business*, *doing business* and *closing business* , defined in Table 1. The first lags of the entrepreneurship variables are used as *Instruments*. *X* in the two equations denotes the control variables: *population growth, inflation, government expenditure, financial size, financial efficiency* and *economic prosperity*. While ξ_t and μ_{it} respectively represent the time-specific constant and error terms in Eq. (2), υ_{it} denotes the error term in Eq. (1).

The estimation technique consists of regressing the entrepreneurship variables separately on their first lags using robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors and then saving the fitted or instrumented values. These instrumented entrepreneurship indicators are then used in the second-stage HAC standard errors regressions.

4. Empirical results

4.1 Presentation of results

The empirical results presented in Table 5 below summarise the findings of Table 6 (Education), Table 7 (ICT), Table 8 (Economic incentives), Table 9 (institutional regime) and Table 10 (Innovation). The following are note-worthy with regards to the summarised results. First on starting business, the following findings have been established. (1) The time to start a business: (a) increases educational enrolment; (b) augments economic incentives in terms of private domestic credit and (c) decreases possibilities of innovation. (2) Depending on dynamics, the cost of starting business may have 'ex-ante negative' and 'ex-post positive' effects. (3) But for two negative expected signs in business number (for institutional regime) and business density (for innovation), the signs of the last-two starting business indicators are in line with economic theory.

Second, with regards to doing business the following are apparent. (1) Cost of export and Tariffs for the most part negatively affect the KE dimensions (but for the effect of Tariffs on Creditex and STJA). The effects of trade openness which are consistently positive show that trade restrictions are an impediment to KE, with the exception of innovation captured by STJA. Hence, the signs of the first-two trade variables (cost of export and tariffs) are supported by the third (trade openness). (2) The effects of technology exports run counter to the effect of trade for the most part. (3) The effects of property rights institutions which are not very apparent do not motivate us to draw comparative conclusions.

Third, the effects of the time needed to resolve insolvency (ending business) do not broadly encourage the building of knowledge-based economies, but for the positive role it has on requiring more private credit from domestic banks.

Most of the control variables are significant with the expected signs. Government expenditure and financial size potentially have positive educational externalities. Inflation decreases private domestic credit and the unexpected effect of financial dynamics of size and efficiency on economic incentives could be traceable to surplus-liquidity issues in African banks (Saxegaard, 2006). Economic prosperity and government expenditure potentially have positive effects in improving institutional regime and stimulating innovation by means of STJA. The consistent negative effect of population growth could be explained by the fact that, quantity of population decreases quality in human resources (Asongu, 2013) and hence, a negative externality on KE.

Table 5: Summary of the results

Entrepreneurship dimensions		Variables	KE Dimensions (Indexes)				
			Education	ICT	Economic Incentives	Institutional regime	Innovation
			Educatex	ICTex	Creditex	Instireg	STJA
Starting Business		Time Start	+	-°	+	-°	-
		Cost Start	-	+	-	+	+
		Bis. Den.	+	+	-°	+	-
		Bis. Num.	+	+	+	-	+
Doing Business	Trade	Cost Exp.	-	-	-	+°	-°
		Tariff	-	-	+	-	+
		T.O	+	+	+	+	-
	Technology Exports	ICT goods	+-	-°	-	+	+°
		ICT ser.	+	-	n.a	-	+
		HT	-	-	n.a	-	+°
	Property Rights	C.En	-°	n.a.	n.a	-°	-
		P.R	n.a.	n.a.	n.a	-	+
		Bus. Dis	n.a.	n.a.	n.a	n.a.	+
Closing Business		Insolv.	-	-	+	-	-

"Educatex: Education. ICTex: Information & Communication Technology. Creditex: Economic Incentives. Instireg: Institutional Regime. STJA: Scientific & Technical Journal Articles. Time Start: Time to Start a Business. Cost Start: Cost of Starting a Business. Bisden: Business density. Bisnum: Business number. Cexp: Cost of exports. Tariff: Trade Barriers. T.O: Trade Openness. ICTg: ICT goods exports. ICTs: ICT service exports. HT: High-tech exports. C. En: Contract Enforcement time. P.R: Property Registration time. Dis: Business Extent Disclosure. Insolv: Insolvency". +: significantly positive. -: significantly negative. -°: not significantly negative. +°: not significantly positive. na: not applicable. +-: sign cannot be determined.

Table 6: Educatex (HAC Instrumental variable panel fixed effects)

			Education (Educatex)				
		Constant	**-3.642**** **(0.0241)**	1.883 (0.533)	0.070 (0.963)	-4.076 (0.179)	**4.80***** **(0.002)**
Starting Business		Time Start(log)	**0.199**** **(0.0418)**	---	**---**	**0.216**** **(0.041)**	-0.091 (0.233)
		Cost Start (log)	-0.0045 (0.975)	---	**---**	**-0.84***** **(0.000)**	**-0.67***** **(0.001)**
		Bis. Den.	**0.143***** **(0.000)**	---	---	-0.066 (0.364)	0.018 (0.721)
		Bis. Num.(log)	**0.828***** **(0.000)**	---	**---**	**0.137**** **(0.019)**	**-0.32***** **(0.000)**
Doing Business	Trade	Cost Exp.(log)	---	**-0.90***** **(0.000)**	---	-0.117 (0.616)	0.100 (0.357)
		Tariff	---	**-0.28***** **(0.000)**	---	-0.016 (0.541)	0.013 (0.557)
		T.O (log)	---	**1.9***** **(0.003)**	**---**	**1.76***** **(0.000)**	**0.68***** **(0.004)**
		ICT goods	---	**0.037*** **(0.080)**	**---**	**-0.09***** **(0.000)**	---
	Technology Exports	ICT ser.	---	**0.07***** **(0.000)**	---	---	---
		HT	---	**-0.03***** **(0.000)**	---	---	---
	Property Rights	C.En (log)	---	-0.162 (0.512)	---	---	---
		P.R (log)	---	---	---	---	---

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| Closing Business | Bus. Dis | --- | --- | --- | --- | --- |
| | Insolv. | | | | -0.130 (0.430) | -1.01*** (0.000) |

Control variables	Inflation	---	---	0.010 (0.648)	---	---
	Gov.E.	0.003** (0.036)	---	-0.003 (0.480)	---	---
	GDPg	-0.05*** (0.001)	0.014 (0.701)	-0.023 (0.273)	---	---
	Fin.Eff	-0.761 (0.268)	---	-0.008 (0.985)	---	---
	Fin.Siz	1.148*** (0.000)	---	2.97*** (0.006)	---	---
	Pop.g	-1.57*** (0.000)	---	-0.75** (0.015)	---	---

Information criteria	Time effects	No	No	No	No	No
	Adjusted R²	0.983	0.886	0.907	0.930	0.958
	Fisher	124.4***	14.61***	38.4***	26.93***	45.83***
	Observations	39	34	70	34	34
	Countries	10	12	12	10	10

*,**,***: significance levels of 10%, 5% and 1% respectively. Gov. Exp: Government Expenditure. GDPg: GDP growth. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm.

Table 7: ICTex (HAC Instrumental variable panel fixed effects)

		ICT (ICTex)				
Starting Business	Constant	-6.017 (0.205)	61.5*** (0.000)	1.448* (0.056)	-19.94* (0.068)	19.57 (0.612)
	Time Start(log)	-0.264 (0.260)	---	---	0.072 (0.832)	-0.366 (0.123)
	Cost Start (log)	-0.751 0.137	---	---	0.008 (0.942)	0.67** (0.026)
	Bis. Den.	0.212** (0.036)	---	---	-0.065 (0.180)	-0.119 (0.235)
	Bis. Num.(log)	1.05*** (0.007)	---	---	1.25*** (0.002)	0.90** (0.044)
Doing Business — Trade	Cost Exp.(log)	---	-2.28** (0.026)	---	0.725 (0.655)	0.342 (0.726)
	Tariff	---	-0.050 (0.483)	---	-0.33*** (0.000)	-0.46*** (0.000)
	T.O(log)	---	2.09** (0.016)	---	1.635 (0.128)	-1.037 (0.322)
	ICT goods	---	0.108 (0.405)	---	-0.078 (0.135)	-0.017 (0.698)
Technology Exports	ICT ser.	---	-0.234* (0.059)	---	---	---
	HT	---	-0.028 (0.143)	---	-0.011 (0.553)	-0.031* (0.066)
Property Rights	C.En(log)	---	-7.5*** (0.000)	---	---	---
	P.R(log)	---	-0.8*** (0.000)	---	---	---

	Bus. Dis	---	0.027	---	---	---
			(0.930)			
Closing Business	Insolv.			**-0.83***		-6.953
				(0.000)		(0.627)
	Inflation	0.005	**0.05**	**0.04***	-0.038	0.009
		(0.788)	**(0.048)**	**(0.003)**	(0.141)	(0.498)
	Gov.E.	0.005	**-0.03**	-0.0001	**-0.006***	-0.0002
		(0.496)	**(0.018)**	(0.979)	**(0.098)**	(0.935)
	GDPg	-0.040	-0.054	-0.009	---	---
Control variables		(0.120)	(0.473)	(0.636)		
	Fin.Eff	1.133	-0.704	0.322	0.514	---
		(0.555)	(0.654)	(0.245)	(0.845)	
	Fin.Siz	1.042	**2.85***	**3.62***	**1.65***	---
		(0.294)	**(0.096)**	**(0.000)**	**(0.001)**	
	Pop.g	-0.141	---	**-0.73***	---	---
		(0.837)		**(0.000)**		
	Time effects	No	No	Yes	No	No
Information criteria	Adjusted R²	0.870	0.808	0.761	0.911	0.933
	Fisher	**23.48***	**10.3***	**7.31***	**19.25***	**26.29***
	Observations	71	56	143	40	39
	Countries	12	12	14	10	10

*,**,***: significance levels of 10%, 5% and 1% respectively. Gov. Exp: Government Expenditure. GDPg: GDP growth. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm.

Table 8: Creditex (HAC Instrumental variable panel fixed effects)

		Economic Incentives (Creditex)				
	Constant	-1.135	-6.740	-0.574	-0.989	**-11.4***
		(0.453)	(0.391)	(0.219)	(0.552)	**(0.006)**
	Time Start(log)	**0.234***	---	---	0.0681	-0.008
		(0.082)			(0.723)	(0.969)
Starting Business	Cost Start (log)	**-0.313**	---	---	0.0515	0.066
		(0.043)			(0.794)	(0.682)
	Bis. Den.	0.013	---	---	-0.0974	-0.069
		(0.595)			(0.234)	(0.385)
	Bis. Num.(log)	**0.249***	---	---	-0.185	0.227
		(0.059)			(0.197)	(0.383)
	Cost Exp.(log)	---	-0.060	---	**-0.230***	**-0.63***
			(0.930)		**(0.073)**	**(0.005)**
	Tariff	---	0.014	---	**0.048**	**0.033**
Trade			(0.830)		**(0.029)**	**(0.045)**
	T.O(log)	---	-0.791	---	0.719	**1.206**
			(0.230)		(0.343)	**(0.030)**
	ICT goods	---	-0.036	---	**-0.05***	---
			(0.274)		**(0.005)**	
Technology Exports	ICT ser.	---	0.012	---	---	---
Doing Business			(0.763)			
	HT	---	0.010	---	---	---
			(0.417)			
	C.En(log)	---	**2.046***	---	---	---
Property Rights			**(0.058)**			
	P.R(log)	---	-0.310	---	---	---

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		Col1	Col2	Col3	Col4	Col5
			(0.244)			
	Bus. Dis	---	**-0.4*** (0.000)**	---	---	---
Closing Business	Insolv.			**0.43*** (0.003)**		**2.95** (0.019)**
Control variables	Inflation	**-0.017** (0.048)**	---	0.008 (0.228)	0.0030 (0.692)	---
	Gov.E.	**0.005* (0.074)**	---	-0.0002 (0.935)	---	---
	GDPg	**0.018* (0.067)**	---	**-0.02** (0.047)**	---	---
	Fin.Eff	**-3.36*** (0.001)**	---	**-0.63** (0.019)**	---	---
	Fin.Siz	**-0.618** (0.050)**	---	**-0.80*** (0.005)**	---	---
	Pop.g	**0.83*** (0.001)**	---	-0.075 (0.795)	---	---
Information criteria	Time effects	No	No	Yes	No	No
	Adjusted R²	0.984	0.950	0.887	0.952	0.967
	Fisher	**162.03***	**44.1***	**12.5***	**45.9***	**70.7***
	Observations	50	44	102	44	43
	Countries	10	11	12	11	11

*,**,***: significance levels of 10%, 5% and 1% respectively. Gov. Exp: Government Expenditure. GDPg: GDP growth. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm.

Table 9: Instireg (HAC Instrumental variable panel fixed effects)

		Institutional regime (Instireg)				
	Constant	**4.704* (0.050)**	-5.378 (0.362)	-1.067 (0.291)	**21.33** (0.041)**	-16.25 (0.372)
Starting Business	Time Start(log)	-0.014 (0.928)			0.111 (0.231)	-0.067 (0.645)
	Cost Start (log)	**0.386*** (0.003)**			0.151 (0.249)	**0.426* (0.076)**
	Bis. Den.	**0.325*** (0.000)**			**0.36*** (0.000)**	**0.281 (0.022)****
	Bis. Num.(log)	-0.088 (0.682)			**-0.397** (0.024)**	-0.168 (0.425)
Doing Business	Cost Exp.(log)	---	0.750 (0.400)	---	0.116 (0.411)	-0.041 (0.948)
Trade	Tariff	---	**-0.1*** (0.002)**	---	-0.041 (0.303)	-0.056 (0.232)
	T.O(log)	---	**2.32*** (0.000)**	---	0.320 (0.353)	-0.438 (0.525)
	ICT goods	---	**0.162* (0.084)**	---	0.035 (0.192)	**0.088** (0.013)**
Technology Exports	ICT ser.	---	**-0.2*** (0.008)**	---	---	---
	HT	---	**-0.03** (0.022)**	---	---	**-0.05*** (0.008)**
Property Rights	C.En(log)	---	-0.675 (0.489)	---	-1.964 (0.231)	4.284 (0.145)
	P.R(log)	---	**-0.7*****	---	---	**-0.49*****

				(0.001)		**(0.008)**
	Bus. Dis	---	0.175	---	---	-0.129
			(0.586)			(0.511)
Closing Business	Insolv.			**-0.84***		**-1.69***
				(0.000)		**(0.002)**
Control variables	Inflation	0.009	0.015	**0.054**	0.001	0.005
		(0.475)	(0.387)	**(0.023)**	(0.924)	(0.802)
	Gov.E.	-0.001	**-0.009***	**-0.010***	**0.006**	---
		(0.685)	**(0.065)**	**(0.099)**	**(0.019)**	
	GDPg	**0.043***	0.016	0.029	---	**0.096***
		(0.002)	(0.742)	(0.106)		**(0.007)**
	Fin.Eff	**-1.202***	2.382	**3.35***	**-2.08**	---
		(0.069)	(0.193)	**(0.000)**	**(0.013)**	
	Fin.Siz	-0.085	-1.274	**2.58***	**-1.52***	---
		(0.905)	(0.162)	**(0.003)**	**(0.001)**	
	Pop.g	**-1.76***	---	**0.422***	**-2.02***	---
		(0.000)		**(0.084)**	**(0.000)**	
Information criteria	Time effects	No	No	Yes	No	No
	Adjusted R²	0.950	0.902	0.796	0.971	0.961
	Fisher	**64.49***	**21.39***	**8.69***	**65.40***	**46.41***
	Observations	71	56	143	49	47
	Countries	12	12	14	12	11

*,**,***: significance levels of 10%, 5% and 1% respectively. Gov. Exp: Government Expenditure. GDPg: GDP growth. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm.

Table 10: STJA (HAC Instrumental variable panel fixed effects)

		Innovation (logSTJA)				
	Constant	**0.935**	**11.006***	**1.95***	**2.264***	**3.604***
		(0.029)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Starting Business	Time Start(log)	-0.110	---	---	**-0.085***	-0.020
		(0.269)			**(0.074)**	(0.660)
	Cost Start (log)	0.155	---	---	**0.110***	0.040
		(0.140)			**(0.007)**	(0.331)
	Bis. Den.	**-0.17***	---	---	**-0.131***	**-0.11***
		(0.000)			**(0.000)**	**(0.000)**
	Bis. Num.(log)	**0.26***	---	---	**0.098***	**0.180***
		(0.000)			**(0.007)**	**(0.001)**
Doing Business	Cost Exp.(log)	---	-0.038	---	-0.001	0.068
			(0.897)		(0.991)	(0.313)
Trade	Tariff	---	0.015	---	**0.018**	**0.018***
			(0.259)		**(0.026)**	**(0.058)**
	T.O(log)	---	**-0.493***	---	**-0.330**	**-0.291***
			(0.000)		**(0.024)**	**(0.063)**
	ICT goods	---	-0.018	---	0.010	0.0009
			(0.154)		(0.246)	(0.934)
Technology Exports	ICT ser.	---	**0.05***	---	---	---
			(0.000)			
	HT	---	0.002	---	---	---
			(0.491)			
Property Rights	C.En(log)	---	**-1.44***	---	---	---
			(0.000)			
	P.R(log)	---	**0.17**	---	---	---

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			(0.039)			
	Bus. Dis	---	**0.43***** (0.000)	---	---	---
Closing Business	Insolv.			**-0.3***** (0.000)		**-1.01***** (0.001)
Control variables	Inflation	0.010 (0.100)	-0.0001 (0.960)	**0.024**** (0.018)	**0.016***** (0.000)	**0.011**** (0.043)
	Gov.E.	-0.0005 (0.743)	**0.005***** (0.000)	0.001 (0.357)	0.0007 (0.451)	**0.001***** (0.003)
	GDPg	0.002 (0.795)	0.025 (0.132)	**0.023**** (0.019)	**0.025***** (0.000)	**0.015*** (0.065)
	Fin.Eff	-0.142 (0.562)	-0.950 (0.113)	**0.618***** (0.005)	**0.762***** (0.006)	0.394 (0.146)
	Fin.Siz	0.204 (0.340)	---	-0.219 (0.333)	0.154 (0.150)	---
	Pop.g	**-0.53***** (0.000)	---	**-0.29***** (0.008)	**-0.303*** (0.097)	---
Information criteria	Time effects	No	No	Yes	No	No
	Adjusted R²	0.958	0.948	0.822	0.979	0.983
	Fisher	**77.91*****	**43.96*****	**10.14*****	**93.06*****	**115.49*****
	Observations	71	57	143	49	48
	Countries	12	12	14	12	12

*,**,***: significance levels of 10%, 5% and 1% respectively. Gov. Exp: Government Expenditure. GDPg: GDP growth. Fin. Eff.: Financial Efficiency. Fin. Size: Financial Size. Pop.g: Population Growth. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm.

4.2 Further discussion and implications

We devote some space to further engaging the results in light of stylized facts and existing literature. First, we have established that increasing the time of starting a business has a positive effect on educational enrolment. Accordingly, the positive effect may be traceable to the education being perceived as an easier alternative to getting a job. This is the case in most African countries where educational enrolments are substantially high while corresponding entrepreneurship initiatives are low (Tvedten et al., 2014). Accordingly, most students engage in formal education as a means of travelling abroad upon graduation and contributing to African development by means of remittances (Ngoma & Ismail, 2013; Osabuohien & Efobi, 2013; Ssozi & Asongu, 2015a) or being recruited by the public sector instead of engaging in entrepreneurship activities. The latter perspective is consistent with an interesting literature on youth employment by Baah-Boateng (2013, 2015).

Second, we have also seen that increasing the time of starting a business has a positive effect on economic incentives in term of private domestic credit. It should be noted that economic incentives are measured in this study with private domestic credit. Hence, the finding is consistent with economic theory because an extension of the time to start a business is inherently an additional cost to the doing of business. When this inference is reflected in the light of the cost of bureaucracy in many African countries, it is logical that potential entrepreneurs should recourse for more financial resources if their files are delayed and/or go through more public administration offices. This interpretation aligns with evidence that applications/files in public offices often have to be pushed from one step to another by means of bribery and corruption (Kiggundu, 2002).

Third, we have also observed that augmenting the time of starting a business has a negative effect on innovation. This nexus is consistent with the predictions of economic theory. In essence, the most innovative countries in Africa (e.g Rwanda and Mauritius) are associated with the lowest time to start a business (World Bank, 2014).

Fourth, interestingly, we have also broadly established that, but for a few exceptions, an increase in the number of businesses has a positive effect on KE dimensions. This relationship is consistent with the stylized facts engaged in Section 2, notably: (i) Suh and Chen (2007) on global trends; (ii) Tchamyou (2014) and Asongu (2015a) in the African literature; (ii) Kim (1997) and Kim and Kim (2014) on the theoretical positions of South Korea's economic miracle and (iv) Asongu (2015b) on catch-up between South Korea and Africa.

Fifth, our findings broadly show that the doing of business is positively linked to the development of knowledge-based economies in Africa. Accordingly, while the effects of openness in trade are consistent with the signs of negative signals like 'cost of exports' and tariffs for the most part, align with those of positive signals. The positive relationship between doing business and the growth of knowledge based societies is consistent with the bulk of literature engaged in the theoretical highlights, namely: Kim (1997); Bruton and Ahlstrom (2003, 2006); Suh and Chen (2007); Bruton et al. (2008, 2010); Tchamyou (2014); Kim and Kim (2014) and Asongu (2015ab). On a practical front, the findings point to the positive nexus between globalisation (especially trade openness) in the drive towards KE.

Accordingly, societies that are more open are very likely to be rewarded with higher levels of KE. Other examples beside South Korea discussed above include: Thailand and Singapore (see Kim, 1997). As a policy implication, whereas openness may engender potential KE rewards, African governments should be cautious of the fact that, openness *per se* is not necessarily good when absorptive capacities are not available for reverse engineering. This line of inference is consistent with Ssozi and Asongu (2015b) on the African comparative economics of catch-up in SSA.

Sixth, we have seen that the effects of technology exports run counter to the impacts of trade for the most part. This may indicate a lack of competitiveness in the trade of ICT and High-tech commodities by African countries or the need to specialise more in KE-oriented agricultural products. While African economies' have an agricultural inclination, there are growing calls for policy makers in Africa to catch-up with global value chains by contributing to the production of what the continent consumes. For instance, whereas the continent is the witnessing comparatively higher mobile phone penetration rates (Asongu, 2013d, 2015c), there are growing calls for governments in the continent to tailor policies towards contributing more to this value chain (Asongu & Ssozi, 2015).

Seventh, the fact that the impacts of property rights institutions are not very apparent may be an indication that policy makers on the continent need to improve property right laws so that they should be more conducive for the development of knowledge-based societies. Accordingly, the positive effect on innovation may also imply that these rights are more skewed towards encouraging contributions to knowledge by means of scientific and technical journal publications, as opposed to mainstream entrepreneurial activities.

Eighth, we have noted that the impact of the time needed to resolve insolvency (or ending business) does not broadly encourage the building of knowledge-based economies. This finding is in accordance with intuition in the perspective that societies with swift

procedures of filling for bankruptcy and ending a business are traditionally associated with comparatively higher levels of KE (e.g the USA).

Ninth, as concerns the poverty implications of the study, the broadly positive nexus between entrepreneurship and KE is quite appealing given that both KE (Tchamyou, 2014; Asongu, 2015ab) and entrepreneurship (Bruton et al., 2015; Si et al., 2015; Alvarez et al., 2015 ; George et al., 2015; Autio & Fu, 2015; Im & Sun, 2015) have been documented to mitigate poverty.

5. Concluding remarks

While we have broadly found entrepreneurship to be playing an appealing role on KE, unexpected signs were also expected because Andrés et al. (2014) have established that the nexuses depends substantially on government policies and commitment to enforcing them. While their conclusions show that formal institutions are not a necessary condition for KE, good policies could change the tendency. This narrative is consistent with Oluwatobi et al. (2014) who have recently established that government effectiveness and regulation quality are the most important determinants of innovation in African countries. This recent literature has a twofold interest for our results: (1) there may be unexpected signs when government policy is not effective and; (2) improving on the formulation and implementation of mechanisms could change the dynamics of these results.

The findings also show for the most part that, creating an enabling environment for starting business and doing business by means of trade globalization substantially boosts KE. While the former is consistent with intuition, the latter which cautions on specializing in trade activities for which the country already has a competitive advantage (like commodities that are not high-tech and ICT related) may not be very positive for long-term development. But at the initial levels of development, policy favoring reverse-engineering accompanied by lowering of IPRs would benefit domestic economies. This line of interpretation is consistent with a recent finding by Asongu (2014) who has established that, lower IPRs in software products could boost scientific publications and hence prospects of innovation in Africa. Thus, our findings confirm the narrative that the technology in African countries at the moment may be more imitative and adaptive for reverse-engineering in ICTs and high-tech products. However, given the massive consumption of ICT and high-tech commodities in Africa, the continent has to start thinking of how to participate in the global value chain of producing what it consumes.

We have also seen that when the time required to resolving insolvency stretches substantially, it prolongs the time required for ending a business. This may be substantially affect the motivation of entrepreneurs in starting a new business, hence, negatively affect KE. Overall, the findings are broadly consistent with a growing body of African entrepreneurship literature on, *inter alia*: management studies (Gerba, 2012) or general education (Singh et al., 2011), entrepreneurial intentions (Gerba, 2012) and the appealing role of entrepreneurship in poverty mitigation by means of KE (Mensah & Benedict, 2010). Hence, investigating the interactions between entrepreneurship and KE in poverty mitigation is an interesting future research direction.

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