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The Role of Knowledge Economy in African Business

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Abstract

This paper assesses the role knowledge economy (KE) in African business in 53 countries for the period 1996-2010. The four KE components of the World Bank are employed, notably: education, innovation, economic incentives & institutional regime and information & communication technology. The business indicators are classified into: starting, doing and ending business. Principal components analysis and panel instrumental variable fixed effects approaches are employed as empirical strategies. The findings which are broadly consistent with intuition and the predictions of economic theory suggest that KE policies will substantially boost the starting and doing of business in Africa. This is relevant in fighting unemployment and improving African competitiveness in global value chains. Policy implications for the relevance of each specific KE dimension in African business are discussed with particular emphasis on the theoretical underpinnings of the study. The investigation is original in its contribution at the same time to the scarce literature on African KE and the growing challenges of improving the business climate of the continent by means of KE.

JEL Classification: L59; O10; O30; O20; O55

Keywords: Knowledge Economy; Doing business; Development; Africa

1. Introduction

Over the past two decades, the economies of leading countries have increasingly evolved towards knowledge-based economies, relying less on traditional resources such as labour and capital for economic prosperity and wealth creation (Dahlman, 2007; Chavula, 2010; Chandra & Yokoyama, 2011; Asongu, 2015a). It is widely acknowledged that the creation of new knowledge, innovation and technological changes drive prosperity in these countries. Accordingly, economic incentives based on new knowledge stimulate economic growth, improve the ladder of employment opportunities, provide higher wages and ultimately enhance the country's competitiveness within the global environment. The appealing economic trends prevalent in many developed countries strongly depend on investments in new technology, high skilled labour and high-technology industries. These are essential ingredients for the development of a knowledge-based economy (African Development Bank: AfDB, 2007).

Whereas innovation has been substantially identified as a driver of economic prosperity and productivity in the developed world, the capacity to innovate remains relatively low in most African countries (Anyanwu, 2012). The globalization of technology however presents new opportunities for development in developing countries if governments can transform political will into adequate economic policies needed for the building of knowledge-based economies (AfDB, 2007). Moreover, in order for developing countries to build their potential as knowledge economies, substantial investments in human capital, high skilled labour force and infrastructure for high-technology industries are imperative. In essence, the fostering of scientific technological collaborations and networks with developed countries are also required to enhance the competitiveness and international trade goals of corporations in developing countries (Lee & Kim, 2009; Suh & Chen, 2007).

In light of the above, a recent stream of African related studies have been consistent on the relevance of knowledge economy (KE) on the continent (AfDB, 2007; Amavilah, 2009; Andrés & Asongu, 2013ab; Nyarko, 2013a; Andrés et al., 2014; Asongu, 2015b; Asongu & Tchamyu, 2016). These include amongst others: general discussions on KE (Rooney, 2005; Lin, 2006; Anyanwu, 2012); innovation (Carisle et al., 2013); information & communication technologies (Butcher, 2011); education (Ford, 2007; Weber, 2011); institutional regime & economic incentives (Cogburn, 2003; Letiche, 2006); indigenous knowledge systems (Raseroka, 2008; Lwoga et al., 2010); research & development (German & Stroud, 2007; Sumberg, 2005);

intellectual capital & economic development (Wagiciengo & Belal, 2012; Preece, 2013); intellectual property rights (Zerbe, 2005; Lor & Britz, 2005; Myburgh, 2011; Andrés & Asongu, 2013ab; Andrés et al., 2014; Asongu, 2013a); KE in space transformation (Moodley, 2003; Maswera et al., 2008) and spatiality in the production of knowledge (Bidwell et al., 2011; Neimark, 2012).

The above stream of narratives is consistent with the need for more scholarly research on factors encouraging KE in Africa. South Korea relied on KE in the doing of business to achieve its spectacular development (Such & Chen, 2007). As far as we have reviewed, there is yet no study that has investigated the relevance of KE in African business. Against this background, it is relevant to position an inquiry on the relevance of KE in African business for the following reasons.

First, since Africa is increasingly nursing ambitious of KE projects¹, understanding the relevance of these projects in the doing of business in the continent would provide policy makers with the much needed guidance. This point is even more crucial due to failed post-independence industrialization-based measures and thwarted structural adjustment policies of liberalization and privatization (Rolfe & Woodward, 2004) that have not substantially boosted African business (especially intra-regional trade).

Second, Knowledge-based African business growth holds high potential for the improvement of existing agricultural economies and development of value-added technology-based services essential for economic prosperity, competitiveness and adaptation to the challenges of globalization².

Third, KE potentially holds the promise of lifting the continent out of poverty through the much needed investment opportunities and employment possibilities (to tackle soaring demographic change). While there are growing challenges in African business (Leke et al., 2010;

¹ Ghana is driving to become West Africa's high tech hub with its ambitious 10 billion USD Information Technology university in Hope City, launched by President John Mahama on the 4th of March 2013. In January 2013, Kenya also unveiled plans to build an "Africa's Silicon Savannah" within 20 years at the cost of 14.5 billion USD. Accordingly, Kenya's Konza Technology City is supposed to create more than 200 000 jobs by 2030. Rwanda and Paul Kagame's ambitions of creating a silicon valley in the small country cannot go unmentioned because, in the 2012 report released by the International Telecommunication Union (ITU), Rwanda, Bahrain, Brazil, Ghana, Kenya, and Saudi Arabia are the developing nations with strong dynamic information & communication technology (ICT) markets because they are **catching-up** quickly to bridge the so-called 'digital divide' (ITU, 2012).

² In comparison to technology-based economies, agricultural –based economies have fewer added values. This is essentially because cocoa and coffee cash crops have not changed for generations (with prices relatively staying the same after controlling for inflation). This is not the case with ICTs and patented innovative services which can create billionaires overnight.

Ernst & Young, 2013), the transition from product-based economies to a KE typically involves measures such as long-run investment in education, modernizing the information infrastructure, innovation capability and nurturing an economic environment that is conducive for market transactions.

In light of the above, this paper aims to assess how KE affects African business dynamics, notably: starting business, doing business and ending business. We employ panel instrumental variable fixed effects to account for the unobserved heterogeneity among sampled countries and issues of potential endogeneity. Concerns of information redundancy in the KE dimensions are mitigated by using principal components analysis. But for some exceptions, the findings broadly show that KE drives the starting and doing of business in Africa. The investigation is original in its contribution at the same time to the scarce literature on African KE and the growing challenges of improving the business climate of the continent by means of KE.

The rest of the paper is organized as follows. Section 2 presents the conceptual framework which embodies stylized facts and theoretical highlights. The literature review of KE and African business is covered in Section 3. The methodology and data are presented in Section 4. The empirical analysis is covered in Section 5. Section 6 concludes.

2. Conceptual framework: stylized facts and theoretical highlights

2.1 Stylized facts: the knowledge revolution and global business

As interestingly documented by Suh & Chen (2007), the worldwide rate at which knowledge is created and disseminated has increased substantially over the past decades. One of the reasons documented for this surge is the rapid growth in ICTs which have substantially mitigated the cost of electronic networking and computing power. According to the narrative, growing affordability of modern ICTs has led to more efficient diffusion of existing knowledge. In this light, researchers from different locations can work together to improve research productivity which ultimately leads to enhanced research and development (R&D), as well as the generation of new technologies and knowledge. To put these creations of technologies and new knowledge into perspective, the number of trademarks and patents granted in the United States increased by more than 120% between 1981 and 2005. During the same period, the share of patents granted outside the USA increased to 48% in 2005 from 39% in 1981.

The world economy has become more competitive with this growing speed in the creation and diffusion of knowledge. The share of world trade as a percentage of GDP which captures global competition and globalization increased to 47% in 2003 from 24% in 1960 (Suh & Chen, 2007). Hence, it is logical to infer that KE has increased the starting and doing of business because international trade augments the number of market participating producers and consumers. Hence, the revolution in knowledge accompanied with growing globalization is presenting valuable opportunities for the promotion of business, social and economic development.

The downside however of these evolving trends is that, nations could also be confronted with a substantial risk of being left behind if they are unable to adapt to or keep even pace with these changes. In addition to the growing levels of business activities, the nature of business itself is also changing. Essentially, while business was once founded on only the dimension of ‘cost’, it has today evolved to a degree whereby, innovation and speed are essential for a successful venture. The production of goods and services that was previously left to the dictates of the lowest-cost producers is no longer the rule of the ‘business game’ because massive competition from an increasingly globalised economy has driven profits down to the neighborhood of zero. In this light, the imperative of using added value is obvious: including design, efficient distribution, differentiation of products, reputable brand names and effective marketing. Hence for an industry to grow sustainably, it is essential for it to actively and productively generate new value chains as well as contribute to existing ones. Accordingly, key elements in value chains are high-value services and innovation, not necessarily production (Suh & Chen, 2007).

Against the above background, sustained economic prosperity in the age of globalization significantly depends on the nurturing and developing of strategies that integrate sustained use of knowledge creation at the center of the process of development. In this scenario, higher development thresholds are characterized by: greater levels of technological capability and science as well as motivations to engage in the production of commodities with higher value added that are consistent with the higher wages demanded by workers in the economies. In the same vein, lower development thresholds are characterized by: tapping from existing know-how and adapting foreign knowledge and technologies locally to improve domestic productivity because of lower levels in technological capability and science.

2.2 Theoretical highlights: knowledge economy and development

In accordance with the literature (Asongu, 2015a; Suh & Chen, 2007), a KE is one that makes use of knowledge as the principal engine of economic prosperity. This is an economy in which knowledge created, acquired, used and disseminated effectively improves economic development. Contrary to some opinions and beliefs, the KE concept does not necessarily and/or essentially revolve around high information technology or technology. As a case in point, the application of subsistence farming techniques could significantly augment yields. According to this narrative, the transition from product-based economies to a KE typically involves measures such as long-run investment in education, modernizing the information infrastructure, innovation capability and nurturing an economic environment that is conducive for market transactions. The World Bank has qualified the four elements as pillars of KE.

On a specific note, some elaborate discussion on the four pillars is necessary. First, institutional regime and economic incentives provide appealing institutions and economic policies. The latter foster efficient resources allocation and stimulate incentives and creativity for the efficient creation, use and dissemination of existing knowledge. Second, the skilled and educated work force that continuously adapts and upgrades skills for the efficient creation and use of knowledge. Third, an adequate and a modern information infrastructure that facilitates effective processing, communication and dissemination of knowledge. Fourth, an effective system of innovation in research centers, firms, consultants, universities and other organizations have a number of positive rewards. They ensure the knowledge revolution derives from an evolving stock of global knowledge that seemingly enhances the assimilation and adaptation of knowledge to the needs of the local population. Hence, the KE framework is a postulation that investments and interactions among the discussed four pillars are imperative for the sustained use, creation, adaptation and adoption of knowledge in the production process of a domestic economy. The ultimate outcome will be commodities with higher added-value that augment the likelihood of economic success in the current globalized and competitive world economy.

Indeed, the globalization phenomenon is now an ineluctable process of which failure to adapt to its challenges can only be at the price of sacrificing the economic prosperity of a nation. Today, it has become very clear that for any country to be actively engaged in the global economy, it has to be competitive. Competition in the 21st century has been centered on KE, which has become the principal theme of the Organization for Economic Co-operation and

Development (OECD) and World Bank reports since the year 2000 (World Bank, 2007; Weber, 2011; Asongu, 2015a). In this light, KE has been perfectly understood by Europe and North America who have been dominating development in the international arena for decades. Latin America has been responding to the challenges in calculated steps that emphasize the growing need for KE (Dahlman, 2007). The Japanese pattern has also set the KE course for the Newly Industrialized Economies of Asia (South Korea, Hong Kong, Taiwan & Singapore), Malaysia and China (Chandra & Yokoyama, 2011; Asongu, 2015a).

Among these freshly industrialized Asian nations, South Korea has achieved one of the most spectacular transitions to ‘knowledge-based economy’ from its ‘product-based economy’ of the industrialization era. In accordance with Suh & Chen (2007), the business oriented experience of the republic of South Korea also known as the ‘Korean model’ could serve as a valuable lesson for African countries because the country has witnessed one the most impressive prosperities of the 20th century: from a low-income country in the 1950s to an OECD industrialized nation before the end of the millennium. Korea is usually used as a model for African development because it had almost the same level of development as most African countries in the 1960s³. The Korean experience in KE is especially relevant in the area of doing business (Tran, 2011; Kim, 2013). This is essential in reversing the Knowledge Economy Index (KEI) trends of the continent that fell between 2000 and 2009 (Anyanwu, 2012).

3 Knowledge Economy and Africa Business

3.1 Knowledge economy in Africa

The interesting literature on KE in Africa can be discussed in eleven main strands: general discourses, innovation, education, ICTs, institutional regime & economic incentives, indigenous knowledge systems, research & development, intellectual capital & economic development, intellectual property rights (IPRs), KE in space information and spatiality in the production of knowledge (Asongu, 2014; Asongu & Tchamyou, 2016).

³ For instance, “*After the Korean war, South Korea was one of the world's poorest countries with only \$64 per capita income. Economically, in the 1960s it lagged behind the Democratic Republic of the Congo (DRC) – currently holding [elections marred by violence](#) . Since then the country's fortunes have diverged spectacularly. South Korea now belongs to the rich man's club, the OECD development assistance committee (DAC). The DRC has gone backwards since independence and, out of 187 countries, ranked bottom in the 2011 [Human Development Index](#)” (Tran, 2011).*

In the first strand on general discourses about KE, Anyanwu (2012) has recently investigated the state of knowledge on the continent and concluded that Africa is substantially lagging behind when compared to other regions and advanced countries. The author confirms his picture of the KE situation by stating that the KEI fell between the year 2000 and 2009. The dominant discourses on society, knowledge, economy and technology had earlier been analyzed by Rooney (2005) who concluded on limitations in a number of dimensions: amongst others, technocracy and KE understanding. Lin (2006) criticizes the classical growth-oriented exposition of KE by providing other neglected and important dimensions after rethinking the KE-growth nexus. The author refocuses on the importance of knowledge in easing equality, environmental conservation and wealth.

In the second strand on innovation, Carisle et al. (2013) assess the role of innovation in tourism and find that institutions have a critical role in preserving best practices, networking and transfer of knowledge. The phenomenon has been recognized as a principal source of productivity and economic growth in an interesting investigation of ‘innovation in African development’ (Oyelaran-Oyeyinka & Gehl, 2007). In summary, the imperative for more innovation in African development has been discussed consistently in the stream of recent literature (Anyanwu, 2012).

In the third stream on education, Africa’s position on the information highway has been investigated by Ford (2007) who has documented interesting challenges the continent is facing in the digital age. The value and production of doctoral dissertations has been investigated by Amavilah (2009) who has concluded on the need for more investment in knowledge production in Africa. Chavula (2010) has assessed how knowledge affects economic growth and concluded that policy needs to lay more emphasis on KE projects. Weber (2011) establishes that education diversifies the economy, preserves cultural integrity and ends illiteracy. Wantchekon et al. (2014) assess the positive role of education on human capital externalities.

The fourth strand on ICTs largely draws from the African Partnership Forum (2008) report which has established that as the continent is on the move, ICTs are necessary in boosting economic growth and reducing poverty. Consistent with the interesting narrative, ICTs create new income generating opportunities, enable access to new markets or services, improve governance and ameliorate efficiency. This line of analysis is broadly in accordance with Butcher (2011) and Chavula (2010).

Economic incentives & institutional regime constitute the fifth strand and fourth KE pillar. In this stream, Cogburn (2003) has provided valuable insights into best practices and lessons for other developing countries while trying to elucidate the transition in international telecommunications regimes. Behavioral economics has been employed by Letiche (2006) to explain the success of economic transitions, presented in an assessment on developing countries with varying customs, traditions...etc. Andrés et al. (2014) have examined the importance of formal governance in African KE to conclude that institutions are not necessarily a sufficient premise for KE given the instrumentality of IPRs. Along the same institutional lines, Andrés & Asongu (2013a) have concluded that the best channel in fighting software piracy is corruption-control. Excess liquidity concerns have also been raised as possible causes for the lack of investment on the continent (Saxegaard, 2006; Nguena & Tsafack, 2014).

The sixth strand is concerned with 'indigenous knowledge systems'. Roseroka (2008) has examined how to preserve indigenous knowledge space and consolidated some points on the comparative advantages of oral knowledge. After applying approaches of knowledge management to indigenous KE, Lwoga et al. (2010) have established that the former could be employed to manage the latter when distinct features are controlled for.

The seventh stream is focused on R&D. In this strand, Sumberg (2005) has investigated the evolving international architecture of research in agriculture and established that global research systems are asymmetric with African research realities. The understanding and applications of R & D have been undertaken by German & Stroud (2007) who have presented types, lessons and implications of learning approaches. In a nutshell, the recent interesting stream of studies has been consistent with the imperative of more R&D (African Development Bank, 2007; Chavula, 2010; Anyanwu, 2012).

In the eighth strand on 'intellectual capital & economic development', Wagiciengo & Balal (2012) have been principally concerned with lifelong learning and information disclosure. Their study concludes that intellectual capital disclosure is on the rise in corporations of the continent. In the same vein, the relationship between the international ambition for lifelong learning and foreign aid in less developed countries have been assessed by Preece (2013) who concludes that international aid priorities have a negative effect on the manner in which government choices and policies affect lifelong learning. This hypothesis has been rejected after verification in Africa (Asongu & Tchamyou, 2015).

The ninth strand covers IPRs. In this stream, Zerbe (2005) has assessed the African Union's Legislation for the protection of Indigenous knowledge to establish that it meets the requirements and needs of countries on the continent by balancing the rights of monopoly breeders with those of the indigenes. The trends in knowledge and their effects on international information flow have been assessed by Lor & Britz (2005) who have provided three main ethical pillars to explain the flow: human rights, common good and social justice. Legal processes have been reviewed by Myburgh (2011) in the protection of plant-related knowledge. The author as an IPRs lawyer presents his/her views on differences in the protection of traditional knowledge that is plant-based. Andrés & Asongu (2013b) and Asongu (2013a) have detailed timelines for common IPRs protection initiatives globally and in Africa respectively. Corruption-control is the best weapon in the fight against software piracy given the instrumentality or enforcement of IPRs (Andrés & Asongu, 2013a). Along the same line of research, Andrés et al. (2014) conclude that formal institutions are not necessarily enough mechanisms for the enhancement of KE.

The tenth strand deals with KE in the transformation of space. In this stream, Moodley (2003) has assessed the importance of electronic (e)-business in the South African apparel sector: discussing challenges, risks and opportunities of e-business in this sector. The adoption rate of e-commerce in the tourism industry has been examined by Maswera et al. (2008). They have concluded that, though Africa has informative websites, these do not have interesting e-transactions interactive facilities.

In the eleventh strand, we cover the spatiality of knowledge production. Here, Bidwell et al. (2001) have an interesting work that assesses how technology can be adapted to rural needs and heritages. They provide valuable explanations on how a rural community manages information spatially and temporarily. Neimark (2012) documents changes in bioprospecting in Madagascar after examining its political economy.

The interesting literature above could be summarized in two points: there is need for greater KE in Africa and like South Korea, business can be enhanced on the continent through KE mechanisms.

3.2 African Business

As far as we have reviewed, African business literature can be classified into three main strands: the factors affecting foreign direct investment (FDI), entrepreneurship, and strategies for achieving sustainable development (Asongu & Tchamyu, 2016).

The first strand concerns a recent stream of studies that has focused on how Africa's share in investment (especially FDI) can be improved (Asongu, 2012). The Zambian experience of using privatization policies to attract FDI has been assessed by Rolfe & Woodward (2004) who conclude that in spite of soaring FDI in the previous decade, the economy was in stagnation. According to the narrative, countries in many SSA nations need to seek alternative sources of investment after the failed privatization projects. Bartels et al. (2009) investigate factors behind SSA's persistently low global share of FDI (1%) to establish that the location decisions of FDI in SSA are strongly affected by political economy issues. Bartels et al. (2014) confirm the factors affecting the location of FDI decisions in SSA in the international business literature: political stability, economic stability, infrastructure, local market, legal framework, local supplies, incentive packages, labour costs...etc. Using 1400 firms in 19 SSA countries, Amendolagine et al. (2013) have examined the determinants of backward nexuses of FDI in the sub-region and concluded that high local relationships are linked with local partners, time and market factors. Kinda (2010) examines how the investment climate affects FDI in 77 developing countries for period 2000 to 2006 to conclude that infrastructural, institutional and financial issues substantially hamper FDI. Tuomi (2011) using micro level analysis finds that skill, exchange volatility, labor regulation and political & regulatory uncertainty are key factors in driving FDI. Yin & Vaschetto (2011) assess a strategic perspective of China's investment in Africa and conclude that China's strategy on non-interference (soft power and complementarity) is paying-off. Kolstad & Wiig (2011) have assessed the motivations for Chinese FDI on the continent to conclude that weak institutions are primarily motivating Chinese FDI location decisions. The public policy challenges, strategies and implications presented by Darley (2012) are broadly consistent with the findings of above studies. De Maria (2010) examines corruption in Malawi and concludes on a challenge on Western appropriation of African corruption.

In the second strand on entrepreneurship, Alagidede (2008) has postulated that doing business in Africa is so risky. Eifert et al. (2008) have assessed the cost of doing business in Africa using data from 7000 firms in 17 countries for the period 2002-2003 to conclude that existing estimates undervalue the relative performance of African firms. Taplin & Synman (2004) provide a legal perspective on doing business in South Africa and describe new regime changes and challenges. Tapsoba (2010) has examined how trade intensity affects business cycle synchronization in 53 African countries with data for the period 1965 to 2004 to conclude that

trade intensity increases the synchronization of business cycles. Khavul et al. (2009) study the establishment and evolution of East African entrepreneurs to conclude that entrepreneurs use strong family and community ties for the growth in activities. Bardy et al. (2012) have assessed if FDI leads to social responsibility in least developed countries to provide valuable theoretical and practical evidences on the relationship. Paul et al. (2010) investigate how labour regulation affects the cost of doing business and conclude that the World Bank ‘Doing Business’ indices on ‘employing workers’ do not provide a complete picture. Gerba (2012) has investigated the entrepreneurial intentions of undergraduate students in Ethiopia to conclude that entrepreneurship studies increase motivations for doing business, especially in male management students. The motivations of Nigerian women’s decisions to become an entrepreneur are assessed by Singh et al. (2011) who find some significance in family capital, internal orientation of social recognition, educational and an internal environment that is characterized by economic deregulation.

The third strand consists of a stream of studies that is oriented towards business strategies for achieving sustainable African development. Rugimbana (2010) provides an interesting literature that links sustainable development in Africa to varying contributions in different business disciplines. The author addresses concerns with interesting outcomes for sustainable development as well as future strategies and thinking. Dimba (2010) analyses the nexus between strategic human resource management practices and firm performance to show that the practices that best predict the performance of firms are compensation systems, training and development. Oseifuah (2010) investigates the relationship between youth entrepreneurship and the level of financial literacy in South Africa to conclude that the latter contributes to entrepreneurial skills. Mensah & Benedict (2010) assess the long-run effect on entrepreneurship training to establish that government hand-out poverty mitigation initiatives only have short-run effects, with unintended consequences of demonstrations and violent protests. On the other hand, the provision of entrepreneurial facilities and training procure small enterprises with the opportunities to improve their businesses and ultimately remove the population from poverty.

The above studies are broadly consistent with recent reports on the challenges of doing business in Africa (Leke et al., 2010; Ernst & Young, 2013). Hence, the current paper aims to assess the role of KE in addressing some of the challenges.

As discussed in the motivation, my contribution to the above literature is threefold. First, the paper is timely given that African countries are currently nursing ambitions of KE projects. It

should be recalled that structural adjustment policies of liberalization and privatization have not yielded the expected fruits in terms of boosting African business (Rolfe & Woodward, 2004). Second, Knowledge-based African business growth holds high potential for the improvement of existing agricultural economies and development of value-added technology-based services that are essential for economic prosperity, competitiveness and adaptation to the challenges of globalization. Third, the most appealing of my modest contributions is that KE holds the promise of lifting the continent out of poverty through the much needed investment opportunities and employment possibilities.

4. Data and Methodology

4.1 Data

We examine a panel of 53 African countries with data from African Development Indicators of the World Bank for the period 1996-2010. The data begins from 1996 because the good governance variables needed for the institutional regime component of KE are only available from the year 1996. The choice of the variables is broadly consistent with recent KE (Asongu et al., 2014; Amavilah et al., 2014) and African business literature summarized in Tables 1-2 and discussed in the preceding section (AfDB⁴, 2007; Aubert, 2005; Britz et al., 2006; Chavula, 2010; World Bank, 2007; Asongu, 2015b; Asongu & Tchamyau, 2016). We classify the indicators into dependent, independent and control variables in order to improve readability.

4.1.1 Dependent variables

As shown in Panel B of Table 1 below, African business dependent indicators are classified into: starting, doing and ending business. The three classes of indicators are adopted for: (i) more robustness and (ii) additional focused policy implications. Essentially, the life cycle of any business activity has the three main phases adopted in the study.

First, three starting business indicators are adopted to appreciate: the time required to start a new business, the cost of starting a new business and the number of newly created businesses. Second, the doing business indicators are classified into trade openness, technology exports and property rights institutions. (1) The cost of export, tariff on products, 'exports plus imports' are

⁴ African Development Bank.

used to proxy for trade openness. (2) Technology exports are presented in terms of: ICT good exports, ICT service exports and High technology commodity exports. (3) Three main dimensions of ‘property rights institutions’ are considered: contract enforcement (time required to enforce a contract), registration of property (time required to register a property) and investor protection (the extent of business disclosure). Third, the time required of resolve insolvency is used to proxy for the last business category: ending business. The choice of the variables is broadly consistent with recent African business literature (Leke et al., 2010; Ernst & Young, 2013). Moreover, the institutional web of formal rules, informal norms and the characteristics of their enforcements determined business climate (La Porta et al., 1998, 1999).

4.1.2 Independent variables

The independent KE variables are in accordance with World Bank’s KEI: innovation, education, institutional regime & economic incentives and ICT. The World Bank’s KEI provides a measure of the relative state of the knowledge in a country. It depicts a view of the bigger picture of a country’s performance in modern KE, as well as enabling benchmarking and monitoring (Suh & Chen, 2007). Due to substantial issues of multicollinearity and overparameterization, each KE dimension is derived from Principal Component Analysis, summarized and defined in Panel A of Table 1, discussed in Section 4.2.1 and presented in Table 4.

4.1.3 Control variables

We control for macroeconomic factors that potentially affect the doing of business and are not correlated with the KE independent variables of interest. These control variables include: inflation, government expenditure, GDP growth and private investment. Naturally, the last-two should be positively associated with starting and doing business while inflation should have the opposite effect. The expected sign of government expenditure is unclear because it depends on a number of factors, amongst others: the percentage of the budget allocated to facilitating business activities and misallocation of budget through institutional malpractices like corruption. More details on the control variables are provided in Panel C of Table 1 below.

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	World Bank (WDI)

		terrorism”.	
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)
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)
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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	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)
Private Investment	Priv. Inv.	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. FDS: Financial Development and Structure Database”.

Table 2 below presents the summary statistics of the variables (Panel A) and the countries used in the sample (Panel B). This descriptive statistics has a twofold motivation. On the one hand, it shows that variables can be compared based on the means. In essence, definition of some variables in Table 1 in logarithms is to enable such a comparison. On the other hand, it shows that there is a significant variation in the variables (standard deviations). Therefore, we can be confident that some reasonable estimated relationships would be derived.

Table 2: Summary statistics and presentation of countries

		Panel A: Summary 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
	Patentes(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 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 Openness (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	
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
	Private Investment	12.979	9.400	-2.437	112.35	658

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 & Príncipe, Seychelles, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

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

The correlation matrix presented in Table 3 below has two main purposes. On the one hand, it helps to avoid overparameterization and multicollinearity issues that could substantially bias the estimated coefficients by producing unexpected signs if specified in the same model. Hence, it is in this regard that some variables are not fitted into the same model in initial specifications in Tables 6-8. For instance ICT (ICTex) and education (Educatex) have a correlation coefficient of

0.73, implying that approximately 73% of the educated population use information and communication technologies. On the other hand, the correlation analysis gives us some feeling on the expected signs between the dependent and independent variables, especially the controlled macroeconomic characteristics.

Table 3: Correlation Analysis

Knowledge Economy (KE)					Business Indicators													Control Variables					
Educ atex	IC Tex	Cred itex	Insti reg	STJ A	Starting Business				Doing Business						Closing Business Insolv.	Infl- ation	Gov. Exp.	GDP g	Priv. Ivt.				
					Time Start	Cost Start	Bis den	Bis num	Trade Cexp	Tariff	T.O	Technology Exports								Property Rights			
1.00	0.73	-0.55	0.50	0.39	-0.17	-0.7	0.48	0.70	-0.47	0.06	0.39	0.35	-0.42	-0.06	0.05	0.11	-0.40	-0.58	-0.001	-0.03	0.01	0.25	Educatex
	1.00	-0.55	0.49	0.21	-0.25	-0.6	0.62	0.54	-0.42	-0.09	0.33	0.26	-0.14	-0.006	0.03	-0.15	0.04	-0.30	0.002	-0.02	-0.04	0.23	ICTex
		1.00	-0.6	-0.50	0.26	0.60	-0.3	-0.50	0.35	0.16	0.03	-0.18	0.13	-0.01	0.02	0.30	-0.36	0.32	0.22	0.05	0.13	-0.04	Creditex
			1.00	0.29	-0.24	-0.6	0.60	0.47	-0.37	-0.22	0.16	0.25	-0.31	-0.09	-0.02	-0.07	0.04	-0.35	-0.09	-0.004	0.06	0.42	Instireg
				1.00	-0.35	-0.4	-0.2	0.67	-0.13	-0.12	-0.2	0.07	-0.16	-0.06	-0.06	-0.09	0.26	-0.44	0.019	-0.01	-0.14	-0.05	STJA
					1.00	0.39	-0.05	-0.09	0.11	0.07	0.26	-0.12	0.02	0.01	0.21	-0.03	-0.02	0.310	0.074	-0.02	-0.03	-0.13	Time Start
						1.00	-0.5	-0.63	0.23	0.25	-0.1	-0.26	0.44	0.07	0.03	0.30	-0.04	0.45	0.10	-0.10	0.03	-0.35	Cost Start
							1.00	0.25	-0.29	-0.34	0.55	0.48	-0.28	0.21	0.33	0.03	0.15	-0.16	-0.11	-0.05	-0.22	0.23	Bis den
								1.00	-0.44	-0.23	0.24	0.29	-0.63	-0.24	0.10	-0.18	0.007	-0.51	0.09	0.04	0.01	0.26	Bis num
									1.00	-0.08	-0.1	-0.18	0.14	-0.11	-0.15	0.002	0.145	0.031	0.14	-0.004	-0.32	0.08	Cexp
										1.00	0.09	0.02	0.02	-0.02	0.17	0.04	-0.15	0.19	0.02	-0.08	-0.03	0.08	Tariff
											1.00	0.21	-0.09	-0.02	0.20	-0.06	-0.03	0.001	0.03	-0.04	0.09	0.39	T.O
												1.00	-0.002	0.13	-0.03	0.16	-0.13	-0.30	-0.01	-0.008	0.04	0.30	ICTg
													1.00	0.21	-0.05	0.04	-0.02	0.340	-0.08	-0.03	-0.14	-0.01	ICTs
														1.00	-0.04	0.14	-0.04	0.108	-0.14	-0.03	0.05	0.05	HT
															1.00	0.04	0.03	0.169	-0.06	-0.04	0.04	-0.05	C.En
																1.00	0.018	0.075	-0.06	-0.06	0.08	-0.09	P.R
																	1.00	0.086	0.10	-0.09	-0.20	-0.09	BDis
																		1.00	0.001	-0.08	0.06	-0.19	Insolv.
																			1.00	-0.13	-0.05	-0.04	Inflation
																				1.00	0.10	0.05	Gov. Exp.
																					1.00	0.37	GDPg
																						1.00	Priv. Ivt.

“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. Priv. Ivt: Private Investment”.

4.2 Methodology

4.2.1 Principal Component Analysis

Consistent with Asongu (2014), one might criticize the redundancy in the information provided for the dependent variables and each dimension of the KEI because the independent variables could be correlated or each dimension of the KEI could be correlated with its component variables individually. Accordingly, we use principal component analysis (PCA). PCA is a common statistical technique that is employed to reduce a larger set of correlated variables into a smaller set of uncorrelated variables called principal components (PCs) that account for most of the variation in the original dataset. The criteria used to determine how many common factors to retain are from Kaiser (1974) and Jolliffe (2002). They recommend dropping factors with an eigenvalue smaller than one.

From Table 4 below it can be observed that the first PC of education (Educatex) represents more than 65% of information in primary school enrolment (PSE), secondary school enrolment (SSE) and tertiary school enrolment (TSE) combined. In the same light, the first PC of institutional regime (*Instireg*) represents more than 77% of information in political governance (voice & accountability and political stability), economic governance (regulation quality and government effectiveness) and institutional governance (corruption-control & rule of law). This explanation is consistent with ICTex (Information & Communication Technology Index), Innovex (Innovation Index) and Creditex (Economic Incentive Index).

The choice of the variables in each KE dimension is broadly consistent with the World Bank's KEI (Suh & Chen, 2007). Moreover, the choice of variables in the economic incentive dimension is motivated by the substantially documented surplus liquidity issues that are stifling business activities on the continent (Saxegaard, 2006).

Table 4: Principal Component Analysis (PCA) for Knowledge Economy Indicators

Knowledge Economy dimensions		Component Matrix (Loadings)						First PC	Eigen Value	Indexes
Education	School Enrolment	PSE	SSE			TSE		0.658	1.975	Educatex
Information & Infrastructure	ICTs	Internet	Mobile		Telephone		0.730	2.190	ICTex	
Innovation System	Innovation	STJA	Trademarks		Patents		0.917	2.753	Innovex	
Economic Incentive & Institutional regime	Economic Incentive	Private Credit			Interest rate Spread		0.656	1.313	Creditex	
	Institutional index	VA	PS	RQ	GE	RL	CC	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”.

The basis for the principal component analysis (or the high degrees of substitution among different constituent variables in the KE dimensions) is detailed in the Appendices. The justification for education (Panel A), ICT (Panel B) and Innovation (Panel C) are presented in Appendix 1, whereas that for institutional regime is provided in Appendix 2. Due to substantial issues in degrees of freedom in the Innovation index, we have exceptionally used Scientific and Technical Journal Articles (STJA) as the proxy for innovation. This is essentially due to the low number of patent applications in comparison to other innovation variables (see Panel A of Table 2). The used of STJA to appreciate innovation is consistent with Chavula (2010, p.20).

4.2.2 Estimation Technique

The estimation strategy controls for potential endogeneity between African business and KE. The intuition for reverse causality is evident since; the improvement in the business climate of countries has some impact on various dimensions of KE. The estimation technique that is consistent with that employed by Ivashina (2009, p. 301) consists of regressing the KE variables on their first lags, then saving the fitted values that are later used in the second-stage (main equation) regressions. This empirical approach is summarized as follows.

First-stage regression:

$$KE_{it} = \gamma_0 + \gamma_1 (Instruments)_{it} + \gamma_j X_{it} + v_{it} \quad (1)$$

Second-stage regression:

$$B_{it} = \beta_0 + \beta_1 (Educatex)_{it} + \beta_2 (ICTex)_{it} + \beta_3 (Creditex)_{it} + \beta_4 (Instireg)_{it} + \beta_5 (STJA)_{it} + \beta_j X_{it} + \xi_t + \mu_{it} \quad (2)$$

Where KE represents education ($Educatex$), ICTs ($ICTex$), economic incentive ($Creditex$), institutional regime ($Instireg$) and innovation ($STJA$). Instruments are first lags of the endogenous variables in Eq. (1). B denotes business indicators, notably: *starting business*, *doing business* and *closing business*. The business indicators are detailed in Panel B of Table 1. In Eqs. (1) and (2), X is the vector of control variables that include: *inflation*, *government expenditure*, *economic growth* and *private investment*. v_{it} and μ_{it} denote the error terms in Eq. (1) and Eq. (2) respectively, whereas ξ_t is the time-specific constant.

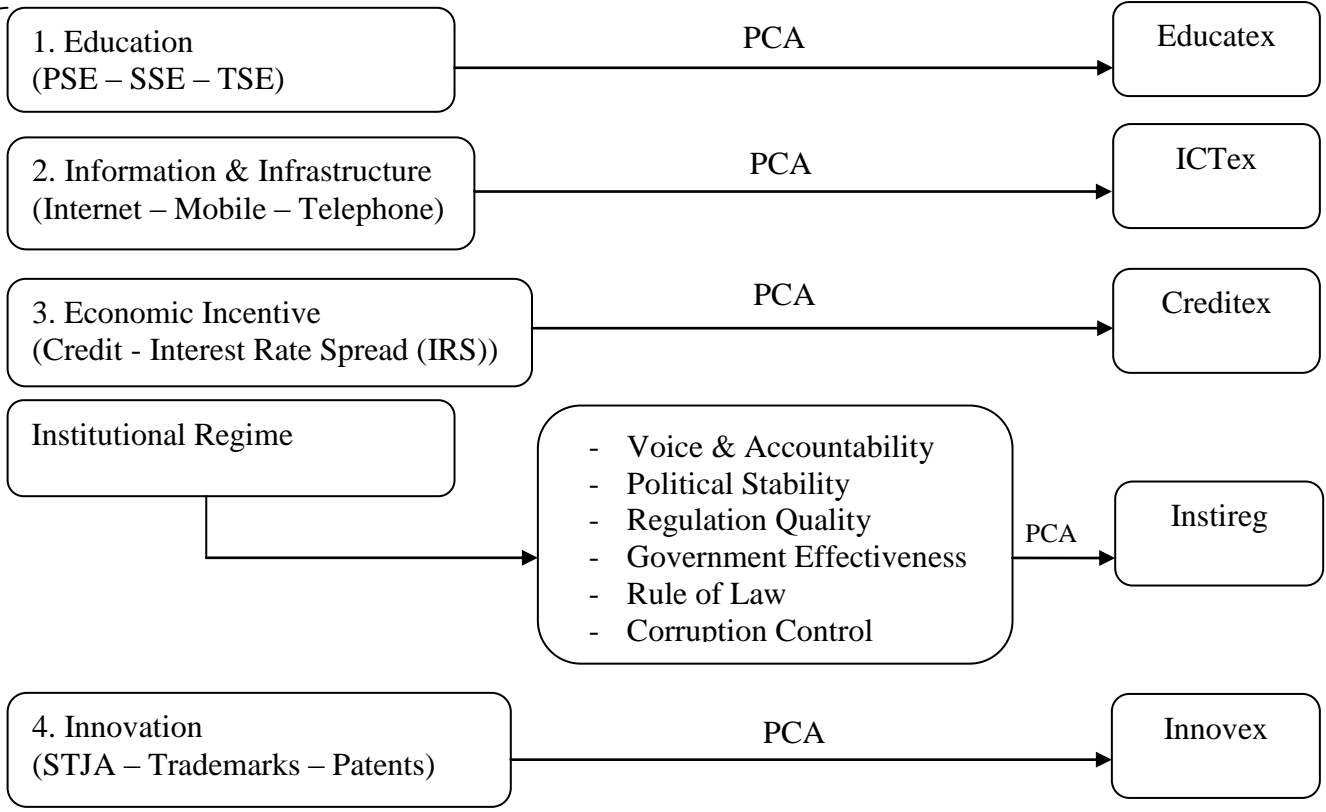
The first-stage of the estimation strategy consists of regressing the KE indicators separately on their first lags with robust Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors. The instrumented (or fitted) values are subsequently employed as the main exogenous variables. The regressions of the second-stage are also HAC and additional checks of robustness are made by: (i) controlling for the unobserved heterogeneity in time-specific effects, (ii) modeling under alternative specifications and (iii) controlling for multicollinearity (or overparameterization) that could substantially bias the expected signs of estimated coefficients.

Before we dive into the empirical specifications, it is relevant to understand the scope of the methodology in schematic format. Accordingly, the schematic model is presented below. The first section presents KE indicators in four dimensions: education, information & infrastructure, economic incentives & institutional regime and innovation. Variables of each dimension are reduced by PCA to produce the KE indexes. The second section entails the business indicators which are methodically classified into: starting business, doing business and ending business. We have 4 starting business indicators, 9 doing business variables and 1 closing business indicator. Control variables are presented in the last section. The variables highlighted in the schema have already been substantially discussed in the data section above. The schematic model aims to clearly articulate: (i) the research objectives and (ii) how the methodology aligns with discussed variables and underpinning objective of assessing the role of KE in African business. This

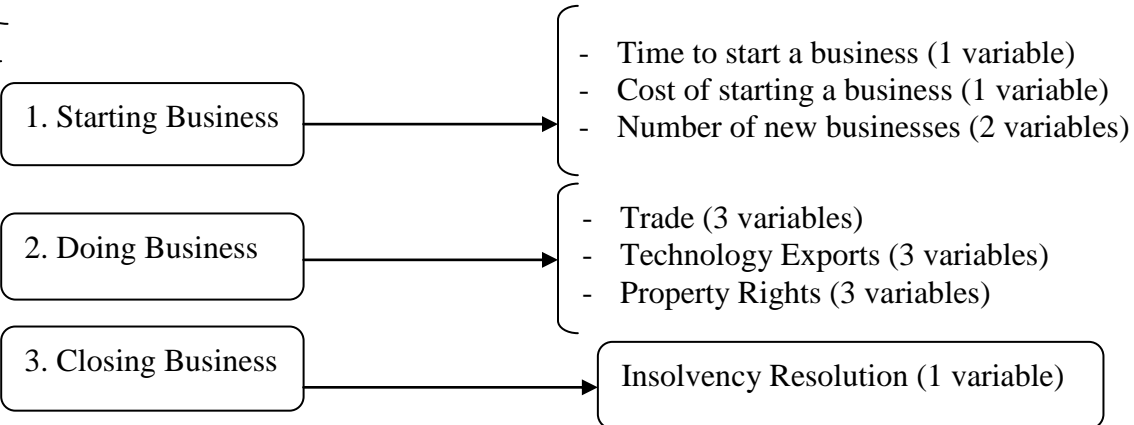
framework is broadly consistent with Mohapatra (2015) and Mohapatra and Thakurta (2014) in recent business education and knowledge management literature.

Schematical Model

Knowledge Economy (4 dimensions)



African Business (3 Dimensions)



Control variables

- Government Expenditure
- Inflation
- GDP growth
- Gross Private Investment

5. Empirical Analysis

5.1 Presentation of Results

The section aims to investigate three main concerns: (i) the incidence of KE on starting business; (ii) the effect of KE on doing business and (iii) the impact of KE on ending business. Table 5 below summarizes the findings of Table 6 (starting business), Table 7 (doing business) and Table 8 (ending business). From the summary the following conclusions could be drawn.

First, regarding the effect of KE on starting a business, we found the following. (1) Education: (i) decreases the time of starting a business; (ii) reduces the cost of starting a business and (iii) increases business density and numbers. (2) ICT: (i) reduces the time of starting a business; (ii) decreases the cost of starting a business and (iii) increases the number of businesses. (3) Economic incentives reduce the cost of starting business but unexpectedly also decrease business density and number. (4) Institutional regime increases the time of starting a business and decreases business density. (5) Scientific & Technical Journal Articles (STJA) proxying for innovation decrease business density but increase business number.

Second, we highlight the incidence of KE on doing business in three strands. (1) On the effect on trade: (i) education increases the cost of exports and reduces trade tariffs; (ii) ICT and Economic incentives have a negative incidence on the cost of exports and trade tariffs whereas, STJA decrease trade tariffs. (2) With regard to the impact of technology exports: (i) education, ICT and economic incentives increase ICT services exports; (ii) ICT has a positive effect on high technology goods exports while (iii) STJA increase ICT goods exports but decrease ICT services and high technology commodity exports. (3) On property rights institutions: (i) education decreases contract enforcement time and the extent of business disclosure; (ii) ICT has a negative impact on contract enforcement and private property registration time but a positive effect on business extent disclosure while (iii) economic incentives decrease private property registration time.

Third, with the exception institutional regime that has a negative effect on the time needed to resolve insolvency, the findings on closing a business are not overwhelmingly significant.

Table 5: Summary of the results

KE dimensions	Indexes	Starting Business				Doing Business									Closing Business
		Time Start	Cost Start	Bis den	Bis num	Cexp	Trade Tariff	T.O	Technology Exports			Property Rights			Insolv.
								ICTg	ICTs	HT	C.En	P.R	BDis		
Education	Educatex	-	-	+	na	+	-	na	na	+	na	-	na	-	na
ICT	ICTex	-	-	na	+	-	-	na	na	+	+	-	-	+	na
Economic & Institutional regime	Creditex	na	-	-	-	-	-	na	na	+	na	na	-	na	na
	Instireg	+	na	na	-	na	na	na	na	na	na	na	na	na	-
Innovation	STJA	na	na	-	+	na	-	na	+	-	-	na	na	na	na

“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. Bisen: 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”.

Table 6 below presents the findings on starting business. While Panel A presents findings of the time to start a business and cost of starting a business, those on the number of businesses (density and registration) are presented in Panel B. In the initial specifications, not all KE variables are modeled together because of a primary concern to control for issues of multicollinearity and overparameterization. These concerns are subsequently relaxed in the third and fourth specifications. The only difference between the third and fourth specifications is that the former does not account for time fixed effects. Overall, all the estimations are Heteroscedasticity and Autocorrelation Consistent (HAC) in standard errors.

Most of the significant control variables have the expected signs. (1) The positive effects of inflation on the time to start a business and cost of doing business are consistent with the predictions of economic theory. This is essentially because inflation could exert a lot of administrative delay and a host of other costs on projects. (2) Government expenditure expectedly reduces the cost of doing business, especially if the funds are allocated for private sector development. (3) Economic prosperity in terms of GDP growth decreases the time to start a business and the cost of starting a business. This is essentially because increasing investment opportunities which accompany economic growth should naturally reduce the cost of entrepreneurship due to the increase in supply of investment opportunities. (4) Private investment is naturally positively associated with increasing business density or new business registration (Panel B).

The information criteria for the validity of models are appealing. Accordingly, the adjusted coefficients of determinations (adjusted R²) are relatively high. Moreover, the Fisher statistics for the overall validity of the models are significant at the 1% level.

Table 6: Starting Business (HAC Instrumental variable panel fixed effects)

		Panel A: Time to start and cost of starting a business							
		A1: Time to start a business (log)				A2: Cost of starting a business (log)			
	Constant	2.826*** (0.000)	1.853*** (0.000)	3.889*** (0.000)	2.400*** (0.003)	3.560*** (0.000)	1.431** (0.023)	4.616*** (0.000)	3.362*** (0.000)
Education	IVEducateX	-0.979*** (0.002)	---	-1.071*** (0.000)	-0.460* (0.076)	-1.369*** (0.000)	---	-1.776*** (0.000)	-1.887*** (0.000)
ICT	IVICTex	---	0.140 (0.416)	-0.267** (0.013)	-0.398** (0.023)	---	0.192* (0.084)	-0.300** (0.044)	0.165 (0.374)
Economic incentive & institutional regime	IVCreditex	---	-0.290 (0.225)	-0.0002 (0.999)	-0.266 (0.491)	---	-0.604*** (0.000)	-2.020*** (0.000)	-1.071** (0.010)
	IVInstireg	0.310** (0.045)	---	0.466*** (0.005)	0.867*** (0.000)	-0.048 (0.785)	---	0.070 (0.583)	0.240 (0.112)
Innovation	IVlogSTJA	-0.022 (0.961)	0.410 (0.213)	0.392 (0.333)	-0.233 (0.575)	0.383 (0.491)	0.326 (0.182)	-0.500 (0.304)	-0.238 (0.631)
	Inflation	0.034*** (0.000)	0.011* (0.069)	-0.004 (0.370)	0.021** (0.023)	0.004 (0.203)	0.009 (0.103)	0.018* (0.076)	0.022** (0.016)
Control variables	Gov. Exp.	-0.0002 (0.952)	-0.0004 (0.918)	-0.005 (0.154)	-0.0001 (0.953)	-0.005* (0.058)	0.001 (0.787)	-0.012** (0.012)	-0.010** (0.012)
	GDPg	0.010 (0.260)	0.001 (0.886)	-0.030** (0.042)	-0.0008 (0.914)	-0.048** (0.037)	0.002 (0.905)	-0.038** (0.028)	-0.040** (0.006)
	Priv. Ivt.	0.014** (0.016)	-0.008 (0.465)	-0.035*** (0.000)	0.027 (0.254)	-0.0002 (0.975)	0.0009 (0.891)	0.028 (0.205)	0.013 (0.308)
	Time effects	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Information criteria	Adjusted R ²	0.842	0.720	0.829	0.892	0.951	0.911	0.968	0.979
	Fisher	11.12***	9.724***	10.13***	13.57***	38.02***	35.78***	59.66***	72.87***
	Observations	69	116	48	48	69	116	48	48
	Countries	24	22	17	17	24	22	17	17

		Panel B: New business density and registration							
		B1: New business density				B2: New business registration (log)			
	Constant	-0.555 (0.884)	4.586*** (0.000)	-2.144 (0.389)	-4.013 (0.296)	7.230*** (0.000)	8.898*** (0.000)	5.405*** (0.000)	6.210*** (0.000)
Education	IVEducateX	1.651 (0.197)	---	1.725** (0.028)	2.963*** (0.000)	-0.053 (0.739)	---	0.246 (0.318)	0.009 (0.715)
ICT	IVICTex	---	0.178 (0.535)	-0.144 (0.760)	0.417 (0.295)	---	-0.028 (0.787)	-0.062 (0.389)	-0.212*** (0.004)
Economic incentive & institutional regime	IVCreditex	---	0.014 (0.976)	-5.711** (0.017)	-4.768* (0.069)	---	0.245 (0.245)	-1.074*** (0.002)	-1.144*** (0.006)
	IVInstireg	-0.350 (0.378)	---	0.092 (0.950)	-1.265 (0.362)	-0.167* (0.090)	---	0.026 (0.822)	0.273* (0.080)
Innovation	IVlogSTJA	-0.044 (0.970)	-1.904** (0.030)	-1.369 (0.538)	-0.058 (0.986)	0.768*** (0.000)	-0.077 (0.921)	0.752** (0.029)	0.351 (0.263)
	Inflation	-0.011 (0.400)	0.010 (0.426)	---	-0.002 (0.892)	-0.008** (0.024)	0.008 (0.205)	0.007 (0.189)	0.006** (0.037)
Control variables	Gov. Exp.	-0.009** (0.048)	-0.005 (0.591)	-0.035*** (0.006)	-0.036*** (0.003)	-0.001 (0.413)	-0.0006 (0.780)	-0.009*** (0.000)	-0.008*** (0.000)
	GDPg	0.076 (0.117)	0.004 (0.876)	-0.098 (0.426)	0.028 (0.786)	0.017 (0.364)	0.023 (0.320)	0.002 (0.854)	-0.016 (0.156)
	Priv. Ivt.	0.042 (0.311)	0.029 (0.430)	0.207* (0.079)	0.120 (0.346)	-0.015** (0.019)	0.003 (0.483)	0.032** (0.025)	0.048** (0.014)
	Time effects	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Information criteria	Adjusted R ²	0.917	0.940	0.973	0.963	0.982	0.961	0.989	0.996
	Fisher	17.49***	38.48***	51.57***	31.899***	83.13***	59.83***	129.44***	294.73***
	Observations	32	53	22	22	32	53	22	22
	Countries	10	11	8	8	10	11	8	8

***, **, *: significance levels of 10%, 5% and 1% respectively. IV: Instrumented Variable. IVEducateX: Instrumented Educational index. IVICTex: Instrumented ICT index. IVCreditex: Instrumented Creditex. IVlogSTJA: Instrumented STJA. STJA: Scientific Journal Articles. Gov.

The findings on doing business are presented in Table 7 below. Panel A, Panel B and Panel C respectively provide findings for trade, technology exports and property rights institutions. Like in the preceding table, the initial specifications do not include all the explaining variables for multicollinearity and overparameterization reasons already discussed above. However, the concern is consistently relaxed in the third specifications. The estimations are also HAC in standard errors. The information criteria for the validity of the models are appealing. Accordingly, the adjusted coefficients of determinations (adjusted R^2) are relatively high. Moreover, the Fisher statistics for the overall validity of models are significant at the 1% level. Exceptions to this significance are: (i) the third specification of tariffs in Panel A2 (2.805) and (ii) third specification of high-technology exports in Panel B3 (1.240). Hence the corresponding significance of estimates in these two insignificant models is not considered in the results summarized in Table 5 above.

Most of the significant control variables have the expected signs. First, from Panel A: (1) inflation increases the cost of exports due to increasing uncertainty in prices and interest rates; (2) government expenditure expectedly reduces the cost of exports and is likely to potentially reduce tariffs if funds are allocated for the improvement of trade openness and private sector development; (3) economic prosperity increases trade openness since it is very likely that GDP is trade-related; (4) private investment as expected is positively associated with trade openness because it is very often linked to more import and export activities (bringing in raw materials and exporting finished products or vice-versa). Second, from Panel B: inflation could substantially reduce the exports of high technology goods, while GDP growth and private investment broadly have the opposite effect. Third, in Panel C: (1) inflation decreases ‘contract enforcement time’ and ‘time for property registration’ but increases ‘business extent disclosure time’ possibly because of uncertainty in prices and requirements for more disclosure on risks in price changes; (2) economic growth expectedly decreases ‘contract enforcement time’ and increases pressures on providing more information about businesses (business extent disclosure) and; (3) private investment is more naturally expected to decrease the time needed to register a property.

Table 7: Doing Business (HAC Instrumental variable panel fixed effects)

		Panel A: Trade								
		A1: Cost of Exports (log)			A2: Tariffs			A3: Trade Openness (log)		
	Constant	6.571*** (0.000)	7.455*** (0.000)	6.662** (0.014)	11.411** (0.028)	21.12*** (0.000)	-4.488 (0.520)	3.940*** (0.000)	3.951*** (0.000)	3.602*** (0.000)
Education	IVEducatex	0.321* (0.064)	---	0.020 (0.776)	-6.77*** (0.004)	---	-10.04** (0.042)	-0.009 (0.842)	---	-0.170 (0.229)
ICT	IVICTex	---	-0.133** (0.023)	-0.012 (0.859)	---	-1.525** (0.034)	-3.700 (0.214)	---	0.031 (0.106)	0.109* (0.053)
Economic incentive & institutional regime	IVCreditex	---	-0.247** (0.022)	-0.247 (0.347)	---	-1.522 (0.373)	-15.52* (0.089)	---	0.017 (0.830)	0.091 (0.252)
Innovation	IVInstireg	-0.039 (0.629)	---	-0.082 (0.226)	1.648 (0.388)	---	4.413 (0.480)	0.055 (0.351)	---	0.076 (0.184)
	IVlogSTJA	0.221 (0.173)	0.016 (0.873)	0.299 (0.254)	0.741 (0.815)	-5.868* (0.078)	2.709 (0.616)	0.005 (0.939)	0.086 (0.357)	0.236** (0.027)
	Inflation	-0.0002 (0.888)	0.0006 (0.716)	0.007* (0.078)	0.036 (0.512)	-0.034 (0.529)	0.080 (0.492)	0.002 (0.559)	0.006*** (0.000)	0.006 (0.130)
Control variables	Gov. Exp.	0.0009 (0.453)	-0.004** (0.026)	-0.002 (0.195)	-0.033 (0.255)	-0.018 (0.619)	-0.113* (0.050)	0.0005 (0.622)	-0.0006 (0.249)	0.0004 (0.736)
	GDPg	-0.005 (0.488)	-0.0008 (0.829)	0.013 (0.165)	0.014 (0.924)	0.117 (0.481)	0.092 (0.769)	0.0001 (0.950)	0.009*** (0.000)	0.008* (0.092)
	Priv. Ivt.	-0.001 (0.693)	0.003 (0.319)	0.009 (0.270)	-0.036 (0.672)	0.045 (0.524)	0.546 (0.110)	0.014*** (0.000)	0.004 (0.106)	0.012*** (0.000)
Information criteria	Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Adjusted R ²	0.980	0.862	0.996	0.713	0.734	0.619	0.958	0.929	0.975
	Fisher	68.12***	17.23***	261.73***	4.54***	11.42***	2.805	50.96***	94.51***	69.41***
	Observations	44	81	29	48	125	32	74	242	51
	Countries	22	21	15	23	23	16	24	24	17

		Panel B: Technology Exports								
		B1: ICT Goods			B2: ICT Services			B3: High-tech Exports		
	Constant	-6.557* (0.075)	-0.077 (0.965)	-29.167* (0.054)	3.600 (0.409)	2.398 (0.605)	16.65*** (0.000)	4.899 (0.412)	9.255** (0.036)	-36.32** (0.083)
Education	IVEducatex	1.099 (0.288)	---	4.360 (0.186)	1.359** (0.048)	---	3.864*** (0.000)	2.555 (0.444)	---	3.837 (0.484)
ICT	IVICTex	---	0.038 (0.791)	-1.919 (0.225)	---	0.342 (0.274)	1.499* (0.074)	---	0.828*** (0.004)	1.258 (0.587)
Economic incentive & institutional regime	IVCreditex	---	-0.198 (0.775)	-10.590 (0.103)	---	1.664 (0.103)	5.816* (0.075)	---	2.235 (0.108)	-14.78** (0.013)
Innovation	IVInstireg	-0.165 (0.831)	---	-0.344 (0.653)	-1.311 (0.174)	---	0.069 (0.791)	0.764 (0.518)	---	-0.238 (0.873)
	IVlogSTJA	3.339** (0.033)	0.873 (0.405)	9.888* (0.060)	1.654 (0.511)	1.073 (0.654)	-3.693* (0.074)	-6.099* (0.061)	-1.964 (0.409)	7.983 (0.206)
	Inflation	0.085 (0.015)	-0.027 (0.466)	0.183*** (0.000)	-0.043 (0.190)	-0.018 (0.597)	-0.16*** (0.000)	-0.022 (0.771)	-0.105* (0.079)	0.270*** (0.000)
Control variables	Gov. Exp.	0.014 (0.629)	0.003 (0.731)	-0.036 (0.283)	-0.071* (0.094)	0.002 (0.887)	0.011 (0.499)	0.060 (0.144)	-0.034 (0.134)	-0.062 (0.228)
	GDPg	-0.046 (0.673)	-0.027 (0.484)	0.122 (0.187)	0.068 (0.458)	-0.092 (0.131)	-0.165** (0.042)	0.338** (0.022)	-0.041 (0.771)	0.864*** (0.000)
	Priv. Ivt.	0.110* (0.091)	-0.035 (0.375)	0.573** (0.043)	0.007 (0.934)	0.050 (0.432)	-0.45*** (0.000)	0.343 (0.136)	-0.025 (0.682)	0.959** (0.020)
	Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Information criteria	Adjusted R ²	0.509	0.518	0.512	0.929	0.480	0.899	0.272	0.367	0.132
	Fisher	3.047***	6.825***	2.713**	24.61***	5.768***	14.25***	1.723*	4.693***	1.240
	Observations	62	174	45	51	140	38	57	192	42
	Countries	21	22	15	18	17	13	19	20	14

Panel C: Property Rights

		C1: Contract Enforcement Time (log)			C2: Property Registration Time (log)			C3: Business Extend Disclosure		
	Constant	6.501*** (0.000)	6.514*** (0.000)	6.536*** (0.000)	3.881*** (0.000)	4.093*** (0.000)	4.037*** (0.000)	3.248 (0.151)	3.852*** (0.000)	4.147*** (0.000)
Education	IVEducatex	-0.046** (0.037)	---	0.033** (0.023)	-0.039 (0.625)	---	0.109 (0.482)	-3.367* (0.065)	---	0.000 (0.162)
ICT	IVICTex	---	-0.016 (0.284)	-0.013** (0.015)	---	-0.165* (0.073)	0.009 (0.758)	---	0.087 (0.345)	0.000** (0.048)
Economic incentive & institutional regime	IVCreditex	---	0.009 (0.697)	-0.009 (0.219)	---	-0.159 (0.424)	-0.45*** (0.000)	---	0.089 (0.664)	0.000 (0.086)
Innovation	IVInstireg	0.005 (0.628)	---	-0.003 (0.381)	0.097 (0.161)	---	-0.113 (0.326)	-0.817 (0.199)	---	0.000 (0.550)
	IVlogSTJA	-0.020 (0.274)	-0.029 (0.644)	-0.0002 (0.981)	0.408 (0.189)	0.028 (0.781)	0.450 (0.358)	3.761 (0.132)	0.380 (0.255)	0.000 (0.082)
	Inflation	0.0005 (0.356)	0.002 (0.147)	-0.001** (0.023)	-0.004** (0.049)	0.006 (0.197)	-0.005 (0.322)	0.048* (0.064)	0.006 (0.215)	---
Control variables	Gov. Exp.	0.0002 (0.263)	-0.0004 (0.115)	0.000 (0.267)	0.006*** (0.000)	0.001 (0.384)	0.005** (0.038)	-0.014 (0.156)	-0.0009 (0.549)	---
	GDPg	-0.0004 (0.395)	0.002 (0.197)	-0.0009** (0.018)	0.002 (0.445)	-0.0008 (0.906)	0.007 (0.329)	0.173* (0.094)	0.023 (0.151)	---
	Priv. Ivt.	0.001 (0.212)	0.003 (0.126)	-0.0002 (0.451)	-0.022** (0.010)	-0.002 (0.738)	-0.033** (0.016)	0.005 (0.869)	0.001 (0.872)	---
Information criteria	Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Adjusted R ²	0.998	0.966	0.999	0.973	0.836	0.977	0.884	0.989	1.000
	Fisher	1149***	104.08***	3820***	63.87***	16.97***	59.21***	11.38***	247***	Inf***
	Observations	68	115	47	57	98	39	43	76	34
	Countries	24	22	17	23	21	16	21	20	17

*, **, ***: significance levels of 10%, 5% and 1% respectively. IV: Instrumented Variable. IVEducatex: Instrumented Educational index. IVICTex: Instrumented ICT index. IVCreditex: Instrumented Creditex. IVlogSTJA: Instrumented STJA. STJA: Scientific Journal Articles. Gov. Exp: Government Expenditure. GDPg: GDP growth. Priv. Ivt: Private Investment. HAC: Heteroscedasticity & Autocorrelation Consistent. Log: logarithm. Inf: means the value is substantially high.

The third assessments of the effect of KE on closing business are presented in Table 8 below. But for the negatively significant effect of institutional regime on time needed to resolve insolvency, the other KE variables do not significantly affect the dependent variable. The information criteria are appealing because, while the coefficients of adjustments are close to unity, the Fisher statistics for the overall validity of the models are significant at the 1% level.

Table 8: Closing Business (HAC Instrumental variable panel fixed effects)

		Time to resolve insolvency			
	Constant	2.708*** (0.000)	2.791*** (0.000)	2.289*** (0.000)	2.097*** (0.000)
Education	IVEducatex	0.089 (0.361)	---	0.060 (0.584)	0.417 (0.139)
ICT	IVICTex	---	-0.020 (0.288)	0.020 (0.480)	-0.010 (0.803)
Economic incentive & institutional regime	IVCreditex	---	-0.017 (0.421)	0.149 (0.367)	0.128 (0.378)
	IVInstireg	-0.063 (0.287)	---	-0.067 (0.366)	-0.126* (0.096)
Innovation	IVlogSTJA	0.192 (0.327)	0.132 (0.313)	0.414 (0.278)	0.486 (0.106)
	Inflation	-0.0009 (0.790)	0.001 (0.333)	-0.007 (0.331)	0.005 (0.340)
Control variables	Gov. Exp.	0.0004 (0.555)	0.0001 (0.630)	0.002 (0.343)	0.004 (0.151)
	GDPg	0.0005 (0.822)	0.002 (0.331)	-0.0007 (0.840)	0.015* (0.080)
	Priv. Ivt.	-0.002 (0.358)	0.0009 (0.364)	-0.011 (0.304)	-0.023* (0.062)
	Time effects	Yes	Yes	No	Yes
Information criteria	Adjusted R ²	0.997	0.996	0.992	0.993
	Fisher	619.08***	982.02***	223.79***	210.74***
	Observations	58	102	38	38
	Countries	22	19	15	19

*,**,***: significance levels of 10%, 5% and 1% respectively. IV: Instrumented Variable. IVEducatex: Instrumented Educational index. IVICTex: Instrumented ICT index. IVCreditex: Instrumented Creditex. IVlogSTJA: Instrumented STJA. STJA: Scientific Journal Articles. Gov. Exp: Government Expenditure. GDPg: GDP growth. Priv. Ivt: Private Investment. HAC: Heteroscedasticity & Autocorrelation Consistent.

5.2 Further discussion of results and policy implications

5.2.1 Education on African business and policy implications

First, on starting business we have found that education: decreases the time for starting a business, reduces the cost of doing business and increases business density. This finding is consistent with theoretical and empirical predictions from the literature review covered in Section 2 above. Notably: (i) Gerba (2012) on how entrepreneurial intentions of undergraduate students increase with entrepreneurial studies, especially management lessons; (ii) Singh et al. (2011) on general education; (iii) Oseifuah (2010) on the relationship between youth entrepreneurship and

the level of financial literacy and (iv) Mensah & Benedict (2010) on the positive long-run effects of entrepreneurial activity on poverty and conflicts mitigation.

Second, with regard to doing business, education: (i) increases the cost of exports and reduces trade tariffs (effects on trade openness); (ii) increases ICT services exports (effect on technology exports) and (iii) decreases contract enforcement time and the extent of business disclosure (effects on property rights institutions). But for the negative effect on the extent of business disclosure, the signs are overwhelmingly consistent with the predictions of economic theory. The unexpected sign on the business disclosure (or less investor protection through disclosure of ownership and financial information) have a threefold justification: (i) the high rate of informal entrepreneurial activities in African countries; (ii) businesses in the formal sector are not generally prone to external finance from investors that formally need such disclosures and (iii) the potentially high rate of business malpractices. Relationships with the expected signs are broadly in accordance with the discussion presented in the first paragraph (Gerba, 2012; Singh et al., 2011; Oseifuah, 2010; Mensah & Benedict, 2010; Wantchekon et al., 2014).

Third, while the effect of education in closing a business has not been significant, there is a broad consensus that education is positively associated with starting and doing business in Africa. Hence, in order to achieve optimal rewards from this dimension of KE, brain drain and lack of investment in education are concerns to be addressed. They have been documented in Section 2 as some issues negatively affecting the consolidation of the educational KE pillar (Ford, 2007; Amavilah, 2009; Chavula, 2010; Anyanwu, 2012). Accordingly, there is a substantial background for dilapidating knowledge infrastructure, brain drain, limited relationships between science and industry, thin support for R&D and outdated curricula. Therefore from an educational standpoint, Africa is on a falling trend and may not completely reap the positive benefits of training in starting and doing business. Hence, bold initiatives are essential to reinvigorate technology & science in higher education. So what can be done to improve the educational climate? We discuss the policy measures in the fourth and fifth strands.

Fourth, countries of the continent need to take very bold steps towards augmenting enrolment rates in colleges and place greater emphasis on entrepreneurial lessons in management specializations. In the same vein, the ratio of R&D to GDP should also be increased. The policy measures should be in conjunction with considerable improvements in other economic and institutional environments. Applying these initiatives would help education consolidate the

continent's ability to acquire novel knowledge and technology. This will also reinvigorate the know-how of individuals that is needed to consolidate blocks of technological knowledge. To this end, it is essential for African governments to assume responsibility for the policy measures needed to enhance this core development in human resources. For instance, consistent with the Korean literature (Suh & Chen , 2007; Asongu, 2014) while South Korea still imports some of its technology, it has however constructed robust indigenous R&D platforms and puts aside approximately 3% of GDP for R&D purposes.

Fifth, the relevance of education in favoring business activities should not be limited to formal educational circles. The policies should also accompany workers throughout their professional careers. This is essential if the workers are to cope with changing and evolving technological conditions. It is complementary with the vocational and technical trainings that African governments need to put in place. In essence, as a nation grows in business activities, training at work places is a critical factor in the acquisition of knowledge and technological competence is needed to face competition. African policy makers should also nurture high-caliber scientists and engineers capable of handling growth and challenges in technology & science. In the Korean situation for instance, business (or industrialization) and education were complementary to each other (Suh & Chen, 2007; Asongu, 2015a). In other words, technological learning and business were the result of education and the former increased the rate of return on educational investment, which ultimately improved the demand for education.

5.2.2 ICT on African business and policy implications

We have established from the findings that ICT: reduces the time of starting a business, decreases the cost of starting a business and increases the number of businesses. These findings are broadly consistent with the predictions of economic theory. Accordingly, the ICT (especially the mobile revolution) has substantially transformed business in Africa by providing not only communication facilities but also access to finance to a previously unbanked fraction of the population (Jonathan & Camilo, 2008; Demombynes & Thegeya, 2012; Asongu, 2014).

In doing business, we have also found that ICT: (i) has a negative effect on the cost of exports and trade tariffs (effects on trade); (ii) increases ICT service exports (effect on high technology exports) and (iii) has a negative impact on the time needed for contract enforcement and property registration but a positive effect on business extent disclosure (effects on property rights institutions). All the effects above are consistent with the predictions of economic theory.

Hence, it is natural to expect that, ICT would: (i) reduce the cost of exports due to reduction in the cost of information; (ii) reduce trade tariffs due to lower information asymmetry, decreasing cost of information and increasing competition; (iii) increase the export of ICT services and high technology goods because they are positively correlated and (iv) improve property rights institutions (decrease the time needed to enforce a contract, decrease the period needed to register a property and increase the extent of business disclosure) due to increasing synchronization of information. We have established no significant ICT effect on closing business. While we have found expected results on the appealing effects of ICT on starting and doing business, it is important to note that more still needs to be done, especially if African countries are to catch-up with reference models like South Korea highlighted in the theoretical underpinnings of the paper. We have already covered how ICT benefits the African society in a multitude of ways in Section 2 (African Partnership Forum, 2008; Chavula, 2010; Butcher, 2011).

In light of the above, in order for Africa to catch-up in ICT with an exemplary developed country like Korea, policy makers should tailor ICT success with the implementation of soundly-integrated measures that encompass a competitive & regulatory policy, an active informatization policy and an industrial policy. African countries should massively invest in telephone lines, internet equipment and multimedia, amongst others. As sustained by Suh & Chen (2007), these investments have been critical for Korea's emergence. According to their narrative, ICT policies were clearly articulated along the three principal dimensions: (i) human resources, venture capital and R&D (an industrial policy); (ii)market liberalization and privatization (enforced regulatory and competitive policy) and (iii) the construction of advanced infrastructure and setting-up of e-government (an active information policy). As sustained by the authors, combining these three policy areas within a framework of consolidated ICT structure was crucial to the success of the Korean development strategy.

5.2.3 Economic incentives on African business and policy implications

Due to substantially documented issues of surplus liquidity in African financial institutions (Saxegaard, 2006; Nguena & Tsafack, 2014; Asongu, 2014), we have defined economic incentives in this paper as the ability of surplus deposits in financial institutions to be transformed into credit for economic operators who can then use the available finance to set-up new business

units or consolidate existing business structures. Hence, we have used ‘domestic credit to the private sector’ and ‘interest rate spreads’ to appreciate this concern of economic incentives. The effects of this economic incentive on business have overwhelmingly revealed the expected signs.

First, economic incentives reduce the cost of doing business but unexpectedly also decrease the business density and number of businesses. The expected negative effect on the cost of starting a business has a simple explanation: the interest rate required by formal banking institutions is much lower than that demanded by non-formal and informal financial institutions in Africa (Chung, 2013). The negative effects on the number of businesses have a twofold explanation: credit from banks may be destined for non-business private investment and/consumption purposes or new businesses could be unregistered because they are created in the informal sector and rural areas.

Second, in the doing of business, economic incentives: (i) decrease the cost of exports and trade tariffs (effects on trade); (ii) increase ICT services exports (effect on high technology exports) and (iii) decrease the time needed to register a property (effect on property rights institutions). There is no significant effect of economic incentives on closing a business. (i) On trade, the negative impacts on the cost of exports and trade tariffs are broadly in line with the predictions of economic theory. This is essentially because incentives by government tailored towards import-substitution would most likely result in these outcomes. (ii) The positive effect on ICT exports has a similar explanation to (i) above. (iii) The negative impact on the time needed to register a property may possibly be explained by: a complementary effort to ease the doing of business or higher preparedness/ability to pay bribes for the property to be registered without delay.

We remain in line with the South Korean model in order to be consistent with our policy implications across various components of KE. Hence, as we have discussed above, while the export-led or extensive development model would expose African industries to more competition, this outward-looking initiative should equally motivate government inducements like fiscal incentives and intensive R&D programs that are essential for the success. Within this framework, protectionist measures which are necessary at the starting stages of business should be curtailed with the growth and competitiveness of a given industrial sector. Otherwise this could lead to complacency in business innovation.

Small & Medium Size Enterprises which inherently are prone to greater capital requirements were helped by government backed research institutes in the Korean experience. They were provided with new knowledge in terms of novel spinoffs and collaborative R&D (Suh & Chen, 2007). Ultimately, the incentives to private enterprise are acutely needed to boost the development of the private business sector and respond to the evolving stream of African business literature on the need for investment (Anyanwu, 2007, 2009; Rolfe & Woodward, 2004; Bartels et al., 2014; Bartels et al., 2009; Tuomi, 2011; Darley, 2012).

5.2.4 Institutional regime on African business and policy implications

First, we have observed from the findings that institutional regime increases the time for starting a business and decreases business density. The finding was not unexpected given the considerable degree of bureaucracy associated with business activities in Africa. This discourages many who may end-up abandoning the whole idea of setting-up a business altogether which ultimately affects business density in a negative manner. As a policy implication, genuine steps are needed to substantially curb institutional bureaucracies that stifle the smooth creation of corporations. Corruption along the lines should also be dealt with because it could be the result of such lengthy administrative business setting processes.

Second, we have also found that while institutional regime has no significant effect on the doing of business, it has a negative impact on the time needed to close a business. The latter result corroborates the findings and discussion of the preceding paragraph. As for the consistent insignificance of the former, it implies that the institutions governing businesses may not be strong enough to adopt and enforce policies that significantly affect the manner in which business on the continent is run. This may be due for several reasons which are not within the scope of this paper, but deserve further investigation as an interesting future research direction.

Overall, in light of the above, institutions either have the unexpected signs or are insignificant, which means policy makers need to work relentlessly on the institutional sectors that affect the doing of business, notably: political governance (political stability and voice & accountability), economic governance (government effectiveness and regulation quality) and institutional governance (rule of law and corruption-control). This is consistent with recent studies on African economies which have concluded that institutional development is crucial for the emergence of the continent (Fosu, 2013ab). We have also gathered from Section 2 how

African economies are substantially lagging in this pillar of KE (Cogburn, 2003; Letiche, 2006), especially on the relevance of institutions in KE (Andrés et al., 2014).

Against this background, it is essential for African institutions to be market focused through the adoption of development strategies that liberate the competitive market forces needed for KE completely. This will substantially enhance the starting and doing of business. In essence, a market-oriented approach fosters competition because of the presence of competitive forces. Moreover, government accountability, transparency in financial markets, foreign investment regimes, liberalized trade and a leveled playing field for most participants in the market are essential institutional components of KE needed to boost African business. An export-led industrialization strategy can go a long way to achieving these goals because the adoption of such an extensive growth strategy exposes African companies to global competition, which is imperative for new business ideas and more investment needed to support the new business ideas (technological assimilation and substantial innovation essential to remain competitive).

In improving institutional quality, policy makers would also be confronted with the very thorny concern of corruption in business circles, especially among the political elite. Hence, credible and effective governments are critical at this juncture to achieve long-run business development objectives. The South Korean example could serve as a model for African policy makers. In accordance with Tran (2011), the country's leader Park adopted a very pragmatic strategy to tackling elite corruption. Contrary to the recommendations of the USA, he did not vehemently crack-down on business men, but forced them to invest in import-substitution industries by expropriating their bank shares. In a nutshell, the principal lesson to be drawn by African governments from this experience is the adoption of pragmatic approaches in fighting corruption. Moreover, the Korean government played a pivotal mission in facilitating the other dimensions of KE needed to boost business activities, notably: assimilation of foreign technologies, mass education, training of the population, access to modern infrastructure, domestic R&D, amongst others.

A credible institutional regime could also help in solving business crises like financial meltdowns. A good case in point is how the South Korean government was able to manage the 1997 crises (Suh & Chen, 2007; Asongu, 2015a). Accordingly, confidence in government institutions was largely credited for the successful reforms implemented by this government such as the removal of non-performing loans, recapitalization of financial institutions...etc.

5.2.5 Innovation on African business and policy implications

Innovation in this paper has been proxied with the number of Scientific & Technical Journal Articles (STJA) due to issues in degrees of freedom already discussed above (last paragraph of Section 4.2.1). We have found the following. First, in starting a business, STJA decrease business density but increase business registration. Second, in doing business, STJA: (i) decrease tariffs (effect on trade); (ii) increase ICT good exports but decrease ICT service and high technology exports (effects on technology exports) and (iii) have no significant effect on property rights institutions. Third, the effect on ending a business is also insignificant. On the first note, while the effect on increasing the number of newly registered businesses is consistent with intuition, the negative effect on business density is unexpected and could be subject to further research. The signs of the effects on trade are broadly in line with our expectations. Elucidation of the positive and negative signs is also broadly in accordance with those already covered and discussed above.

While the policy recommendations covered in the preceding sections also broadly apply to innovation in African business, it is worthwhile highlighting some policy dimensions that are specific to this pillar of KE in light of the East Asian miracle underlying this paper. In order to facilitate innovation, at the early stages of business units and/or industrialization; imitation, less stringent property rights and reversed engineering may be necessary. This policy which is essential for the copying of commodities that are technology-intensive largely contributed to the East Asian miracle (Bezmen & Depken, 2004). These informal technology transfer mechanisms are needed at the early stages of industrialization in African countries. This would potentially decrease the cost of acquiring new technology and reduce dependence on business operations. In order to succeed, the policy initiatives should be clearly articulated with education and human development in a strategy of lifelong learning.

6. Conclusion

This paper has analyzed the role of Knowledge Economy (KE) in African business with data from 53 African countries for the period 1996 to 2010. The World Bank's four KE components have been employed: education, innovation, economic incentives & institutional regime and information & communication technology (ICT). The business indicators are classified into: starting, doing and ending business. The dimensions of the KE variables have

been reduced with principal component analysis due to multicollinearity and overparameterization concerns. The empirical strategy adopted is an instrumental variable panel fixed effects estimation method. The findings are classified in three strands.

First, regarding the effect of KE on starting a business, we found the following. (1) Education: (i) decreases the time of starting a business; (ii) reduces the cost of starting a business and (iii) increases business density and numbers. (2) ICT: (i) reduces the time of starting a business; (ii) decreases the cost of starting a business and (iii) increases the number of businesses. (3) Economic incentives reduce the cost of starting business but unexpectedly also decrease business density and number. (4) Institutional regime increases the time of starting a business and decreases business density. (5) Scientific & Technical Journal Articles (STJA) proxying for innovation decrease business density but increase business number.

Second, we highlight the incidence of KE on doing business in three strands. (1) On the effect on trade: (i) education increases the cost of exports and reduces trade tariffs; (ii) ICT and Economic incentives have a negative incidence on the cost of exports and trade tariffs whereas, (iii) STJA decrease trade tariffs. (2) With regard to the impact of technology exports: (i) education, ICT and economic incentives increase ICT services exports; (ii) ICT has a positive effect on high technology goods exports while STJA increase ICT goods exports but decrease ICT services and (iii) high technology commodity exports. (3) On property rights institutions: (i) education decreases contract enforcement time and the extent of business disclosure; (ii) ICT has a negative impact on contract enforcement and private property registration time but a positive effect on business extent disclosure while (iii) economic incentives decrease private property registration time.

Third, with the exception institutional regime that has a negative effect on the time needed to resolve insolvency, the findings on closing a business are not overwhelmingly significant.

Policy implications for the relevance of each specific KE dimension in African business are discussed with particular emphasis on the theoretical underpinnings of the study. The investigation is original in its contribution at the same time to the scarce literature on African KE and the growing challenges of improving the business climate on the continent by means of KE. As a caveat, whereas the fixed effects estimation technique employed has accounted for the unobserved heterogeneity, employing other empirical strategies that have more bite on endogeneity would improve the extant literature. Using the Generalized Method of Moments is a

step towards this direction because the underlying data structure is consistent with the estimation technique ($N>T$)⁵.

⁵ N being the number of cross sections and T the number of years per cross section.

Appendices

Appendix 1: Correlation analysis for Education, ICT & Innovation

Panel A: Correlation Analysis for Educatex (Education)

PSE	SSE	TSE	
1.000	0.427	0.270	PSE
	1.000	0.747	SSE
		1.000	TSE

Panel B: Correlation Analysis for ICTex (Information and Communication Technology)

Internet	Mobile	Telephone	
1.000	0.724	0.582	Internet
	1.000	0.479	Mobile
		1.000	Telephone

Panel C: Correlation Analysis for Innovex (Innovation)

STJA	Trademarks	Patents	
1.000	0.901	0.831	STJA
	1.000	0.919	Trademarks
		1.000	Patents

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).

Appendix 2: Correlation analysis for Instireg (Institutional regime)

VA	PS	RQ	GE	RL	CC	
1.000	0.659	0.701	0.680	0.723	0.665	VA
	1.000	0.630	0.640	0.795	0.684	PS
		1.000	0.812	0.814	0.729	RQ
			1.000	0.883	0.836	GE
				1.000	0.871	RL
					1.000	CC

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.

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