AFRICAN GOVERNANCE AND DEVELOPMENT INSTITUTE

A G D I Working Paper

WP/14/014

Knowledge Economy Gaps, Policy Syndromes and Catch-up Strategies: Fresh South Korean Lessons to Africa

Simplice A. Asongu
African Governance and Development Institute,
Yaoundé, Cameroon.
E-mail: asongusimplice@yahoo.com

 WP/14/04

AGDI Working Paper

Research Department

Knowledge Economy Gaps, Policy Syndromes and Catch-up Strategies: Fresh South Korean Lessons to Africa

Simplice A. Asongu[1]

August 2014

Abstract

Africa's overall knowledge index fell between 2000 and 2009. South Korea's economic miracle is largely due to a knowledge-based development strategy that holds valuable lessons for African countries in their current pursuit towards knowledge economies. Using updated data (1996-2010), this paper presents fresh South Korean lessons to Africa by assessing the knowledge economy (KE) gaps, deriving policy syndromes and providing catch-up strategies. The 53 African frontier countries are decomposed into fundamental characteristics of wealth, legal origins, regional proximity, oil-exporting, political stability and landlockedness. The World Bank's four KE components are used: education, innovation, information & communication technology (ICT) and economic incentives & institutional regime. Absolute beta and sigma convergence techniques are employed as empirical strategies. With the exception of ICT for which catch-up is not very apparent, in increasing order it is visible in: innovation, economic incentives, education and institutional regime. The speed of catch-up varies between 8.66% and 30.00% per annum with respective time to full or 100% catch-up of 34.64 years and 10 years. Based on the trends and dynamics in the KE gaps, policy syndromes and compelling catch-up strategies are discussed. Issues standing on the way to KE in Africa are dissected with great acuteness before South Korean relevant solutions are provided. The paper is original in its provision of practical policy initiatives drawn from the Korean experience to African countries embarking on a transition to KE.

JEL Classification: O10; O30; O38; O55; O57
Keywords: Knowledge economy; Catch-up; South Korea; Africa

[1] Simplice A. Asongu is Lead economist in the Research Department of the AGDI (asongus@afridev.org).

1. Introduction

The phenomenon of globalization has become an ineluctable process whose challenges can be neglected only by sacrificing the prosperity of nations. It is increasingly relevant today that for nations to be competitive and integrated into or involved in the world economy, they have to play by competitive-rules that come with embracing globalization. Twenty-first century competition is centered on knowledge economy (KE), a golden rule that has emerge as a key theme in the Organization of Economic Co-operation and Development (OECD) and World Bank reports since the start of the third millennium (World Bank, 2007; Weber, 2011; Tchamyou, 2014; Amavilah et al., 2014).

It is in this spirit that the dynamics of KE have been mastered by North America and Europe, who are inexorably charting the course of development in the international arena. In calculated steps, Latin America and Asia have been growingly asserting the need for KE in their pursuits of national and regional initiatives (Dahlman, 2007; Chandra & Yokoyama, 2011). The historic pattern formulated by Japan has set the course for China, Malaysia and the Newly Industrialized Economies of Asia (Singapore, Taiwan, Hong Kong & South Korea). These nations have been witnessing a remarkable march from post-industrialization era 'product-based economies' to 'knowledge-based economies'. The East Asian Miracle has left many scholars and policy makers debating on the implications and lessons for Africa (Kim, 2013). Among the Newly Industrialized Economies of Asia, South Korea has increasingly been the object of comparison with African countries because it was far less developed than most countries in the continent in the aftermath of colonial independence (Tran, 2011). Aware of the fact that 21st development is KE-centered and Africa's lagging global position in KE, Korea's KE experience is an important benchmark for development prospects in the continent, especially when its overall knowledge index fell between 2000 and 2009 (Anyanwu, 2012; Tchamyou, 2014).

While a substantial portion of the literature has been devoted to the emerging economies of Latin America and Asia, very scanty scholarly attention has been devoted to African countries (Dahlman, 2007; Chavula, 2010; Chandra & Yokoyama, 2011). However, in recent years KE themes have been increasingly taking central stage in discussions on development in the continent (AfDB, 2007; Amavilah, 2009; Asongu, 2013a; Andrés & Asongu, 2013ab; Nyarko, 2013a; Andrés et al., 2014; Tchamyou, 2014). Indeed, a recent stream of literature is consistent with the imperative for urgent policy measures needed to foster the drive towards African KE, inter alia: general discourses about KE in the continent (Rooney, 2005; Lin, 2006; Anyanwu, 2012); education (Ford, 2007; Weber, 2011); information & communication technologies (Butcher, 2011); innovation (Carisle et al., 2013); institutional regime & economic incentives (Cogburn, 2003; Letiche, 2006); intellectual capital & economic development (Wagiciengo & Belal, 2012; Preece, 2013); indigenous knowledge systems (Raseroka, 2008; Lwoga et al., 2010); research & development (German & Stroud, 2007; Sumberg, 2005); intellectual property rights (Zerbe, 2005; Lor & Britz, 2005; Myburgh, 2011; Andrés & Asongu, 2013ab; Andrés et al., 2014; Asongu, 2013a); spatiality in knowledge production (Bidwell et al., 2011; Neimark, 2012) and KE in the transformation of space (Moodley, 2003; Maswera et al., 2008).

The above narratives are also predominantly motivated by the need for greater emphasize on KE-based research that focuses on strategies towards bridging the gaps between benchmark countries (AfDB, 2007; Bizri, 2009; Aubert, 2005; Britz et al., 2006; Chavula, 2010 ; Makinda, 2007; Lightfoot, 2011). To the best of our knowledge, there is yet no African KE study that has addressed this concern with respect to benchmark Newly Industrialized Asian countries. The present paper aims to investigate the gaps in KE between Africa and South Korea. Based on assessed gaps, we provide recommendations from resulting catch-up policy syndromes. The

updated dataset (1996-2010) essential for fresh policy measures also enables us to examine if the impressive growth experienced by some African countries during the past decade has been accompanied by similar patterns of catch-up in KE dimensions relative to South Korea.

In line with Suh & Chen (2007), the dramatic economic prosperity experienced by South Korea since the 1960s that enabled it to emerge from a low-income country to a high-income industrialized nation could substantially be attributed to the accumulation of knowledge rather than to traditional factors of labor and capital in production. According to the narrative, Korea was able to achieve this knowledge-oriented prosperity by: heavily investing in training and education; developing accessible and modern information infrastructure; using intensive research & development (R&D) to boost innovation; focusing on economic incentives and a favorable institutional regime that were conducive to boosting knowledge-oriented investments. In this light, the country has been able to use KE as an engine for growth: an experience that could offer lessons for developing countries, especially frontier African nations that were at the same development threshold as the core country in the 1960s.

The Korea-Africa relationship is a relatively little studied nexus in contemporary development literature (Kim, 2013; Tchamyou, 2014). This is probably due to the skepticism about South Korea as a role model of development for other countries[2]. However recent evidence suggests that the core country can serve as a role model of development for other emerging countries, particularly in terms of KE (Lee, 2009). By using the South Korean KE experience are a core model for frontier African countries, the paper also extends a recent stream of studies on 'achieving development success: strategies and lessons from the developing world' (Fosu, 2013a; Lee, 2013; Jomo & Wee, 2013; Warr, 2013; Thoburn, 2013; Khan, 2013; Singh, 2013; Yao,

[2] "*There is some scepticism about Korea as role model of development as the Korean model involved a considerable degree of state activism, unacceptable in today's global environment*" (Lee, 2009, p.1).

2013; Santos-Paulino, 2013; Asongu & Aminkeng, 2013; Robinson, 2013; Subramanian, 2013; Lundahl & Petersson, 2013; Fosu, 2013b; Naudé, 2013; De Mello, 2013; Solimano, 2013; Trejos, 2013; Pozo et al., 2013; Cardoso, 2013; Looney, 2013; Baliamoune-Lutz, 2013; Nyarko, 2013b & Drine, 2013).

In light of the above, by positioning this paper on the important development concern of KE and the relatively little investigated Korean-African nexus; this study contributes to existing literature by addressing the following policy issues. First, the paper provides a KE diagnosis on the current growth situation and prospects of frontier African countries by: investigating the KE gaps in relation to a core country (South Korea) and; providing compelling catch-up policies to bridge the KE gaps. Second, the study also presents a unique opportunity of examining whether the impressive growth experienced over the last decade by African countries has moved hand-in-hand with identical catch-up trends in KE, relative to South Korea. Third, in response to a growing strand of studies on the need for KE as the main axis of future development (Makinda, 2007; Lightfoot, 2011), a comparison with South Korea is ideal in understanding growth prospects of Africa. Accordingly, very practical policy lessons are offered to African countries already embarking on the route to KE. Fourth, the decomposition of frontier countries into fundamental characteristics of income levels, legal origins, openness to sea, political stability, natural resources and regional proximity, enable comparative insights for more focused policy implications.

The intuition and theoretical motivations underpinning this KE catch-up are typically in line with cross-country income convergence literature substantially documented within the framework of neoclassical models growth and recently extended to other fields of economic development (Swan, 1956; Barro, 1991; Mankiw et al., 1992; Solow, 1956; Baumol, 1986; Barro & Sala-i-Martin, 1992, 1995; Narayan et al., 2011; Andrés & Asongu, 2013ab; Fung, 2009 ;

Mayer-Foulkes, 2010; Bruno et al., 2012; Asongu, 2014abc, 2013abc). In this light, the theoretical underpinnings have been used in the harmonization/timing/modeling of: intellectual property rights (IPRs) on software piracy (Asongu, 2013a; Andrés & Asongu, 2013b), common measures in the fight against capital flight (Asongu, 2014d, 2013d), the future of KE (Asongu, 2013e,f,g); as well as the health of currency areas and financial markets (Narayan et al., 2011; Bruno et al., 2012; Asongu, 2013b, 2014b; Asongu, 2013ch, 2014c).

The World Bank's four dimensions of the Knowledge Economy Index (KEI) are employed, notably: information & communication technology (ICT), innovation, economic incentives & institutional regime and education. This employment of a plethora of KE dimensions is essentially motivated by the fact that existing literature has focused only on one or a few KEI components (Aubert, 2005; Britz et al., 2006; AfDB, 2007; Bizri, 2009). The empirical evidence is based on 13 panels. Accordingly, because of the richness of the dataset, we are able to disaggregate countries into fundamental characteristics of KE based on income-levels, legal origins, petroleum-exporting, openness to sea, political stability and regional proximity. Three main issues are investigated between the homogenous panels and South Korea: KE gaps or evidence of catch-up, the speed or rate of catch-up and the corresponding time needed for full catch-up. To ensure robustness in the assessments, both *sigma* and *beta* catch-up empirical strategies are employed. Based on the findings of the three concerns assessed, we are able to provide catch-up policies necessary to bridge the KE gaps.

Beside specific policy recommendations that would emerge from the catch-up estimations, we are comfortable that four main categories of policy implications would emerge from the proposed study. First, the presence or not of catch-up informs policy makers on the various KE gaps vis-à-vis South Korea. Second, decomposing Africa into fundamental characteristics (legal origins, income-levels…etc), provides the analytical subtlety needed for

more targeted policy implications. Third, the rate of convergence and time needed for full convergence inform policy makers about the urgency of measures needed for bridging the KE gaps. Fourth, common catch-up trends among fundamental characteristics are relevant in informing policy on the effectiveness of current regional integration efforts in the investigated KE dimensions.

The rest of the study is organized as follows. Section 2 reviews existing literature. Data and methodology are discussed in Section 3. Section 4 covers the empirical analysis, discussion of results and policy implications. We conclude with Section 5.

2. Knowledge Economy in Africa and the South Korean Development Model

2.1 Knowledge Economy in Africa

The present extant of literature on African KE can be summarized into eleven main strands: general discourses on KE, education, ICT, innovation, institutional regime & economic incentives, intellectual capital & economic development, indigenous knowledge systems, R&D, IPRs, spatiality in knowledge production and, KE in the transformation of space (Tchamyou, 2014).

The first strand concerns the general discourses about KE. Rooney (2005) had earlier analyzed the dominant discourses on knowledge, society, technology and economy to conclude that they are limited in various dimensions, inter alia: KE understanding and technocracy. Lin (2006) has criticized the mainstream growth-focused exposition of KE by rethinking the KE-growth relationship and providing other important or neglected dimensions: the relevance of knowledge in facilitating equality in wealth and environmental conservation. Anyanwu (2012) has recently assessed the state of knowledge in Africa with the perspective of indentifying key

constraints and concluded that the continent does not compare well with advanced countries and other regions. According to the narrative, the KEI for the continent fell between 2000 and 2009.

In the second strand on education, Ford (2007) has assessed Africa's stance on the information highway and documented the state and critical challenges on the continent in the digital age. Amavilah (2009) examines the production and value of doctoral dissertations and establishes that more investment is needed in the production of knowledge in the continent. Chavula (2010) investigates the role of knowledge in economic prosperity and concludes that African governments need to put more energy in KE promotion. Weber (2011) concludes that education ends illiteracy, preserves cultural integrity and diversifies the economy; after assessing the relevance of education in the KE of developing countries. The appealing effect of education on externalities in human capital is investigated by Wantchekon et al. (2014). Asongu (2013f) examines the future of scientific monopoly after the publication of the August 15th 2013 Shanghai university rankings to conclude that African countries are not catching-up with advanced nations.

The third strand on ICT is motivated by the African Partnership Forum's (2008) report which suggests that Africa is on the move and ICTs are essential in mitigating poverty and boosting economic prosperity. According to the narrative, ICTs improve efficiency, create novel opportunities for generating income, provide a voice to the poor, enable access to services or new markets and ameliorate governance. This stream of thought is broadly consistent with Chavula (2010) and Butcher (2011).

On innovation in the fourth strand, Oyelaran-Oyeyinka & Gehl Sampath (2007) in their assessment of 'innovation in African development' have recognized the phenomenon as a major source of modern growth in productivity and prosperity of nations. Carisle et al. (2013) after investigating innovation for tourism concludes that institutions have a predominant mission in sustaining best practices, transfer of knowledge and networking. In substance, the need for

innovation for development in the continent has been consistently raised in recent streams of KE literature (Anyanwu, 2012; Asongu, 2013eh).

Institutional regime & economic incentives which make-up the fourth KE pillar constitute the fifth strand. Cogburn (2003) in trying to understand the transition in regimes of international telecommunications has provided insights into lessons and best practices for other emerging countries. Letiche (2006) has used behavioral economics to understand the success of economic transitions and presented an interesting analysis on the transition economies with different traditions, customs…etc. Andrés et al. (2014) have recently assessed the relevance of formal institutions in African KE and concluded that with the instrumentality of IPRs, institutions are not a sufficient condition for KE. Andrés & Asongu (2013a) conclude that corruption-control is the most effective institutional mechanism in the fight against piracy. Surplus liquidity issues in African financial institutions have also been documented as one of the cause of slow economic activity (Saxegaard, 2006; Nguena & Tsafack, 2014).

The sixth strand on 'intellectual capital & economic development' is mainly concerned with information disclosure and lifelong learning. Wagiciengo & Belal (2012) have engaged in an investigation of intellectual capital disclosure and concluded that the disclosure of intellectual capital is on the rise in African corporations. Preece (2013) has substantially discussed the nexus between an international ambition for lifelong learning and development assistance to poor countries and established that priorities in international aid have a negative incidence on how government policies and choices impact lifelong learning.

'Indigenous knowledge systems' is the focus of the seventh strand. Roseroka (2008) has investigated how to salvage the indigenous knowledge space and presented a case for the relative advantage in oral knowledge. Lwoga et al. (2010) apply knowledge management approaches to

indigenous KE and conclude that the former can be used to manage the latter if distinct characteristics are accounted for.

The eighth strand embodies R&D. Sumberg (2005) has examined the progress on the international architecture of agricultural research and concluded that the global systems of research are at odds with the realities of African research. German & Stroud (2007) investigate the application and understanding of R&D and present lessons, types, as well as implications of learning approaches. In summary, the plethora of recent African KE literature has been consistent on the need to invest more in R&D (African Development Bank, 2007; Chavula, 2010; Anyanwu , 2012) especially to mitigate Western monopoly in scientific publications (Asongu, 2013fg).

The interesting stream of IPRs is covered in the ninth strand. Zerbe (2005) in investigating the African Union's Legislation for the protection of Indigenous knowledge has concluded that it satisfies the requirements and needs of African countries by balancing the monopoly rights of breeders with those of the indigenous population. Lor & Britz (2005) examine the trends in knowledge as well as their incidence on the international flow of information and establish three ethical pillars to elucidate the flow: common good, social justice and human rights. Myburgh (2011) reviews legal processes in the protection of plant-oriented digital know-how and presents the perspective of an IPRs lawyer on recent variations in the protection of plant-based traditional knowledge. Asongu (2013a) and Andrés & Asongu (2013b) have presented timelines for the harmonization of IPRs in Africa and globally respectively. Based on the instrumentality or enforcement of IPRs, Andrés & Asongu (2013a) have established that corruption is the best tool in fighting software piracy whereas, Andrés et al. (2014) conclude formal institutions are not sufficient mechanisms for KE.

On the spatiality of knowledge production in the tenth strand, Bidwell et al. (2001) have worked on how to adapt technology to rural community heritages and needs. They provide

valuable insights into the manner in which a rural community temporarily and spatially manages information. Neimark (2012) investigates the political economy of bio-prospecting and documents changes of the phenomenon in Madagascar.

Finally, the last but not the least strand focuses on KE in the transformation of space. Moodley (2003) examines the relevance of electronic (e)-business in the apparel sector of South Africa: discussing the opportunities, challenges and risks of e-business in the sector. Maswera et al. (2008) on their part investigate the degree by which e-commerce is being adopted in the tourism organization and conclude that, though websites in Africa are informative, they are deficient of interactive facilities for e-transactions.

The eleven interesting strands above could be summarized into one sentence: the need for greater emphasis on KE in Africa as a development strategy: a South Korean model.

2.2 South Korea as a Knowledge Economy and Development Model

Consistent with Suh & Chen (2007) and Tchamyou (2014), the South Korean republic has experienced one of the most spectacular growths in the 20th century, starting as a low-income nation in the 1950s to an industrialized OECD economy by the turn of the century. While a development strategy that clearly articulated knowledge was not apparent, development in the economy critically hinges on interactions between the four dimensions of the World Bank's KEI, notably: innovation, education, ICT, economic incentives & institutional regime. Characteristics of the development model included, inter alia: human resource development fortified with technological capacity building and intensive learning processes, proactive leadership by government in providing sustaining and fostering transformations, promotion of export- and

import- substitution industries…etc. South Korea has often been used as a development model for Africa because it lagged behind most African countries even before the 1980s[3].

Consistent with Lee (2009) and Lee & Kim (2009), Korea can be used as a model for African countries because it has achieved so far one of the most successful rapid economic prosperities in recent history: from approximately 160 USD in per capita income in 1960 to about 20000 USD per capita GDP in 2007. According to the narrative, because of the skepticism over whether Korea could serve as a model for other developing nations, earlier literature focused on the mission of market versus government in catch-up processes (Amsden 1989; Chang 1994; World Bank 1993). This has been parallel to another stream of literature contending that Korea has been catching-up by assimilating and adapting to seemingly obsolete technology from advanced countries (Utterback, 1975; OECD, 1992; Hobday, 1995; Dahlman et al., 1985; Andrés & Asongu, 2013a; Andrés et al., 2014; Asongu, 2013g, 2014g).

Consistent with Andrés et al. (2014), the ongoing debate about the 'East Asian miracle' has been on 'governing the market' and/ 'soft authoritarian' concepts. It is based on the fact that certain politico-economic conditions (especially in South Korea) have been conducive for the miracle. This narrative also sustains that some scholars advocate the miracle might have resulted from the low enforcement of IPRs at the early stages of development (Bezmen & Depken, 2004). This is consistent with the recent findings of Kim et al. (2012) who have concluded that the protection of patent is instrumental in innovation, with patentable innovation contributing to economic prosperity in developed, but not in developing countries (Kim et al., 2012). On the other hand, other authors have argued that there is nothing to be miraculous about the East Asian

[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).

miracle (Lucas, 1988, 1993). A recent strand of KE literature has been substantially devoted to analyzing this miracle in the context of Africa. Notably: the enforcement of IPRs through governance channels not being a sufficient condition for KE in Sub-Saharan Africa (SSA) and Middle East & North African (MENA) countries (Andrés et al., 2014); timelines for the fight against piracy (Asongu, 2013a; Andrés & Asongu, 2013b); corruption as the greatest fuel to software piracy and hence deterrence to the potential for KE (Andrés & Asongu, 2013da); how IPRs matter in the KE-finance nexus (Asongu, 2013h); the future of KE (Asongu, 2013e) & catch-up in scientific publications (Asongu, 2013fg); dynamics of financial sector competition & KE (Asongu, 2014ef); how legal origins & IPRs protection channels matter in fight against piracy (Asongu, 2014g); the pro-poor character of software piracy (Asongu, 2014h), inter alia.

In the catch-up literature specifically positioned on South Korea, Lee (2009) has debunked the skepticism surrounding the Korean experience as a model for other developing countries by arguing that capacity building, standard trade openness and devaluation cannot result in sustained catch-up because they grease short-run and temporary booms for the most part. The study has analyzed the manner in which Korea made use of various access modes to knowledge and learning in order to boost technological capabilities. The author has concluded that the Korean lessons are transferable to other countries, thus confirming an earlier report that recommended the Korean model to other developing countries (Suh & Chen, 2007). The present study is therefore a response to the above recommended future research directions.

The paper is also an extension of a recent stream of studies on 'achieving development success: strategies and lessons from the developing world' (Fosu, 2012, 2013a) and learning from the past (Fosu, 2010). The recent stream of papers has focused on: South Korea, Malaysia, Thailand and Vietnam in East Asia & the Pacific (Lee, 2013; Jomo & Wee, 2013; Warr, 2013; Thoburn, 2013; Khan, 2013); the emerging Asian giants of China & India (Singh, 2013; Yao,

2013; Santos-Paulino, 2013; Asongu & Aminkeng, 2013); sub-Saharan Africa with examples of Botswana, Mauritius, Ghana and South Africa (Robinson, 2013; Subramanian, 2013; Lundahl & Petersson, 2013; Fosu, 2013b; Naudé, 2013); Latin America & the Caribbean in which emphasis is placed on Brazil, Costa Rica, Chile and the Dominican Republic (De Mello, 2013; Solimano, 2013; Trejos, 2013; Pozo et al., 2013; Cardoso, 2013) and; the MENA region with analyses from Oman, Bahrain, Tunisia and the United Arab Emirates (Looney, 2013; Baliamoune-Lutz, 2013; Nyarko, 2013b; Drine, 2013).

Starkly contrasting with the skeptical strand on lessons for developing countries (Lucas, 1988, 1993; Lee, 2009), a common denominator to studies in the preceding paragraph is the position that compelling lessons could be conditionally drawn from other success developing countries. In other words, every developing success story has a dimension. Consistent with Fosu (2013a), they portray a substantial diversity in development strategies, inter alia: the 'disinterested-government' political economy of China; the high-sector and democratically based Indian development approaches; reforms in China & Ghana based on the 'Washington-Consensus'; the strategies of diversification in Bahrain, the United Arab Emirates (UAE) & Oman; the optimal natural-resource management strategies of the UAE, Oman, Botswana & Bahrain; the social-sector development programs underpinning progress in Tunisia & Costa Rica; the democratic political system of diversity management in India and; the dynamic orthodox-heterodox strategy in Vietnam & Malaysia. Inspired by above narratives, this paper is positioned on the KE success story of South Korea with particular emphasis on Africa.

3. Data and methodology

3.1 Data

We examine 53 African countries with data from Principal Component Analysis (PCA) and World Development Indicators for the period 1996-2010. The investigated interval begins from 1996 because government quality indicators essential for the institutional regime component of KE are not available before this year. The KE variables that are obtained from the former source are consistent with recent literature (Andrés et al., 2014; Andrés & Asongu, 2013b; Asongu, 2014efg). These KE variables include: innovation, ICT, education and, economic incentives & institutional regime. We devote space to discussing the determination of fundamental characteristics in frontier African countries. These include: legal origins (English common law versus (vs) French civil law), income-levels (low- vs middle-income), openness to sea (landlocked vs not landlocked), political stability (conflict-affected vs stability), regional proximity (sub-Saharan Africa vs North Africa) and natural resources (petroleum vs non-petroleum exporting) countries. The fundamental characteristics are in accordance with recent KE literature (Asongu & Andrés, 2013b).

First, the basis of legal origin has foundations on the substantially documented evidence of colonial legacy on openness, education & economic growth (Agbor, 2011), institutional quality (La Porta et al., 1998, 1999) and adaptation to changes in economic conditions (Beck et al., 2003). Agbor (2011) has recently documented that in Africa, English common law countries have a better educational system and economic incentives that have given them an edge in economic prosperity over their French civil law counterparts. In terms of institutional quality (or regime), the edge of English common law documented in pioneering law-finance literature (La Porta et al., 1998, 1999) has been recently confirmed in the African continent (Asongu, 2012ab). The underlying intuition for this categorization is that informal rules, formal norms and

enforcement measures influence an institutional regime are necessary for KE. This narrative has a consensus that whereas French civil law places more emphasis on the power of the State, private property rights that are needed for KE is prioritized by English common law. The classification of countries in this dimension is in line with La Porta et al. (2008, p. 289).

Some practical issues could arise when classifying the 'conflict-affected' category. This is essentially because; it is not easy to assign a country to this strand in exclusive and non arbitrary manner. Some distinctions have to be made on the degree of significance and periodicity of instability because a country cannot be completely conflict-free. Hence, this strand is presented in two-groups. The first 'civil war' group entails: Burundi (1993-2005), Chad (2005-2010), Angola (1975-2002), Côte d'Ivoire (1999 coup d'état, 2002-2007 civil war, rekindled in 2011), Sierra Leone (1991-2002), Central African Republic (the wave of aborted coup d'états between 1996-2003 and the 2004-2007 Bush War), Congo Democratic Republic, Liberia (1999-2003), Sudan and Somalia. On the second group, despite the absence of formal characteristics of civil war, we include Zimbabwe and Nigeria due to the seriousness of internal strife. From logic and common sense, severe conflict and political strife inhibit a favorable KE environment.

Third, in selecting petroleum-exporting countries two issues arise. On the one hand, a country could qualify only for part of the investigated periodicity either because of a recent oil discovery or substantial decline in production. On the other hand, some countries (e.g Botswana) have macroeconomic characteristics that are similar to those of oil-exporting countries. To tackle these constraints, we select only countries for which exports have been oil-dominated over the last decade and take a minimalistic approach in the categorization by adopting only oil-resource countries. These include: Angola, Algeria, Chad, Cameroon, Congo Republic, Gabon, Equatorial Guinea, Nigeria, Libya and Sudan.

Fourth, two main reasons motivate the dimension of wealth-effects with income-levels. On the one hand, economic prosperity should come with higher opportunities for KE; and on the other hand, the wealth of African nations has been documented to be instrumental in institutional quality necessary for KE (Asongu, 2012c). Consistent with Asongu (2014i), we use the Financial Development and Structure Database (FDSD) of the World Bank for the classification of wealth into low- and middle- income countries.

Fifth, the distinction between North and sub-Saharan African countries has two premises. On the one hand, proximity to Europe is likely to influence the drive towards KE. On the other hand, in accordance with Boyce & Ndikumana (2008), the distinction is consistent with the World Bank's regional classification in terms of policy implications.

Sixth, 'openness to sea' should provide a relative KE advantage, such that landlocked countries incur higher costs to competition and openness, essential to KE. This is also in accordance with the institutional price of being landlocked (Arvis et al., 2007). Conversely, landlockedness could predispose certain countries to devote more efforts towards developing KE (e.g Rwanda).

It is important to note that in the categorization of frontier KE African countries, some nations could qualify for more than one category. In contrast to Weeks (2012), we have not imposed any constrains on categorical priority such that, a country may fall into as many categories as possible so long as it is consistent with the categorical features. Appendix 4 summarizes the categorization of frontier African countries discussed above. Variables are defined in Appendix 1, the summary statistics presented in Appendix 2 and the correlation matrix displayed in Appendix 3.

3.2 Methodology

The first step in the empirical strategy consists of reducing the dimensions of the KE indicators with principal component analysis (PCA) discussed in Section 4.1 below. The KE gaps are then assessed by means of sigma and absolute beta convergence strategies. Based on the latter estimations, we provide rates of catch-up and timelines for complete (full) catch-up. The former enables us to drive policy syndromes based on which catch-up strategies are recommended. But before we dive into the empirical analysis, it is worthwhile to justify the choice of the estimation strategies.

Borrowing from Asongu (2014a), there are substantial differences in ways in which convergence can be studied. Notably, convergence across economies versus (vs) convergence within an economy; convergence in terms of income vs. convergence in terms of economic growth; TFP (total factor productivity) convergence vs. income convergence; stochastic convergence vs. deterministic convergence; sigma convergence vs. beta convergence; local or club-convergence vs. global convergence; absolute (unconditional) vs. conditional convergence (Islam, 2003).

There is some nexus between the highlighted definitions of convergence and the corresponding methodologies employed. This correspondence is not particularly unique since some have all employed beta convergence either conditionally or unconditionally (panel, time series, cross-sectional, informal & formal approaches). Most of the approaches have been oriented towards cross-economy per capita income convergence. In addition, the formal panel and cross-sectional approaches have been employed to investigate TFP and club convergence. The time series strategy has also been employed to assess both across- and within-economy convergence. The cross-sectional strategy has been used for sigma-convergence whereas the

distribution measurement has been employed beyond the former and has assessed the whole shape of distribution and intra-distribution dynamics.

The basic premise of income convergence is based on the assumption of decreasing returns which represent higher marginal productivity in capital-poor nations. Consistent with this narrative, poor countries would grow faster and a negative nexus between the subsequent growth rate and the initial income levels reflect the scenario. This form of convergence is beta convergence. However, as a draw-back of this approach, a negative beta from the initial growth levels is not necessarily synonymous to a reduction in dispersion. This shortcoming has given birth to the notion of sigma-convergence which is an assessment of cross-sectional standard deviations across time. While absolute beta convergence does not depend on country-specific characteristics, conditional beta convergence is contingent on these characteristics. Hence the latter form of beta convergence has two critical shortcomings. On the one hand, the specification is substantially reliant on the conditionality of variables that are chosen for the model, which in certain situations may not reflect all the variables needed for the form of convergence to take place. On the other hand, the possibility of multiple equilibria since every nation could converge to its own long-term equilibrium or steady state (Asongu, 2014a: Monfort, 2008, p. 4-5). In light of the above, the empirical strategies adopted in this paper are absolute beta convergence and sigma convergence. The absolute beta approach is based on yearly averages and means of fundamental characteristics for two reasons: enable comparison with sigma convergence and avoid misspecification in catch-up among frontier countries. The latter point is very important because without usage of fundamental characteristics' means, the convergence could be among frontier countries within a given homogenous panel and not with the core South Korean country. Hence, the empirical strategy may not calibrate the problem statement.

4. Empirical Analysis

4.1 Principal Component Analysis

Consistent with Asongu (2013eh, 2014ef), constituent components of the World Bank's Knowledge Economy Index (KEI) may be correlated with each other. Hence, due to the high degree of substitution among the constituent components, some information is redundant. We tackle the issue by using principal component analysis (PCA) in order to reduce the dimensions of the variables into a single indicator for each component. The PCA is a widely employed empirical strategy that consists of reducing a set of highly correlated variables into a smaller set of uncorrelated indicators called principal components (PCs) that represent a significant variation in or information from the initial set of indicators. The criterion employed to retain a common factor is consistent with Kaiser (1974) and Jolliffe (2002) who have recommended stopping at factors with an eigenvalue greater than the mean (or one). This eigenvalue corresponds to the eigenvector that represents a significant proportion of the initial information.

Table 1 below shows PCA in KE components for African frontier countries (Panel A) and the South Korean core country (Panel B). PCAs are needed for both frontier and core countries to illustrate that based on the eigenvalues (reflecting the vectors), the KE dimensions are comparable. In Panel A for instance, ICTex which is the first PC for ICT represents about 73% of information in constituent elements (internet, mobile & telephone) and has an eigenvalue of above one (2.190). This is comparable with a corresponding 80% in Panel B.

Table 1: Principal Component Analysis (PCA) for KE Indicators

Panel A: PCA for Frontier countries (Africa)

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

Panel B: PCA for the Core country (South Korea)

Knowledge Economy dimensions		Component Matrix (Loadings)						First PC	Eigen Value	Indexes
Education	School Enrolment	PSE		SSE		TSE				
		-0.359		-0.675		0.645		0.688	2.065	Educatex
Information & Infrastructure	ICTs	Internet		Mobile		Telephone				
		0.612		0.625		0.484		0.800	2.400	ICTex
Innovation System	Innovation	STJA		Trademarks		Patents				
		0.576		0.573		0.582		0.946	2.839	Innovex
Economic Incentive & Institutional regime	Economic Incentive	Private Credit				Interest rate Spread				
		0.707				0.707		0.682	1.365	Creditex
	Institutional index	VA	PS	RQ	GE	RL	CC			
		0.453	-0.064	0.487	0.460	0.458	0.364	0.664	3.985	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 PC of Private domestic Credit and Interest rate spread.

4.2 Knowledge Economy Gaps

4.2.1 Absolute Beta Convergence

4.2.2.1 Catch-up specification

The two equations below are the standard procedures for estimating convergence (Fung, 2009).

$$\ln(Y_{i,t}) - \ln(Y_{i,t-\tau}) = \beta \ln(Y_{i,t-\tau}) + \delta W_{i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \qquad (1)$$

$$\ln(Y_{i,t}) = a\ln(Y_{i,t-\tau}) + \delta W_{i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \qquad (2)$$

Where $a = 1+ \beta$, $Y_{i,t}$ is the measure of a KE dimension in country *i* at period *t*. $W_{i,t}$ is a vector of determinants of KE, η_i is a country-specific effect, ξ_t is a time-specific constant and $\varepsilon_{i,t}$ an error term. In line with the exogenous growth theory, a statistically negative coefficient of β in Eq. (1) suggests that countries comparatively close to their equilibrium or steady-state in KE will experience a slowdown in KE, known as beta convergence (Narayan et al., 2011, p. 2773). In the same vein, consistent with Fung (2009, p. 59), if $0 < |a| < 1$ in Eq. (2), then $Y_{i,t}$ is stable dynamically around the path with a growth rate in trend the same as that of W_t, and with a corresponding height relative to the level of W_t (Asongu, 2014a). The proxies contained in $W_{i,t-\tau}$ and the individual-effect η_i measure for the long-run level KE is converging to. Accordingly, the country-specific effect η_i measures other determinants of a country's equilibrium not captured by $W_{i,t-\tau}$. For convergence to take place $W_{i,t}$ must be strictly exogenous. Unfortunately, it is not always the case and a means of correcting the problem between some potential correlation between the lagged endogenous variables and the individual-specific effect involves eliminating the latter by first differencing.

Hence, Eq. (2) becomes:

$$\ln(Y_{i,t}) - \ln(Y_{i,t-\tau}) = a(\ln(Y_{i,t-\tau}) - \ln(Y_{i,t-2\tau})) + \delta(W_{i,t-\tau} - W_{i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \qquad (3)$$

A means of further dealing with the correlation between the lagged endogenous variable and the error term consists of regressing the equations in levels jointly with the equations in first difference in order to exploit all the orthogonality conditions. The process uses lagged differences of the regressors as instruments in the levels equation and lagged levels of the regressors as

instruments in the difference equation. Consistent with Bond et al. (2001, pp. pp. 3-4)[4], we prefer the system GMM estimator (Arellano & Bover, 1995; Blundell & Bond, 1998) to the difference GMM specification (Arellano & Bond, 1991). A *two-step* procedure is also preferred to a *one-step* specification because it accounts for heteroscedasticity.

Since yearly intervals are not appropriate for investigating catch-up because short-run disturbances may loom substantially large, we use 3 year non-overlapping intervals (NOI). Hence, τ is set to 3. Therefore in order to compute the implied catch-up rate, we calculate 'a/3' or '1+β/3' because we have used 3 NOI to mitigate short-run disturbances. For convergence to take place, the following information criterion is needed: $0 < |a| < 1$ or β<0. We choose the former to avoid too much arithmetic gymnastics[5]. With the absolute value of the lagged coefficient less than one but greater than zero ($0 < |a| < 1$), the existence of catch-up can be confirmed. A general interpretation consistent with the neoclassical growth model is as follows: past variations have a less proportionate incidence on future variations. Hence with the left hand side of Eq. (3) decreasing with time, the country is approaching equilibrium or a steady-state. The Sargan over-identifying restrictions (OIR) test and second-order Arellano & Bond autocorrelation (AR(2)) test are used to assess the validity of the instruments and absence of autocorrelation in the residuals respectively.

---

[4] "*We also demonstrate that more plausible results can be achieved using a system GMM estimator suggested by Arellano & Bover (1995) and Blundell & Bond (1998). The system estimator exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series, and it has been shown to perform well in simulations. The necessary restrictions on the initial conditions are potentially consistent with standard growth frameworks, and appear to be both valid and highly informative in our empirical application. Hence we recommend this system GMM estimator for consideration in subsequent empirical growth research*". Bond et al. (2001, pp. 3-4).

[5] To put our point into perspective, consistent with Asongu (2014a) the estimated lagged value of a standard dynamic GMM approach is a from which 1 is subtracted to obtain β (β= a-1). Under this scenario, the information criterion for *beta*-convergence is $\beta < 0$. Hence, in order to limit the arithmetical gymnastics, a could be reported and the $0 < |a| < 1$ information criterion used to determine convergence. This is interpretation is in line with recent convergence literature (Prochniak & Witkowski, 2012a, p. 20; Prochniak & Witkowski, 2012b, p. 23; Asongu, 2013a, 2014a).

4.2.2.2 Presentation of absolute beta catch-up results

Three main issues are assessed in this section: (1) the presence of catch-up; (2) the speed of catch-up and; (3) the time required for full catch-up. Table 2 below summarizes the findings of Table 3. Owing to the shortcomings discussed in the methodology section on conditional beta catch-up, we only model absolute beta catch-up. Hence, absolute (or unconditional) convergence has been estimated with only the lagged difference of the dependent variable as independent variable. In other words, absolute catch-up is modeled without $W_{i,t}$.

To investigate the validity of the estimation and indeed the catch-up hypothesis, two tests have been performed to validate the models: the Sargan OIR and AR(2) tests. The latter assesses the null hypothesis of no autocorrelation in the residuals whereas the former investigates the null hypothesis for the absence of correlation between the error terms and the residuals. Hence, failure to reject the null hypotheses of both tests is essential for the validity of the models. Based on the findings presented in Table 3, the null of both tests are overwhelmingly rejected.

Before discussing the results, we devote some space to elucidating how the numbers in Table 2 have been obtained. For an estimated initial value of 0.49 that is consistent with the information criterion ($0 < |a| < 1$), the rate of catch-up is 16.33% per annum (0.49/3) and the period needed to achieve full or 100% catch-up is 18.37 years (300%/16.33%).

In the summary of the results presented in Table 1 below, the following could be established between African frontier countries and the South Korean core country. First, with the exception of ICT where no catch-up is apparent, in increasing order it is visible in: innovation, economic incentives, education and institutional regime. Second, the essence of using fundamental characteristics is sound, since there is evidence of wealth-effects, legal-origin effects…etc, in KE catch-up patterns (e.g Education). The speed of convergence varies between

8.66% per annum (Nonoil in Economic incentive dimension) and 30.00% (Innovation dimension) with respective time to full or 100% convergence of 34.64 years and 10 years.

Table 2: Summary of results

Panel A: Education (Educatex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Catch-up(C)	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Rate of C (%)	16.33	---	18.33	---	---	15.00	12.00	16.66	14.33	16.33	14.66	---	17.83
Time to FC (Yrs)	18.37	---	16.36	---	---	20.00	25.00	18.00	20.93	18.37	20.46	---	16.82

Panel B: Information & Communication Technology (ICTex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Catch-up(C)	No	No	No	No	No	No	No	No	No	No	No	No	No
Rate of C (%)	---	---	---	---	---	---	---	---	---	---	---	---	---
Time to FC (Yrs)	---	---	---	---	---	---	---	---	---	---	---	---	---

Panel C: Innovation (Innovex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Catch-up(C)	No	No	No	No	Yes	No	Yes	No	Yes	No	No	No	No
Rate of C (%)	---	---	---	---	30.00	---	30.00	---	29.33	---	---	---	---
Time to FC (Yrs)	---	---	---	---	10.00	---	10.00	---	10.22	---	---	---	---

Panel D: Institutional Regime (Instireg)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Catch-up(C)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rate of C (%)	15.33	16.66	15.00	15.66	11.66	13.66	16.33	17.00	18.00	16.33	17.33	17.33	13.00
Time to FC (Yrs)	19.56	18.00	20.00	19.15	25.72	21.96	18.37	17.64	16.66	18.37	17.31	17.31	23.07

Panel E: Economic Incentives (Creditex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Catch-up(C)	No	No	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Rate of C (%)	---	---	---	12.00	---	8.66	19.00	14.66	17.00	---	12.66	20.00	---
Time to FC (Yrs)	---	---	---	25.00	---	34.64	15.78	20.46	17.64	---	23.69	15.00	---

Low: Low Income countries. Middle: Middle Income countries. English: English Common law countries. French: French Civil law countries. Oil: Petroleum Exporting countries. NoOil: Non-petroleum Exporting countries. Closed: Landlocked countries. Open: Countries open to the sea. Conf: Conflict Affected countries. NoConf: Countries not Affected by Conflicts. SSA: Sub-Saharan Africa. NA: North Africa. C: Catch-up. FC: Full Catch-up. Yrs: Years.

Table 3: Dynamic System GMM

Panel A: Education (Educatex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Initial	**0.49*** **	-0.164	**0.55*** **	0.688	0.530	**0.45*** **	**0.36*** **	**0.50*** **	**0.43*** **	**0.49*** **	**0.44*** **	-6.575	**0.53** **
	(0.001)	(0.876)	**(0.003)**	(0.240)	(0.608)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.129)	**(0.022)**
AR(2)	**(0.745)**	**(0.837)**	**(0.330)**	**(0.228)**	**(0.480)**	**(0.177)**	**(0.307)**	**(0.281)**	**(0.303)**	**(0.252)**	**(0.229)**	n.a	**(0.418)**
Sargan	**(0.996)**	**(0.995)**	**(0.992)**	**(0.988)**	**(0.987)**	**(0.998)**	**(0.999)**	**(0.992)**	**(0.999)**	**(0.993)**	**(0.995)**	**(1.000)**	**(0.990)**
Wald	**10.2*** **	0.024	**8.48*** **	1.377	0.262	**120*** **	**72.3*** **	**23.0*** **	**31.8*** **	**24.1*** **	**59.0*** **	**2.300**	**5.23** **
	(0.001)	(0.876)	(0.003)	(0.240)	(0.608)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.129)	(0.022)

Panel B: Information & Communication Technology (ICTex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Initial	0.536	0.973	0.797	0.668	0.743	0.686	0.522	0.785	0.549	0.763	0.619	1.227	0.736
	(0.166)	(0.448)	(0.244)	(0.295)	(0.444)	(0.175)	(0.128)	(0.337)	(0.183)	(0.277)	(0.129)	(0.493)	(0.487)
AR(2)	**(0.356)**	**(0.337)**	**(0.342)**	**(0.360)**	**(0.353)**	**(0.356)**	**(0.354)**	**(0.351)**	**(0.359)**	**(0.348)**	**(0.358)**	**(0.312)**	**(0.301)**
Sargan	**(0.981)**	**(0.982)**	**(0.988)**	**(0.988)**	**(0.963)**	**(0.978)**	**(0.982)**	**(0.986)**	**(0.980)**	**(0.972)**	**(0.981)**	**(0.982)**	**(0.965)**
Wald	1.914	0.575	1.357	1.092	0.584	1.838	2.313	0.921	1.766	1.177	2.299	0.468	0.483
	(0.166)	(0.448)	(0.244)	(0.295)	(0.444)	(0.175)	(0.128)	(0.337)	(0.183)	(0.277)	(0.129)	(0.493)	(0.487)

Panel C: Innovation (Innovex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Initial	0.064	0.193	**1.22*** **	0.302	**0.90*** **	-0.162	**0.90*** **	0.338	**0.88*** **	0.318	0.319	0.211	2.845
	(0.540)	(0.902)	**(0.000)**	(0.551)	**(0.000)**	(0.885)	**(0.000)**	(0.708)	**(0.000)**	(0.736)	(0.747)	(0.867)	(0.564)
AR(2)	**(0.412)**	**(0.903)**	**(0.300)**	**(0.603)**	**(0.306)**	**(0.640)**	**(0.293)**	**(0.816)**	**(0.313)**	**(0.878)**	**(0.886)**	**(0.933)**	**(0.597)**
Sargan	**(0.998)**	**(0.994)**	**(0.992)**	**(0.994)**	**(0.985)**	**(0.999)**	**(0.985)**	**(0.996)**	**(0.985)**	**(0.997)**	**(0.991)**	**(0.996)**	**(0.995)**
Wald	0.374	0.014	**48.7*** **	0.354	**1503*** **	0.020	**322*** **	0.140	**10797*** **	0.113	0.103	0.027	0.332
	(0.540)	(0.902)	**(0.000)**	(0.551)	**(0.000)**	(0.885)	**(0.000)**	(0.708)	**(0.000)**	(0.736)	(0.747)	(0.867)	(0.564)

Panel D: Institutional Regime (Instireg)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Initial	**0.46*** **	**0.50*** **	**0.45*** **	**0.47*** **	**0.35***	**0.41*** **	**0.49*** **	**0.51*** **	**0.54*** **	**0.49*** **	**0.52*** **	**0.52*** **	**0.39*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.062)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.007)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**
AR(2)	**(0.355)**	**(0.254)**	**(0.349)**	**(0.330)**	**(0.497)**	**(0.413)**	**(0.341)**	**(0.291)**	**(0.259)**	**(0.296)**	**(0.279)**	**(0.281)**	**(0.413)**
Sargan	**(0.998)**	**(0.998)**	**(0.998)**	**(0.994)**	**(0.992)**	**(0.994)**	**(0.998)**	**(0.994)**	**(0.993)**	**(0.994)**	**(0.998)**	**(0.998)**	**(0.998)**
Wald	**92.9*** **	**25.7*** **	**110*** **	**514*** **	**3.46***	**12.03*** **	**569*** **	**149*** **	**7.05*** **	**243*** **	**63.0*** **	**20.6*** **	**9.19*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.062)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.007)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**

Panel E: Economic Incentives (Creditex)

	Income Levels		Legal Origins		Petroleum		Openness to sea		Stability		Regions		Africa
	Low	Middle	English	French	Oil	NoOil	Closed	Open	Conf	NoConf	SSA	NA	
Initial	**-2.2*** **	-0.47	-0.054	**0.36*** **	0.756	**0.26***	**0.57*** **	**0.44*** **	**0.51*** **	0.128	**0.38***	**0.60*** **	-0.928
	(0.005)	(0.649)	(0.902)	**(0.000)**	(0.514)	**(0.089)**	**(0.000)**	**(0.000)**	**(0.004)**	(0.707)	**(0.065)**	**(0.000)**	(0.384)
AR(2)	**(0.573)**	**(0.512)**	**(0.386)**	**(0.312)**	**(0.243)**	**(0.339)**	**(0.312)**	**(0.261)**	**(0.294)**	**(0.367)**	**(0.292)**	**(0.304)**	**(0.549)**
Sargan	**(0.995)**	**(0.999)**	**(0.999)**	**(0.998)**	**(0.989)**	**(0.996)**	**(0.998)**	**(0.989)**	**(0.992)**	**(0.997)**	**(0.997)**	**(0.993)**	**(1.000)**
Wald	**7.82*** **	0.206	0.015	**80.1*** **	0.424	**2.87***	**128*** **	**7.14*** **	**7.92*** **	0.140	**3.384***	**20.9*** **	0.755
	(0.005)	(0.649)	(0.902)	**(0.000)**	(0.514)	**(0.089)**	**(0.000)**	**(0.007)**	**(0.004)**	(0.707)	**(0.065)**	**(0.000)**	(0.384)

*,**,**: significance levels of 10%, 5% and 1% respectively. Initial: Lagged dependent variable. AR(2): Second-order Autocorrelation test. Sargan: Sargan Overidentifying Restrictions (OIR) test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(2) tests and; b) the validity of the instruments in the Sargan OIR test. P-values in brackets. Low: Low Income countries. Middle: Middle Income countries. English: English Common law countries. French: French Civil law countries. Oil: Petroleum Exporting countries. NoOil: Non-petroleum Exporting countries. Closed: Landlocked countries. Open: Countries open to the sea. Conf: Conflict Affected countries. NoConf: Countries not Affected by Conflicts. SSA: Sub-Saharan Africa. NA: North Africa.

We have already seen in the methodology section that beta convergence is a necessary but not a sufficient condition for sigma convergence. Hence, beta convergence is generally

appreciated as catch-up whereas; sigma convergence is a reduction in cross-country dispersions necessary for convergence to really take place. To this end, we complement the absolute beta catch-up estimations above with tabular and graphical sigma convergence patterns for robustness purposes and greater subtlety in the analysis.

4.2.2 Sigma convergence: tabular and graphical of KE dispersions

Table 4 below is a tabular representation of KE convergence between frontier African countries and the core South Korean country in terms of education (Panel A), ICT (Panel B), innovation (Panel C), institutional regime (Panel D) and economic incentives (Panel E). The sigma convergence approach consists of computing standard deviations across time between the frontier fundamental characteristics and South Korea.

Table 4: Tabular representation of KE dispersions

Panel A: Education (Educatex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.279	2.670	2.134	1.462	1.886	1.689	1.626	1.782	1.536	1.739	1.523	2.540	1.714
1997	0.567	2.469	1.900	1.289	0.468	1.653	0.593	1.826	0.573	1.653	1.215	2.429	1.518
1998	0.289	1.377	1.136	0.668	0.086	0.968	0.129	1.094	-1.563	0.968	0.492	1.333	0.772
1999	0.023	1.052	0.734	0.375	0.637	0.470	0.334	0.562	0.268	0.546	0.296	1.634	0.495
2000	0.483	0.379	0.390	0.438	0.370	0.078	0.341	0.009	0.254	0.111	0.222	0.994	0.132
2001	1.250	0.157	0.169	0.916	1.021	0.569	0.914	0.358	1.526	0.519	0.706	0.003	0.610
2002	1.272	0.373	0.437	0.522	1.045	0.715	0.965	0.230	---	0.485	0.803	0.660	0.485
2003	1.139	0.406	0.277	0.508	0.243	0.605	0.994	0.092	1.076	0.373	0.797	1.043	0.441
2004	1.078	0.287	0.308	0.636	0.331	0.577	0.931	0.326	1.026	0.484	0.797	0.632	0.542
2005	1.055	0.118	0.290	0.734	0.330	0.625	0.996	0.349	0.873	0.536	0.745	0.444	0.586
2006	1.099	0.067	0.362	0.822	0.856	0.661	1.014	0.422	1.205	0.646	0.776	0.080	0.669
2007	1.029	0.409	0.078	0.758	---	0.650	1.202	0.329	1.023	0.606	0.803	0.162	0.160
2008	0.995	0.461	0.078	0.712	0.867	0.582	1.138	0.138	1.099	0.482	0.722	0.319	0.612
2009	0.881	0.812	0.277	0.511	0.134	0.580	0.993	0.091	0.938	0.369	0.702	0.870	0.478
2010	0.818	0.072	0.414	0.548	0.428	0.566	0.755	0.263	0.686	0.491	0.525	0.766	0.540

Panel B: Information and Communication Technology (ICTex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.488	1.804	1.714	1.542	1.559	1.625	1.514	1.661	1.484	1.657	1.598	1.787	1.616
1997	1.236	1.577	1.478	1.302	0.595	1.388	1.262	1.420	1.230	1.417	1.358	1.500	1.372
1998	1.035	1.422	1.318	1.112	1.088	1.213	1.067	1.241	-1.697	1.240	1.176	1.329	1.191
1999	0.309	0.167	0.034	0.200	0.195	0.093	0.263	0.052	0.315	0.052	0.138	0.097	0.112
2000	0.714	0.130	0.309	0.570	0.572	0.448	0.653	0.400	0.723	0.398	0.502	0.235	0.472
2001	0.898	0.216	0.430	0.727	0.747	0.584	0.830	0.530	0.914	0.527	0.651	0.328	0.615
2002	0.980	0.219	0.469	0.782	0.790	0.634	0.909	0.567	0.991	0.568	0.711	0.290	0.664
2003	0.950	0.114	0.353	0.736	0.749	0.560	0.884	0.480	0.954	0.500	0.654	0.154	0.596
2004	0.850	0.158	0.129	0.571	0.563	0.379	0.788	0.260	0.845	0.310	0.502	0.238	0.415
2005	0.879	0.289	0.094	0.529	0.446	0.358	0.830	0.186	0.468	0.254	0.502	0.577	0.375
2006	0.647	0.682	0.259	0.230	0.054	0.049	0.608	0.173	0.604	0.092	0.209	1.088	0.050

2007	0.741	0.754	0.155	0.288	0.046	0.138	0.704	0.110	0.729	0.057	0.298	1.272	0.642
2008	0.805	0.918	0.160	0.241	0.034	0.119	0.770	0.179	0.779	0.112	0.310	1.636	0.090
2009	1.070	0.709	0.282	0.402	0.035	0.430	1.024	0.073	1.036	0.167	0.642	1.722	0.359
2010	1.101	0.928	0.199	0.479	0.027	0.297	1.106	0.119	1.019	0.080	0.536	1.856	0.249

Panel C: Innovation (Innovex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.010	2.321	1.974	1.518	1.407	1.757	1.023	2.126	1.056	1.874	1.678	1.808	1.725
1997	0.950	2.629	2.166	1.036	1.020	1.897	0.862	1.975		1.789	1.897	1.249	1.789
1998	1.569	3.107	2.849	2.212	1.888	2.622	1.456	2.684		2.530	2.567	2.469	2.530
1999	0.927	2.482	2.028	1.381	1.073	1.915	0.803	1.834	0.910	1.818	1.646	1.881	1.705
2000	0.100	1.832	1.638	0.678	0.380	1.373	0.111	1.481	0.206	1.237	1.024	1.252	1.090
2001	0.005	1.842	1.675	1.174	0.283	2.269	0.005	1.842	0.077	1.824	1.675	1.174	1.475
2002	0.048	1.815	1.757	0.534	0.297	1.362	0.015	1.237	0.167	1.206	1.029	1.130	1.058
2003	0.258	1.501	1.394	0.262	0.053	1.067	0.349	0.929	0.267	0.916	0.691	0.888	0.747
2004	0.682	0.963	1.076	0.092	0.416	0.600	0.757	0.503	0.664	0.490	0.332	0.369	0.346
2005	1.150	0.662	0.756	0.482	0.815	0.248	1.253	0.159	0.895	0.136	0.053	0.041	0.018
2006	1.426	0.534	0.695	1.056	1.031	0.016	1.521	0.103	1.345	0.133	0.201	0.568	0.306
2007	1.706	0.391	0.596	1.110	1.399	0.296	1.769	0.388	1.633	0.405	0.601	0.421	0.748
2008	1.715	0.586	0.337	0.699		0.181		0.181		0.181	0.231	0.082	0.181
2009	1.654	1.346	1.262	0.598		0.146		0.146		0.146	0.217	0.039	0.146
2010													

Panel D: Institutional Regime (Instireg)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.570	2.279	2.269	1.609	0.464	2.267	2.337	1.729	0.180	2.273	1.843	2.097	1.877
1997													
1998	2.332	3.575	3.474	2.501	1.540	3.123	2.810	2.858	-3.127	3.249	2.808	3.117	2.844
1999													
2000	1.131	2.295	2.091	1.347	0.366	1.876	1.508	1.652	0.286	2.072	1.564	1.955	1.610
2001													
2002	1.041	0.070	0.152	0.819	1.648	0.355	0.794	0.496	2.369	0.148	0.642	0.140	0.583
2003	0.380	0.689	0.548	0.206	0.953	0.277	0.114	0.133	1.816	0.518	0.002	0.523	0.060
2004	0.660	0.359	0.288	0.528	1.255	0.023	0.368	0.187	2.087	0.210	0.307	0.257	0.240
2005	1.721	0.693	0.728	1.608	2.352	1.072	1.401	1.254	1.458	0.862	1.359	0.836	1.298
2006	0.057	0.943	1.020	0.009	0.755	0.592	0.261	0.393	1.302	0.759	0.319	0.624	0.355
2007	1.799	0.803	0.723	1.752	2.528	1.144	1.477	1.352	3.063	0.980	1.431	1.067	0.017
2008	0.141	0.923	0.972	0.071	0.846	0.542	0.244	0.319	1.411	0.714	0.267	0.522	0.297
2009	1.533	0.485	0.421	1.472	2.205	0.865	1.149	1.081	2.679	0.716	1.128	0.901	1.101
2010	1.905	0.993	0.804	1.925	2.692	1.280	1.491	1.545	3.029	1.164	1.528	1.539	1.529

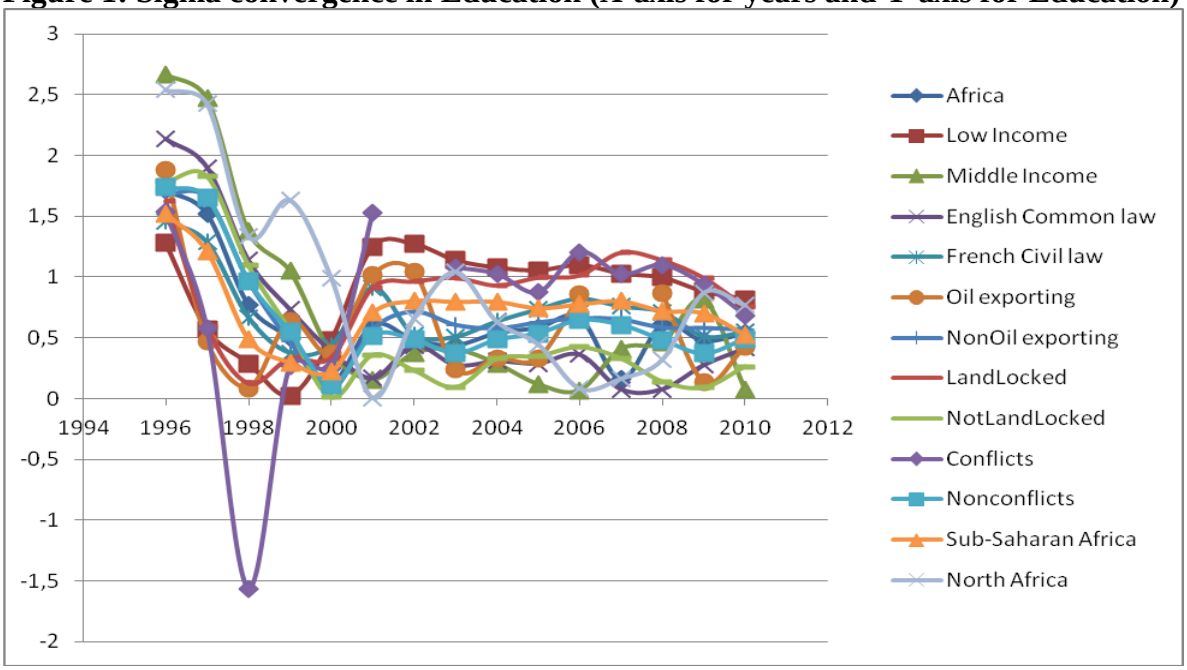
Panel E: Economic Incentives (Creditex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.366	1.028	1.022	1.372	1.511	1.085	1.241	1.183	1.637	1.112	1.226	1.000	1.203
1997	1.530	1.160	1.246	1.444	0.767	1.252	1.502	1.262	1.626	1.278	1.366	1.189	1.345
1998	0.372	0.067	0.070	0.224	0.405	0.068	0.343	0.062	0.091	0.088	0.195	0.107	0.152
1999	0.907	0.507	0.607	0.794	1.043	0.585	0.872	0.625	1.140	0.621	0.753	0.406	0.707
2000	1.831	1.467	1.544	1.741	2.064	1.498	1.806	1.570	2.180	1.543	1.703	1.297	1.649
2001	0.192	0.610	0.496	0.317	0.039	0.533	0.205	0.499	0.055	0.492	0.346	0.760	0.401
2002	0.247	0.661	0.541	0.394	0.173	0.578	0.252	0.559	0.013	0.546	0.397	0.791	0.460
2003	0.438	0.810	0.740	0.539	0.305	0.763	0.438	0.721	0.130	0.726	0.567	0.954	0.630
2004	0.393	0.811	0.747	0.501	0.271	0.764	0.416	0.716	0.125	0.714	0.562	0.966	0.616
2005	0.303	0.786	0.681	0.434	0.188	0.692	0.342	0.664	0.457	0.655	0.506	0.849	0.553
2006	0.053	0.571	0.435	0.212	0.036	0.464	0.110	0.431	0.046	0.401	0.317	0.446	0.332
2007	0.002	0.662	0.529	0.135	0.059	0.444	0.104	0.426	0.084	0.441	0.315	0.522	0.531
2008	0.155	0.988	0.720	0.349	0.428	0.597	0.282	0.696	0.138	0.680	0.565	0.633	0.572
2009	1.112	2.025	1.768	1.293	1.517	1.607	1.278	1.705	1.147	1.712	1.594	1.586	1.593
2010													

Low. I: Low Income countries. Mid. I: Middle Income countries. Eng: English Common law countries. Frch: French Civil law countries. Oil: petroleum exporting countries. NOil: Non-petroleum exporting countries. LL: Landlocked countries. NLL: Not Landlocked countries. Con: Conflict affected countries. NCon: Non conflict affected countries. SSA: Sub-Saharan Africa. NA: North Africa. S.K: South Korea.

Figures 1-5 below are based on Table 4. As will be discussed in Section 4.3 below, both tabular and graphical representations are needed to fully calibrate 'policy syndromes' for more targeted/focused policy implications/strategies.

Figure 1: Sigma convergence in Education (X-axis for years and Y-axis for Education)



It can be seen from Figure 1 above that the gap between Korea and African countries was very substantial in 1996, with Middle-income and Low-income countries witnessing the highest and lowest gaps respectively. It should be noted that a decreasing value in the Y-axis depicts a more balanced development in KE between the frontier fundamentals and the core country (South Korea). However, the gap decreased substantially up to the year 2000 in all fundamental characteristics. After this period, it has averagely remained stable, though fluctuating considerably in North Africa and Oil exporting countries. A reason for the increase in gap from the year 2000 can be explained from the KE strategies Korea adopted in the beginning of the millennium. Consistent with Suh & Chen (2007, p. 25), in 2000 Korea embarked on human resource development in its transition to intensive KE by greatly improving on education.

Figure 2: Sigma convergence in ICT (X-axis for years and Y-axis for ICT)

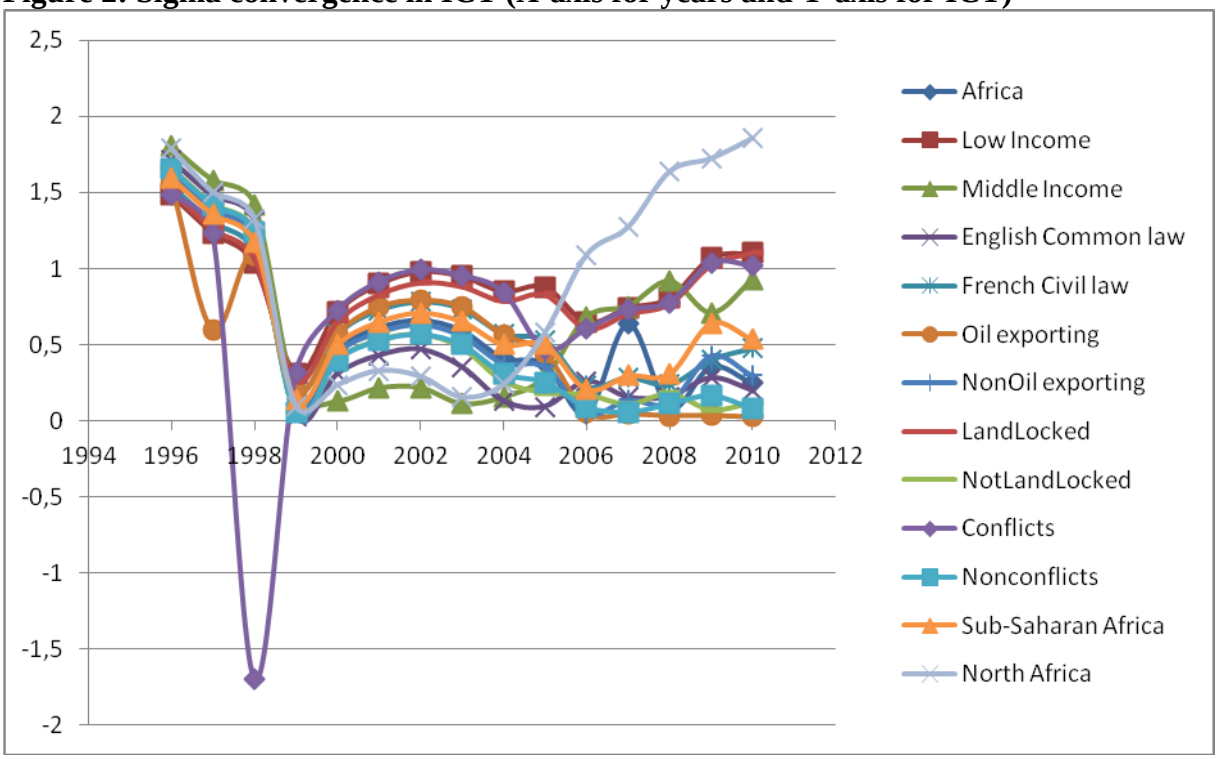
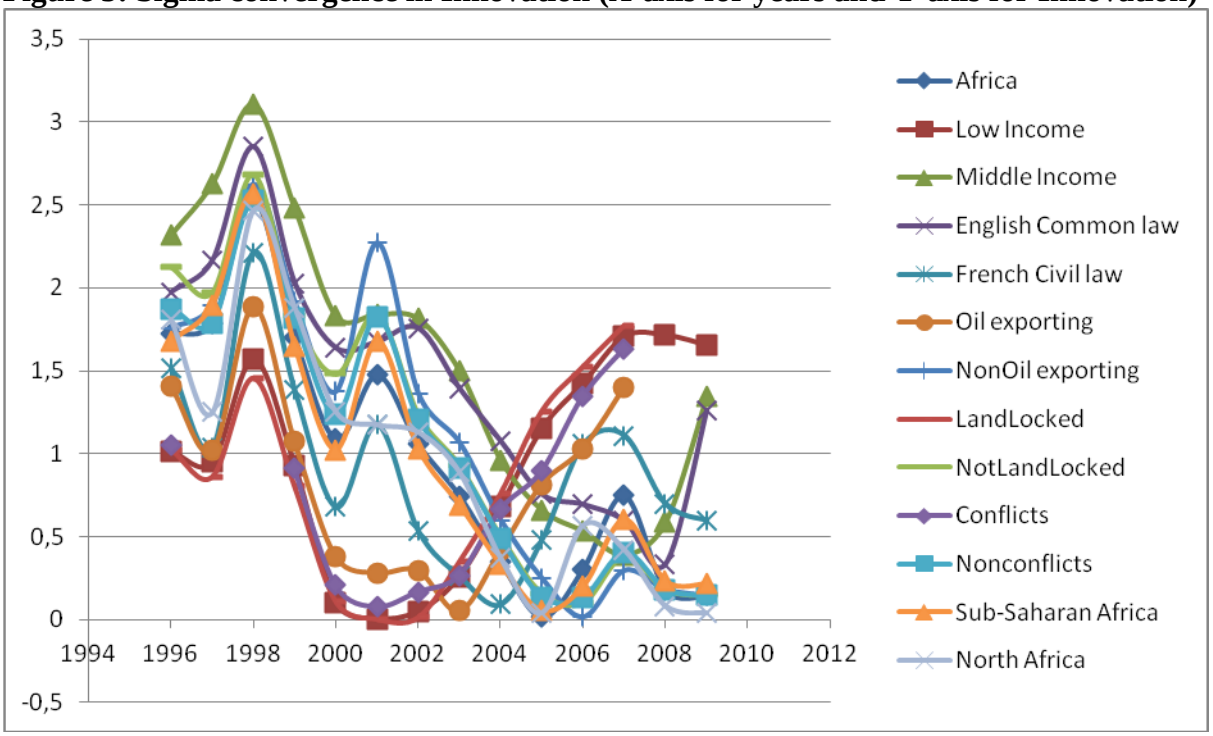


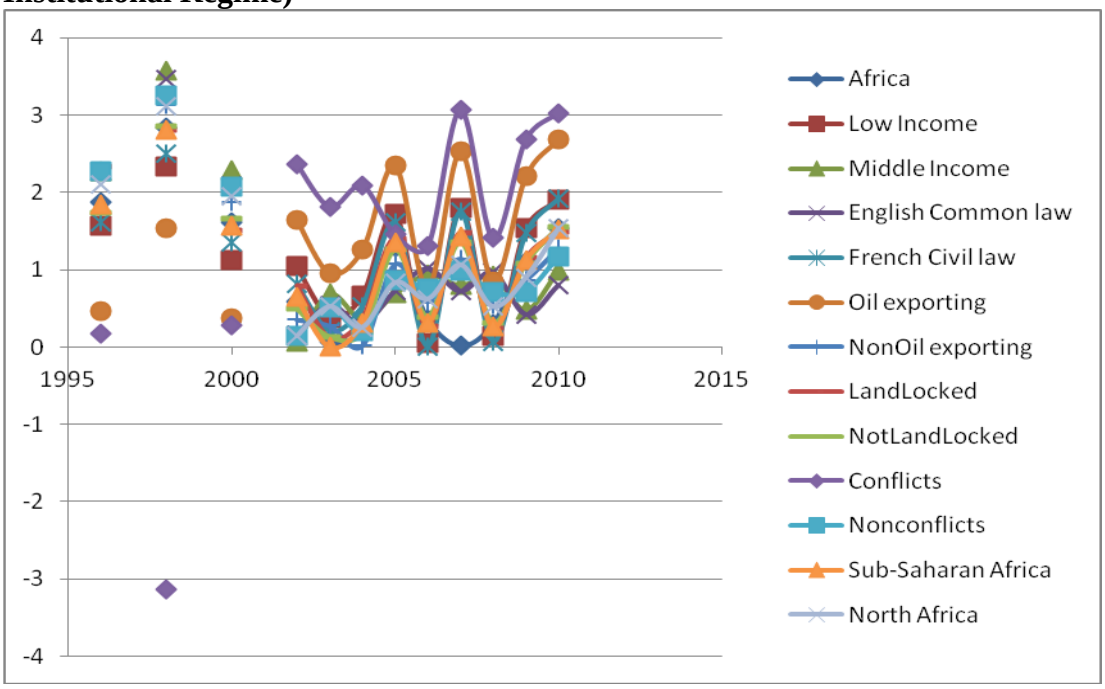
Figure 2 depicts the dispersions in ICT. The trends can be broadly summarized in three phases. A first phase between 1996 and 1999 entailing sharp declines in the dispersions. A second phase of gradual improvement and slow decline from 1999 to 2005, with a peak in 2002. A third of phase of increases in the dispersions with mixed tendencies: sharp (North Africa, Conflicts, Low-income, Landlocked) and gradual (Nonconflicts, Oil-exporting, Notlandlocked).

Figure 3: Sigma convergence in Innovation (X-axis for years and Y-axis for Innovation)



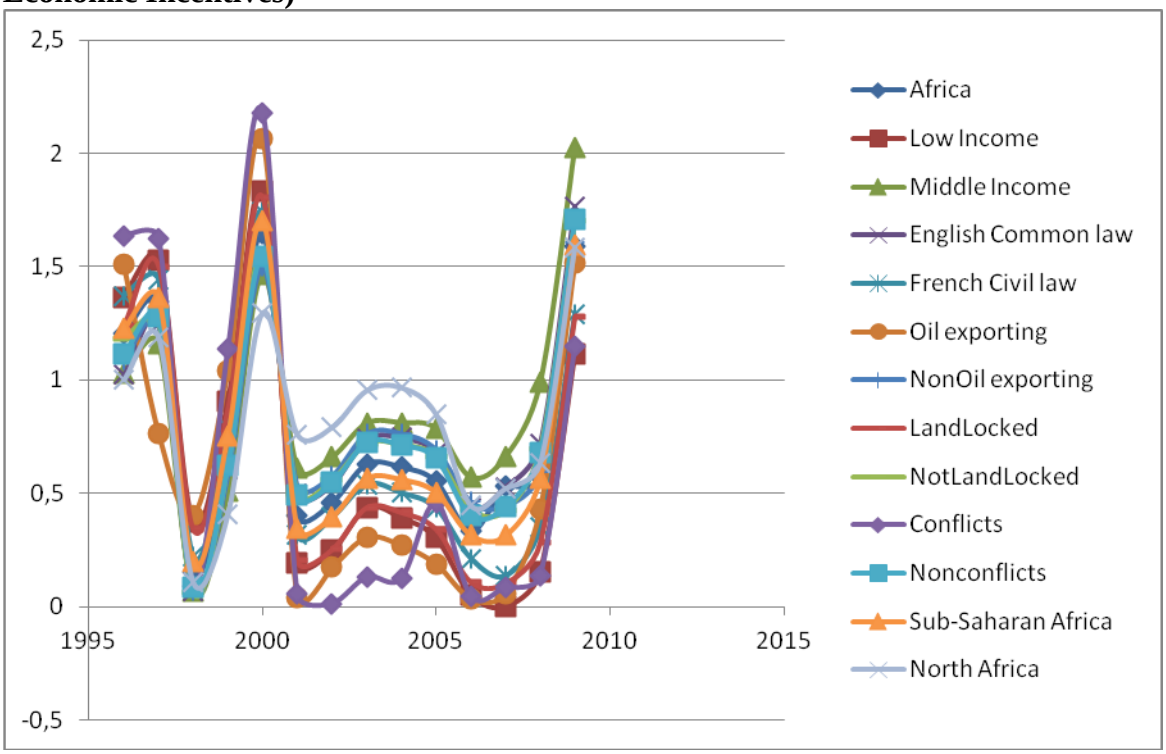
Dynamics in the dispersions of innovation depicted in Figure 3 above generally display an oscillating pattern. First, a steep decline from 1996 to 1997, then a sharp rise between 1997 and 1998, followed by another steep decline to the year 2000, after which two tendencies are observed: a first with some countries leveling-up for two years before witnessing a another sharp rise to 2011 (Oil exporting, Conflicts, Low-income, Landlocked) and; a second category of countries broadly experiencing sharp rises and decreases between 2000 and 2002 before displaying wave-like reductions in the dispersions.

Figure 4: Sigma convergence in Institutional Regime (X-axis for years and Y-axis for Institutional Regime)



Patterns of dispersions in institutional regime shown in Figure 4 above are almost uniform across fundamental characteristics. The breaks in 1997, 1999 and 2001 are due to missing data. Generally there are approximately eight wave-like patterns (or increases and reductions) in the dispersions. The last phase of these oscillations depicts a sharp increase in the dispersions: signaling a growing gap in the institutional dimension of KE between the core country and frontier African countries.

Figure 5: Sigma convergence in Economic Incentives (X-axis for years and Y-axis for Economic Incentives)



In Figure 5 above, the tendencies observed in economic incentive dispersions are broadly similar across fundamental characteristics. However, while the magnitude in elimination of dispersions are almost indistinguishable in the first (1996 to 2001) and third (2008 to 2008) phases, the second phase (2001 to 2008) is characterized by the following dispersion magnitudes, in increasing order: conflict, oil-exporting, landlocked, low-income, French civil law, Sub-Saharan Africa, Nonconflicts, English common law, Africa, Middle-income and North Africa.

One common factor in Figures 1-5 is an increasing gap in KE after the year 2000: an indication that compelling catch-up strategies are required to mitigate the growing gaps. In fact the growing gaps are consistent with the Anyanwu (2012) finding that the African KEI has decreased between the years 2000 and 2009.

4.3. Policy syndromes and Catch-up strategies

4.3.1 Policy syndromes

Fosu (2013c) defines policy syndromes as situations that are detrimental to growth: 'administered redistribution', 'state breakdown', 'state controls', and 'suboptimal inter temporal resource allocation' with the absence of syndromes qualified as 'syndrome-free'. The syndromes are thought to have substantially contributed to the poor post-independence growth of Africa. In the context of this paper, policy syndromes are negative tendencies of dispersions in KE dimensions between African frontier countries and the core South Korean economy. Hence, increasing deviations for a given KE dimension denotes 'policy syndromes' (PS) whereas a trend portraying diminishing dispersions is qualified as a 'syndrome-free' (SF) tendency. While catch-up strategies discussed in this section are more relevant in PS scenarios, enhancing existing policies in SF events are essential to ensure a complete elimination of dispersions. This is essentially because SF situations are prone to become PS scenario given the history of wave-like trends in the KE dispersion patterns. Therefore, the catch-up strategies are essential both for preventing and curing dispersions in SF and PS scenarios respectively. Hence, we devote space to specifically detailing the PS before discussing the catch-up strategies.

As we have already discussed in Section 4.2.2 above, both tabular and graphical representations are needed to fully calibrate PS for more targeted/focused policy implications/strategies. Hence Table 5 below depicting comparative PS and SF scenarios is obtained from both representations. While the left-hand-side of the table shows PS (or high dispersion panels), the right-hand-side presents SF (or low dispersion panels). Based on the patterns, it is consistently observed for the first-three dimensions of KE that 'landlockedness', 'low income' and 'political instability' are high PS fundamental characteristics. We discuss

catch-up strategies relevant to the fundamental characteristics and degree of PS in the following section.

Table 5: 'Policy Syndrome' and 'Syndrome Free' Information Criteria

	Policy Syndrome (PS) ----------→										**Syndrome Free (SF)**		
Educatex	Low.I	LL	NA	Con	Frch.	NOil	Africa	SSA	NCon	Oil	Eng.	NLL	Mid. I
ICTex	NA	Low.I	LL	Con	Mid. I	SSA	Frch	Africa	NOil	Eng	NLL	NCon	Oil
Innovex	LL	Low. I	Con	Oil	Mid. I	Eng	Frch	SSA	NOil	Africa	NCon	NLL	NA
Instireg	Con	Oil	Low. I	Frch.	NA	SSA	Africa	LL	NOil	NLL	NCon	Mid.I	Eng
Creditex	Mid. I	Eng	NCon	NLL	NOil	SSA	Africa	NA	Oil	Frch	LL	Con	Low.I
	Highest Dispersions ----------→										**Lowest Dispersions**		

Low. I: Low Income countries. Mid. I: Middle Income countries. Eng: English Common law countries. Frch: French Civil law countries. Oil: petroleum exporting countries. NOil: Non-petroleum exporting countries. LL: Landlocked countries. NLL: Not Landlocked countries. Con: Conflict affected countries. NCon: Non conflict affected countries. SSA: Sub-Saharan Africa. NA: North Africa. S.K: South Korea. P.C: Principal Component. PSE: Primary School Enrolment. SSE: Secondary School Enrolment. TSE: Tertiary School Enrolment. 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 PC of Private domestic Credit and Interest rate spread.

4.3.2 Catch-up strategies

The interesting questions motivating this section of whether other countries can adapt to the Korean model and catch-up have already been answered by Lee (2009) in the affirmative. Hence, consistent with Suh & Chen (2007), there are two important lessons from the experiences of Korea. First, human capital is essential for the development of science & technology and economic prosperity. Second, market competition is the greatest motivator of privates business to engage in technology development. Thus it is important to consolidate the capabilities of scientific research and ameliorate conditions for innovation.

4.3.2.1 Education and Innovation strategies

The lack of investment in education and brain drain have been recently documented as some of the issues standing on the way to consolidating the educational pillar of KE in Africa (Kamara et al., 2007; Ford, 2007; Amavilah, 2009; Chavula, 2010; Weber, 2011; Anyanwu,

2012; Asongu, 2013fg; Andres et al., 2014; Asongu, 2014j). There is a background of depleting knowledge infrastructure, limited support for R&D, brain-drain, limited direct nexuses between science & industry and outdated curricula. The continent is on a downward trend in KE (Anyanwu, 2012) and risk losing the new economy unless bold measures are implemented to reinvigorate science & technology, innovation and higher education (Kamara, 2007). We have established Africa's deficiency in innovation in Section 2 (Oyelaran-Oyeyinka & Gehl Sampath, 2007; Anyanwu, 2012; Carisle et al., 2013; Asongu, 2013eh). What lessons does South Korea hold for the above issues?

First, African economies should take bold steps towards increasing college enrolment and the ratio of R&D/GDP. As shown by Lee (2009), such measures are effective and possible only in conjunction with substantial improvements in other institutional and policy environments, including the capacity and autonomy of government. Education consolidates a nation's ability to acquire new technology and knowledge. It also gives birth to the tacit knowledge of individuals which are essential in consolidating blocks of technological learning. In this light, African governments have to take full responsibility for the necessary measures needed to promote this core human resource development (Suh & Chen, 2007; Tchamyou, 2014). In essence, while Korea continues to import a substantial portion of its technology from more advanced nations, it has developed a solid indigenous R&D platform and allocates about 3% of its GDP to R&D. Essentially, these strategies for technology and education best illustrate the disciplinary and practical dimensions that should motivate African countries in their efforts towards KE.

Second, in order for workers to cope with changing technological conditions, African governments need to provide technical and vocational trainings as well as take the necessary steps to encourage trainings at work places. The intuition behind this strategy is that as a nation becomes more advanced, a critical factor that comes with the prosperity is technological

competence. For these strategies to be implemented, African government policy makers should nurture engineers and high-caliber scientists that are capable of handling prosperity on the frontiers of science & technology. In the Korean experience, industrialization and education complemented one another in accelerating and sustaining development. In essence, education produced technological learning and industrialization and the latest boosted the return rate on educational investment, which further promoted the demand for education (Such & Chen, 2007).

Third, consistent with the documented literature in the preceding sections (Bezmen & Depken, 2004), the industrialization of Korea progressed from imitation to innovation. Hence, reverse engineering and less stringent property rights are essential to enable the copying of technology-intensive commodities. Frontier African countries should therefore engage in informal channels of technology transfer at the initial stages of their industrialization. As documented by Suh & Chen (2007) & Tchamyou (2014), the nexus between education and human development needs to be tailored into a lifelong learning strategy.

Based on the 'policy syndromes', the increasing relevance of the strategies is as follows: (1) Middle-income, Not Landlocked, English Common law, Oil-exporting, Nonconflict, SSA, Africa, Non-Oil exporting, French Civil law, Conflict-affected, North Africa, Landlocked & Low-income countries for the educational dimension and; (2) North Africa, Not Landlocked Nonconflict, Africa, Non-Oil exporting, SSA, French Civil law, English Common law, Middle Income, Oil exporting, Conflict-affected, Low income & Landlocked countries for the innovation dimension of KE.

4.3.2.2 ICT catch-up strategies

The plethora of Africa benefits in ICT catch-up has already been substantially covered in Section 2 (African Partnership Forum, 2008; Chavula, 2010; Butcher, 2011). As we have already

highlighted in the preceding section, reverse engineering of imported ICTs and less stringent IPRs on ICTs would be steps in the right direction towards enhancing the African base in ICTs. These would drive down the cost technological acquisition and mitigate the dependence on business operations.

Korea's ICT success has hinged on the exercise of soundly-integrated approaches entailing an industrial policy, an active informatization policy and competitive & regulatory policies that are well enforced. The core country invested massively in internet equipment, telephone lines, multimedia, inter alia. These investments have substantially contributed to its economic prosperity. Consistent with Such & Chen (2007) and Tchamyou (2014), the policy was clearly articulated along three main areas highlighted in the first sentence of this paragraph, which entailed: R&D, venture capital and human resources (an industrial policy); privatization & market liberalization (enforced competitive & regulatory policy) and; setting-up of e-government, constructing an advanced infrastructure (an active information policy). In essence, combining the three areas of policy in a complementary mechanism has been main cause for IT strategy success. Hence it is a lesson that could inspire African countries because the well-tailored information infrastructure has been the basis for the exceptional development of Korea. In decreasing order, the relevance of above strategies applies to: North Africa, Low-income, Landlocked, Conflict-affected, Middle-income, SSA, French Civil law, Africa, Non-Oil exporting, English Common law, Not Landlocked, Non-conflicts and Oil exporting countries.

4.3.2.3 Institutional regime and Economic incentive catch-up strategies

Good institutions are central to the emergence of African economies (Fosu, 2013d). In Section 2, we have seen that African countries are substantially lacking in this fourth pillar of KE (Cogburn, 2003; Letiche, 2006). The issues include, inter alia: poor institutions (Andrés et al.,

2014), especially corruption in upholding IPRs (Andrés & Asongu, 2013a); surplus banking liquidity or absence of credit to finance investment needs (Saxegaard, 2006; Nguena & Tsafack, 2014; Tchamyou, 2014).

4.3.2.3.1 Institutional regime

Poor institutions and capital flight repugnant to investment and economic prosperity have been substantially documented in African development literature (Boyce & Ndikumana, 1998, 2001, 2003, 2008, 2011; Fofack & Ndikumana, 2009). African institutions need to be market-focused by adopting a development strategy that completely liberates the competitive forces essential for the dynamics of KE. A market-oriented strategy requires the presence of competitive forces and therefore enhances competition. Hence, to fight capital flight, transparency of financial markets, a leveled playing field for all market participants, government accountability, foreign investment regimes and liberalized trade are essential components of the KE.

African governments' institutions should foster an industrialization strategy that is export-led. Accordingly, by adopting extensive development strategies, they would expose African corporations to global competition like Korean industries. This would ultimately compel domestic industries to invest substantially in innovation and technological assimilation in order to remain competitive.

One of the advantages of having a credible institutional regime is drawn from the manner in which the Korean government solved the 1997 crisis. The lesson holds some potential for the mitigation of capital flight. African governments can learn from the special recognition in the long-term fiscal prudence of the Korean government, which allowed it to put in place a plethora of post-1997 reforms. Measures such as recapitalization of financial institutions, removal of non-performing loans, provision of financial support to families with low-income and social programs

like unemployment insurance, inter alia: entailed a lot of fiscal pressures on the State because the measures required a lot of public funds. Nonetheless, the Korean government was able to issue new bonds to finance the reforms and handle the public debt because of its history of financial credibility and fiscal prudence. African governments can learn from this and beware that their ability to emerge from a potential financial and/or economic crisis would depend on their institutional credibility (Tchamyou, 2014).

Then there is the thorny issue of corrupt political elites in Africa (Garoupa & Jellal, 2007; Jellal & Bouzahzah, 2013). Narratives on the Korean model have been consistent on the position that an effective government is crucial for the success of the KE strategy in order to achieve the long-term development objectives. The pivotal role of the Korean government has been very remarkable through the development process. The government has been visionary in ensuring effective leadership that enabled a conducive macroeconomic environment for KE: training of the population, mass education, domestic R&D initiatives, access to modern infrastructure, assimilation of foreign technologies, inter alia. Hence, consistent with Tran (2011) the leader Park was able to adopt a pragmatic approach to elite corruption. Instead of cracking down on them as well as some business men as was urged by the USA, he expropriated their shares in banks and obliged them to invest in industries that encouraged import-substitution. The lesson from this experience is for African governments to be more pragmatic in their approaches to fighting corruption in the continent: a massive industry that account for about 25% of its GDP (Asongu, 2014d).

Overall, based on the policy syndromes presented in Table 5 above, the importance of the policy recommendations apply to the following African frontier fundamental characteristics in increasing relevance: English Common-law, Middle-income, Non-conflict, Not-Landlocked,

Non-Oil exporting, Landlocked, Africa, SSA, North Africa, French Civil-law, Low-income, Oil-exporting, Conflict-affected countries.

4.3.2.3.2 Economic incentives

The extensive or export-led development model as we have seen would expose African industries to more competition. While the outward-looking strategy would induce intensive R& D programs, fiscal incentives from governments are essential for the success. In the same vein, protectionist measures are only necessary at the initial stages of development in a given industry and should be eventually curtailed. If not, it would encourage complacency in innovation due to the absence of exposure to competitive forces.

Incentives to private credit should be provided by African governments to curtail the substantially documented surplus liquidity issues (Saxegaard, 2006; Nguena & Tsafack, 2014). This would stimulate private sector development and respond to the growing stream of literature on the need for investment in the continent (Anyanwu, 2007, 2009; Asongu, 2013j) from recent African business literature (Rolfe & Woodward, 2004; Bartels et al., 2014; Bartels et al., 2009; Tuomi, 2011; Darley, 2012; Tchamyou, 2014). Moreover, as established by Suh & Chen (2007), Small & Medium Size Enterprises: a sector with more risk or greater capital requirements were aided by the research institutes of governments which furnished them with new know-how in terms of collaborative R&D as well as novel spinoff government backed firms.

Based on the information criteria for 'policy syndrome' and 'syndrome free' fundamental characteristics presented in Table 5, the above strategies in increasing relevance apply to: Low-income, Conflict-affected, Landlocked, French Civil law, Oil-exporting, North Africa, Africa, SSA, Non-Oil exporting, Not-landlocked, Not conflict-affected, English Common law and Middle-income countries.

4.3.3 Catch-up horizons, cautions, and caveats

First, while we have presented catch-up rates and timelines needed for full catch-up, we have essentially used this dimension of the analysis for insights into potential catch-up horizons in the absence of multiple equilibria. While the absolute beta-convergence procedure may have less draw-backs than the conditional beta-convergence approach (which has not been implemented for reasons already discussed in the methodology section), multiple equilibria remains a caveat even in the absence of conditioning information set. For the above reasons, we have based the 'policy syndrome' and 'syndrome free' information criteria on sigma convergence dynamics because absolute beta catch-up is a necessary but not a sufficient condition for sigma convergence.

5. Conclusion

Africa's overall knowledge index fell between 2000 and 2009. South Korea's economic miracle is largely due to a knowledge-based development strategy that holds valuable lessons for African countries in their current pursuit towards knowledge economies. Using updated data (1996-2010), this paper presents fresh South Korean lessons to Africa by assessing the knowledge economy (KE) gaps, deriving policy syndromes and providing catch-up strategies. The 53 African frontier countries are decomposed into fundamental characteristics of wealth, legal origins, regional proximity, oil-exporting, political stability and landlockedness. The World Bank's four KE components are used: education, innovation, information & communication technology (ICT) and economic incentives & institutional regime. Absolute beta and sigma convergence techniques are employed as empirical strategies. With the exception of ICT for which catch-up is not very apparent, in increasing order it is visible in: innovation, economic incentives, education and institutional regime. The speed of catch-up varies between 8.66% and

30.00% per annum with respective time to full or 100% catch-up of 34.64 years and 10 years. Based on the trends and dynamics in the KE gaps, policy syndromes and compelling catch-up strategies are discussed. Issues standing on the way to KE in Africa are dissected with great acuteness before South Korean relevant solutions are provided. The paper is original in its provision of practical policy initiatives drawn from the Korean experience to African countries embarking on a transition to KE.

Appendices

Appendix 1: Definition of variables

Variables	Signs	Variable definitions	Sources
		Panel A: 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
		Panel B: 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
		Panel C: Economic Incentives & 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 Incentives in KE	Creditex	First PC of Pcrbof and IRS	PCA
Corruption-Control	CC	Control of Corruption (estimate): Captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.	World Bank (WDI)
Rule of Law	RL	Rule of Law (estimate): Captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence.	World Bank (WDI)
Regulation Quality	RQ	Regulation Quality (estimate): Measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Bank (WDI)
Political Stability/ No violence	PS	Political Stability/ No Violence (estimate): Measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism.	World Bank (WDI)
Government Effectiveness	GE	Government Effectiveness (estimate):	World Bank (WDI)

		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 government's commitments to such policies.	
Voice & Accountability	VA	Voice and Accountability (estimate): Measures the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association, and a free media.	World Bank (WDI)
Institutional Regime in KE	Instireg	First PC of CC, RL, RQ, PS, GE & VA	PCA
		Panel D: 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 STJA, Trademarks and Patents	World Bank (WDI)

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

Appendix 2: Summary statistics

	Mean	S.D	Min	Max	Obs.
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
Innovation (Innovex)	1.021	2.542	-0.770	8.859	102

Appendix 3: Correlation Analysis

Education				ICT				Innovation				Eco Incentive			Institutional Regime							
PSE	SSE	TSE	Educatex	Inter	Mob	Tel	ICTex	STJA	TM	Pat	Innovex	Pcrd	IRS	Creditex	CC	RL	RQ	PS	GE	VA	Instireg	
1.00	0.42	0.27	0.64	0.24	0.27	0.25	0.30	0.10	0.07	0.07	0.11	0.16	0.08	-0.01	0.16	0.23	0.21	0.24	0.25	0.22	0.24	PSE
	1.00	0.74	0.91	0.57	0.59	0.82	0.75	0.43	0.57	0.61	0.74	0.62	-0.36	-0.62	0.55	0.55	0.35	0.43	0.59	0.35	0.55	SSE
		1.00	0.84	0.46	0.40	0.59	0.57	0.57	0.50	0.69	0.83	0.61	-0.27	-0.51	0.21	0.29	0.14	0.10	0.35	-0.05	0.21	TSE
			1.00	0.58	0.51	0.69	0.69	0.48	0.43	0.53	0.65	0.63	-0.24	-0.54	0.41	0.46	0.31	0.29	0.51	0.17	0.43	Educatex
				1.00	0.72	0.58	0.90	0.24	0.27	0.18	0.27	0.45	0.01	-0.42	0.28	0.33	0.21	0.25	0.36	0.18	0.32	Inter
					1.00	0.47	0.86	0.26	0.38	0.47	0.54	0.45	-0.10	-0.46	0.25	0.30	0.25	0.29	0.31	0.16	0.29	Mob
						1.00	0.78	0.27	0.36	0.41	0.51	0.56	-0.12	-0.54	0.50	0.57	0.33	0.43	0.56	0.33	0.53	Tel
							1.00	0.39	0.50	0.39	0.50	0.56	-0.08	-0.55	0.39	0.45	0.30	0.37	0.46	0.25	0.43	ICTex
								1.00	0.83	0.90	0.96	0.78	-0.09	-0.77	0.21	0.23	0.29	0.01	0.36	0.15	0.26	STJA
									1.00	0.91	0.93	0.89	-0.31	-0.89	0.32	0.26	0.41	0.01	0.50	0.33	0.35	TM
										1.00	0.97	0.86	-0.34	-0.91	0.47	0.42	0.54	0.27	0.61	0.57	0.55	Pat
											1.00	0.93	-0.39	-0.94	0.49	0.46	0.60	0.28	0.71	0.50	0.57	Innovex
												1.00	-0.31	-0.96	0.53	0.51	0.51	0.27	0.64	0.39	0.55	Pcrd
													1.00	0.54	-0.23	-0.25	-0.32	-0.15	-0.21	-0.16	-0.26	IRS
														1.00	-0.56	-0.54	-0.52	-0.30	-0.68	-0.51	-0.60	Creditex
															1.00	0.87	0.72	0.68	0.83	0.66	0.88	CC
																1.00	0.81	0.79	0.88	0.72	0.95	RL
																	1.00	0.63	0.81	0.70	0.86	RQ
																		1.00	0.64	0.65	0.80	PS
																			1.00	0.68	0.92	GE
																				1.00	0.82	VA
																					1.00	Instireg

ICT: Information & Communication Technology. Eco: Economic. PSE : Primary School Enrolment. SSE: Secondary School Enrolment. TSE: Tertiary School Enrolment. Educatex: Edication index (first principal component of PSE, SSE & TSE). Inter: Internet Penetration. Mob: Mobile Phone Penetration. Tel: Telephone Subscriptions. ICTex: ICT index (first principal component of Inter, Mob & Tel). STJA: Scientific & Technical Journal Articles. TM: Trademark Applications. Pat: Patent Applications. Innovex: Innovation index (first principal component of STJA, TM & Pat). Pcrd: Private Domestic Credit. IRS: Interest Rate Spread. Creditex: Economic Incentive index (first principal component of Pcrd & IRS). CC: Corruption-Control. RL: Rule of Law. RQ: Regulation Quality. PS: Political Stability. GE: Government Effectiveness. VA: Voice & Accountability. Instireg: Institutional Regime index (first principal component of CC, RL, RQ, PS, GE & VA).

Appendix 4: Categorization of Countries

Category	Panels	Countries	Num
Income levels	Middle Income	Algeria, Angola, Botswana, Cameroon, Cape Verde, Côte d'Ivoire, Egypt, Equatorial Guinea, Gabon, Lesotho, Libya, Mauritius, Morocco, Namibia, Nigeria, Sao Tome & Principe, Senegal, Seychelles, South Africa, Sudan, Swaziland, Tunisia.	22
	Low Income	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Djibouti, Eritrea, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, Tanzania, Togo, Uganda, Zambia, Zimbabwe.	31
Legal Origins	English Common-law	Botswana, The Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mauritius, Namibia, Nigeria, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe.	20
	French Civil-law	Algeria, Angola, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Guinea, Guinea-Bissau, Libya, Madagascar, Mali, Mauritania, Morocco, Mozambique, Niger, Rwanda, Sao Tomé & Principe, Senegal, Togo, Tunisia.	33
Regions	Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Chad, Central African Republic, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Rwanda, Sao Tomé & Principe, Seychelles, South Africa, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.	47
	North Africa	Algeria, Egypt, Libya, Mauritania, Morocco, Tunisia.	6
Resources	Petroleum Exporting	Algeria, Angola, Cameroon, Chad, Congo Republic, Equatorial Guinea, Gabon, Libya, Nigeria, Sudan.	10
	Non-Petroleum Exporting	Benin, Botswana, Burkina Faso, Burundi, Cape Verde, Central African Republic, Comoros, Congo Democratic Republic, Côte d'Ivoire, Djibouti, Eritrea, Ethiopia, Egypt, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Senegal, Sierra Leone, Somalia, Rwanda, Sao Tomé & Principe, Seychelles, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.	43
Stability	Conflict	Angola, Burundi, Chad, Central African Republic, Congo Democratic Republic, Côte d'Ivoire, Liberia, Nigeria, Sierra Leone, Somalia, Sudan, Zimbabwe.	12
	Non-Conflict	Algeria, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Comoros, Congo Republic, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Senegal, Rwanda, Sao Tomé & Principe, Seychelles, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia.	41
Openness to Sea	Landlocked	Botswana, Burkina Faso, Burundi, Chad, Central African Republic, Ethiopia, Lesotho, Malawi, Mali, Niger, Rwanda, Swaziland, Uganda, Zambia, Zimbabwe	15
	Not landlocked	Algeria, Angola, Benin, Cameroon, Cape Verde, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia,	38

Libya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Sao Tomé & Principe, Seychelles, South Africa, Tanzania, Togo, Tunisia.

Num: Number of cross sections (countries)

References

African Development Bank (2007, December). "Growing a Knowledge Based Economy: Evidence from Public Expenditure on Education in Africa", *Economic Research Working Paper Series* No. 88.

Africa Partnership Forum (2008), "ICT in Africa: Boosting Economic Growth and Poverty Reduction", 10th Meeting of Africa Partnership Forum, Tokyo, Japan (7-8th April).

Agbor, J.A., (2011), "How Does Colonial Origin Matter for Economic Performance in Sub-Saharan Africa", *World Institute for Development Economics Research*, Working Paper, No. 2011/27.

Amavilah, V. H., (2009). "Knowledge of African countries: production and value of doctoral dissertations," *Applied Economics*, 41,(7-9), pp. 977-989.

Amavilah, V. H., Asongu, S. A., & Andrés, A. R., (2014). "Globalization, peace & stability, governance and knowledge economy", African Governance and Development Institute Working Paper.

Amsden, A., (1989). *Asia's Next Giant*. New York: Oxford University Press.

Andrés, A. R., & Asongu, S. A., (2013a). "Fighting software piracy: which governance tools matter in Africa?", *Journal of Business Ethics*, 118(3), pp. 667-682.

Andrés, A. R., & Asongu, S. A., (2013b). "Global dynamic timelines for IPRs harmonization against software piracy", *Economics Bulletin*, 33(1), pp. 874-880.

Andrés, A. R., Asongu, S. A., & Amavilah, V. H. S., (2014). "The Impact of Formal Institutions on Knowledge Economy", *Journal of the Knowledge Economy*: Forthcoming. http://link.springer.com/article/10.1007%2Fs13132-013-0174-3

Anyanwu, J. C., (2012). "Developing Knowledge for the Economic Advancement of Africa", *International Journal of Academic Research in Economics and Management Sciences*, 1(2), pp. 73-111.

Anyanwu, J., (2007). "Promoting Investment in Africa", *African Development Review*, 18(1), pp. 42-71.

Anyanwu, J., (2009). "Why Does Foreign Direct Investment Go Where It Goes?: New Evidence From African Countries", *Annals of Economics and Finance*, 13(2), pp. 425-462.

Asongu, S. A. (2012a) "On the effect of foreign aid on corruption" *Economics Bulletin*, 32(3), 2174-2180.

Asongu, S. A., (2012b), "Law and finance in Africa", *Brussels Economic Review*, 55(4), pp. 385-408.

Asongu, S. A., (2012c), "Government quality determinants of stock market performance in African countries", *Journal of African Business*, 13(2), pp. 183-199.

Asongu, S. A., (2013a). "Harmonizing IPRs on Software Piracy: Empirics of Trajectories in Africa", *Journal of Business Ethics*, 118(3), pp. 667-682.

Asongu, S. A., (2013b). "African Stock Market Performance Dynamics: A Multidimensional Convergence Assessment", *Journal of African Business*, 14(3), pp. 186-201.

Asongu, S. A., (2013c). "Real and Monetary Policy Convergence: EMU Crisis to the CFA Zone", *Journal of Financial Economic Policy*, 5(1), pp. 20-38.

Asongu, S. A., (2013d, October). "Fighting African capital flight: timelines for the adoption of common policies", *The Empirical Economics Letters*, http://www.eel.my100megs.com/volume-12-number-10.htm (accessed: 30/11/2013).

Asongu, S. A., (2013e). "Modeling the future of knowledge economy: evidence from SSA and MENA countries", *Economics Bulletin*, 33(1), pp. 612-624.

Asongu, S. A., (2013f). "On the Obituary of Scientific Knowledge Monopoly", *Economics Bulletin*, 33(4), pp. 2718-2731.

Asongu, S. A., (2013g). "A brief history of Time in the monopoly of scientific knowledge", *African Governance and Development Institute Working Paper* No. 13/001.

Asongu, S. A., (2013h). "The 'Knowledge Economy'-finance nexus: how do IPRs matter in SSA and MENA countries?", *Economics Bulletin*, 33(1), pp. 78-94.

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

Asongu, S. A., (2013j). "How Would Population Growth Affect Investment in the Future? Asymmetric Panel Causality Evidence for Africa", *African Development Review*, 25(1), pp. 14-29.

Asongu, S. A., (2014a). "African Development: Beyond Income Convergence", *South African Journal of Economics*, http://onlinelibrary.wiley.com/doi/10.1111/saje.12021/abstract

Asongu, S. A., (2014b). "African Financial Development Dynamics: Big Time Convergence", *African Journal of Economic and Management Studies*, 5(2), pp. 160-194.

Asongu, S. A., (2014c). "Are Proposed African Monetary Unions Optimal Currency Areas? Real, Monetary and Fiscal Policy Convergence Analysis", *African Journal of Economic and Management Studies*, 5(1), pp. 9-29.

Asongu, S. A., (2014d). "Fighting African Capital Flight: Empirics on Benchmarking Policy Harmonization", *European Journal of Comparative Economics*, 11(1), pp. 93-122.

Asongu, S. A., (2014e). "Financial Sector Competition and Knowledge Economy: Evidence from SSA and MENA Countries", *Journal of the Knowledge Economy*: Forthcoming. http://link.springer.com/article/10.1007/s13132-012-0141-4

Asongu, S. A., (2014f). "Knowledge economy and financial sector competition in African countries", *African Development Review*, 26(2), pp. 333-346

Asongu, S. A., (2014g). "Fighting software piracy in Africa: how do legal origins and IPRs protection channels matter?", *Journal of Knowledge Economy*: Forthcoming. http://link.springer.com/article/10.1007/s13132-012-0137-0

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

Asongu, S. A., (2014i). "Globalization, (fighting) corruption and development: how are these phenomena linearly and nonlinearly related in wealth-effects?", *Journal of Economic Studies*, 41(3), pp. 346-369.

Asongu, S. A., (2014j). "The impact of health worker migration on development dynamics: evidence of wealth-effects from Africa", *The European Journal of Health Economics*, 15(2), pp. 187-201.

Asongu, S. A., & Aminkeng, G. A. A., (2013). "The economic consequences of China-Africa relations: debunking myths in the debate", *Journal of Chinese Economic and Business Studies*, 11(4), pp. 261-277.

Arvis, J-F., Marteau, J-F., & Raballand, G., (2007). "The cost of being landlocked: logistics costs and supply chain reliability", *Word Bank Working Paper Series* No. 4258.

Aubert, J. E., (2005). "Knowledge economies: A global perspective", In A. Bonfour & L. Edvinsson (Eds.), *Intellectual capital for communities*. Elsevier, Oxford.

Baliamoune-Lutz, M., (2013). "Tunisia's Development Experience: A Success Story?", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Barro, R., (1991). “Economic Growth in a Cross Section of Countries”. *Quarterly Journal of Economics* 196 (2/May): 407–443.

Barro, R. J., & Sala-i-Martin, X., (1992). “Convergence”, *Journal of Political Economy*, 100, pp. 223-251.

Barro, R. J., & Sala-i-Martin, X., (1995). *Economic Growth*. The MIT Press, Cambridge, MA.

Bartels, F. L. Napolitano, F., & Tissi, N. E., (2014). “FDI in Sub-Saharan Africa: A longitudinal perspective on location-specific factors (2003–2010)”, International Business Review: Forthcoming.

Bartels, F. L., Alladina, S. N., & Lederer, S. (2009). Foreign Direct Investment in Sub- Saharan Africa: Motivating Factors and Policy Issues, *Journal of African Business*, 10(2), 141-162.

Baumol, W. J., (1986). “Productivity, growth, convergence and welfare: what the long run data show”, *American Economic Review*, 76, pp. 1072-1085.

Beck, T., Demirgüç-Kunt, A., & Levine, R.,(2003), “Law and finance: why does legal origin matter?”, *Journal of Comparative Economics*, 31, pp. 653-675.

Bezmen, T. L., & Depken, C. A., (2004). “The impact of software piracy on economic development”, Working Paper. Francis Marion University.

Bidwell, N. J., Winschiers-Theophilus, H., Kapuire, G. K., & Rehm, M., (2011). “Pushing personhood into place: Situating media in rural knowledge in Africa”, *International Journal of Human-Computer Studies*, 69 (10), pp. 618-631.

Bizri, O., (2009). “The Knowledge economy and the Arab Countries: current climate and future prospects in education, innovation and technology”, Carthage High Level International Conference on Building Knowledge Economies for job creation, increased competiveness and balanced development. December, 1-3, 2009.

Blundell, R., & Bond, S., (1998). “Initial conditions and moment restrictions in dynamic panel data models”, *Journal of Econometrics*, 87(1), pp.115-143.

Bond, S., Hoeffler, A., & Tample, J., (2001). “GMM Estimation of Empirical Growth Models”, University of Oxford.

Boyce, J. K., & Ndikumana, L., (2008), “New Estimate of Capital Flight from Sub-Saharan African Countries: Linkages with External Borrowing and Policy Option”, *PERI Working Paper* No. 166, University of Massachusetts Amherst, USA.

Boyce, J. K., & Ndikumana, L., (1998). “Congo’s odious debt: External borrowing and capital flight in Zaire”, *Development and Change*, 29, pp. 195-217.

Boyce, J. K., & Ndikumana, L., (2001). "Is Africa a Net Creditor? New Estimate of Capital Flight from Severely Indebted Sub-Saharan African Countries, 1970-1996", *Journal of Development Studies*, 38(2), pp. 27-56.

Boyce, J. K., & Ndikumana, L., (2003). "Public Debt and Private Assets: Explaining Capital Flight from Sub-Saharan African Countries", *World Development*, 31(1), pp. 107-130.

Boyce, J. K., & Ndikumana, L., (2011). "Capital flight from sub-Saharan Africa: linkages with external borrowing and policy options", *International Review of Applied Economics*, 25(2), pp. 149-170.

Britz, J. J., Lor, P. J., Coetzee, I. E. M., & Bester, B. C., (2006). "Africa as a knowledge society: A reality check", *The International Information & Library Review*, 38, pp. 25-40.

Bruno, G., De Bonis, R., & Silvestrini, A., (2012). "Do financial systems converge? New evidence from financial assets in OECD countries". *Journal of Comparative Economics*; 40(1), pp. 141-155.

Butcher, N., (2011). *ICT in Africa. A Few Key Challenges*, in: ICT, Education, Development, and the Knowledge Society, Thematic Paper prepared for GeSCI African Leadership in ICT Program, December 2011, pp. 33-39.

Cardoso, E., (2013). "Between Past and Future of Latin America: Lessons from Brazil, Chile, Costa Rica and the Dominican Republic ", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Carisle, S., Kunc, M., Jones, E., & Tiffin, S., (2013). "Supporting innovation for tourism development through multi-stakeholder approaches: Experiences from Africa", *Tourism Management*, 35, pp. 59-69.

Chandra, D. S., & Yokoyama, K., (2011). "The role of good governance in the knowledge- based economic growth of East Asia – A study on Japan, Newly Industrialized Economies, Malaysia and China", Graduate School of Economics, Kyushu University.

Chang, H.J., (1994). *The Political Economy of Industrial Policy*. New York: St. Martin Press.

Chavula, H. K., (2010). "The Role of Knowledge in Economic Growth. The African Perspective", ICT, Science and Technology Division (ISTD),United Nations Economic Commission for Africa (UNECA).

Cogburn, D., (2003). "Governing global information and communications policy: Emergent regime formation and the impact on Africa", *Telecommunications Policy*, 27, pp. 135-153.

Dahlman, C., (2007). "The Challenge of the Knowledge Economy for Latin America", *Globalization, Competitiveness and Governability Journal*, 1(1), pp. 18-46.

Dahlman, C., Westphal, L. E., & Kim, L., (1985). "Reflections on Korea's Acquisition of Technological Capability". In N. Rosenberg and C. Frisctak (eds), International Technology Transfer: Concepts, Measures and Comparisons. New York: Pagamon.

Darley, W. K. (2012). Increasing Sub-Saharan Africa's Share of Foreign Direct Investment: Public Policy Challenges, Strategies, and Implications, *Journal of African Business,* 13(1), 62-69.

De Mello, L., (2013). "Brazil's Growth Performance: Achievements and Prospects", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Drine, I., (2013). "'Successful' Development Models: Lessons from the MENA Region", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Fofack, H., & Ndikumana, L., (2009). "Potential Gains from Capital Flight Repatriation from Sub-Saharan African Countries", *World Bank Working Paper* No. 5024.

Ford, D. M., (2007). "Technologizing Africa: On the bumpy information highway", *Computers and Composition*, 24, pp. 302-316.

Fosu, A., (2010), "Africa's Economic Future: Learning from the Past", CESifo Forum, Info Institute for Economic Research at the University of Munich, 11(1), pp. 62-71.

Fosu, A., (2012), "Development Success: Historical Accounts from More Advanced Countries", UNU-WIDER Research Paper.

Fosu, A., (2013a), "Achieving development success: Strategies and lessons from the developing world", *UNU-WIDER Policy Brief* (November).

Fosu, A., (2013b). "Country Role Models for Development Success: The Ghana Case", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Fosu, A., (2013c), "Growth of African Economies: Productivity, Policy Syndromes and the Importance of Institutions", *Journal of African Economies*, 22(4), pp. 523-551.

Fosu, A., (2013d), "Institutions and African Economies: An Overview", *Journal of African Economies*, 22(4), pp. 491-498.

Fung, M. K., (2009). "Financial development and economic growth: convergence or divergence?", *Journal of International Money and Finance*, 28, pp. 56-67.

Garoupa, N., & Jellal, M., (2007). "Further notes on information, corruption and optimal law enforcement", *European Journal of Law and Economics*, 23(1), pp. 59-69.

German, L., & Stroud, A., (2007). "A Framework for the integration of diverse learning approaches: Operationalizing agricultural research and development (R&D) linkages in Eastern Africa", *World Development*, 35(5), pp. 792-814.

Hobday, M. (1995). *Innovation in East Asia: The Challenge to Japan*. Cheltenham: Edward Elgar.

Islam, N. (2003). "What have we learnt from the convergence debate?", *Journal of Economic Surveys*, 17(3), pp. 309-362.

Islam, N., (1995). "Growth Empirics: A Panel Data Approach", *The Quarterly Journal of Economics*, 110, (4), pp. 1127-1170.

Jellal, M., & Bouzahzah, M, (2013). "Transparency and corruption: an optimal taxation policy", *European Economics Letters*, 2(2), pp. 66-70.

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

Jomo, K. S., & Wee, C. H., (2013). "Lessons from Post-Colonial Malaysian Economic Development", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Kaiser, H. F., (1974). "An index of factorial simplicity". *Psychometrika*, 39, pp. 31–36.

Kamara, A. B., Bourish, L., & Nyende, M., (2007). "Growing a Knowledge-Based Economy: Evidence from Public Expenditure on Education in Africa", *Economic Research Working Paper* No. 88.

Khan, H. A., (2013). "Development Strategies: Lessons from the Experiences of South Korea, Malaysia, Thailand and Vietnam", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Kim, S., (2013). "Korea in Africa: A Missing Piece of the Puzzle?"; (ed. Kitchen Nicolas) in Emerging Powers in Africa, pp. 51-66. http://www.lse.ac.uk/IDEAS/publications/reports/pdf/SR016/SR-016-Kim.pdf (Accessed: 14/03/2014)

Kim, Y., Lee, K., Park, W. G., & Choo, K., (2012). "Appropriate intellectual property protection and economic growth in countries at different levels of development", *Research Policy*, 41(2), pp. 358-375.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W., (1998), "Law and finance", *Journal of Political Economy*, 106, pp. 1113-1155.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W., (1999), "The quality of government", *Journal of Law, Economics and Organization*, 15, pp. 222-279.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A., (2008), "The Economic Consequences of Legal Origin," *Journal of Economic Literature*, 46(2), pp. 285-332.

Lee, K., (2013), "How can Korea be a Role Model for Catch-up Development? A 'Capability-based' View", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Lee, K., (2009), "How Can Korea be a Role Model for Catch-up Development? A 'Capability-based' View", *UN-WIDER Research Paper* No. 2009/34.

Lee, K., & Kim, B. Y., (2009), "Both Institutions and Policies Matter but Differently for Different Income Groups of Countries: Determinants of Long-Run Economic Growth Revisited", *World Development*, 37(3), 533-549.

Letiche, J. M., (2006). "Positive economic incentives. New behavioural economics and successful economic transitions", *Journal of Asian Economics*, 17, pp. 775-796.

Lightfoot, M., (2011). "Promoting the Knowledge Economy in the Arab World", London Knowledge Lab, Institute of Education.

Lin, B., (2006). "A sustainable perspective on the knowledge economy: A critique of Austrian and mainstream view", *Ecological Economics*, 60(1), pp. 324-332.

Looney, R. E., (2013). "The Omani and the Bahraini Paths to Development: Rare and Contrasting Oil-Based Economic Success Stories", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Lor, P. J., & Britz, J., (2005). "Knowledge Production from an African perspective: International information flows and intellectual property", *The International Information & Library review*, 37, pp. 61-76.

Lucas, R. E., (1988). "On the mechanics of economic development", *Journal of Monetary Economics*, 22, pp. 3-42.

Lucas, R.E., (1993). "Making a miracle", *Econometrica*, 61(2), pp. 251-272.

Lundahl, M., & Petersson. L., (2013). "Post Apartheid South Africa: An Economic Story?", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Lwoga, E. T., Ngulube, P., & Stilwell, C., (2010). "Managing indigenous knowledge for sustainable agricultural development in developing countries: Knowledge management approaches in the social context", *The International Information & Library Review*, 42(3), pp. 172-185.

Makinda, S. M., (2007). "How Africa can benefit from knowledge", *Futures*, 39, pp. 973-985.

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

Maswera, T., Dawson, R., & Edwards, J., (2008). "E-commerce adoption of travel and tourism organisations in South Africa, Kenya, Zimbabwe and Uganda", *Telematics and Informatics*, 25 (3), pp. 187-200.

Mayer-Foulkes, D., (2010). "Divergences and Convergences in Human Development". *UNDP Human Development Research Paper 2010/20*.

Monfort, P., (2008). "Convergence of EU Regions: Measures and Evolution", *European Union Regional Policy Paper* No. 01/2008.

Moodley, S., (2003). "The Challenge of e-business for the South African apparel sector", *Technovation*, 23, pp. 557-570.

Myburgh, A. F., (2011). "Legal developments in the protection of plant-related traditional knowledge: An intellectual property lawyer's perspective of the international and South African legal framework", South African Journal of Botany 77, pp. 844-849.

Narayan, P. K., Mishra, S., & Narayan, S., (2011). "Do market capitalization and stocks traded converge? New global evidence", Journal of Banking and Finance, 35, pp. 2771-2781.

Naudé, W., (2013). "Development Progress in Sub-Saharan Africa: Lessons from Botswana, Ghana, Mauritius and South Africa", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Neimark, B. D., (2012). "Industrializing nature, knowledge, and labour: The political economy of bioprospecting in Madagascar", *Geoforum*, 43, pp. 980-990.

Nguena, C. L., & Tsafack, N. R., (2014). "On the Sensitivity of Banking Activity Shocks: Evidence from the CEMAC Sub-region". *Economics Bulletin*, 34(1), pp. 354-372.

Nyarko, Y., (2013a). "Sustaining High Economic Growth in Sub-Saharan Africa: Knowledge and the Structure of the Economy", Journal of African Economies, 22, suppl_1(January), pp: -i101.

Nyarko, Y., (2013b). "The United Arab Emirates: Some Lessons in Economic Development", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

OECD (Organization for Economic Cooperation and Development) (1992). *Technology and Economy: The Key Relationships*. Paris: OECD.

Oyelaran-Oyeyinka, B., & Gehl Sampath, P., (2007). "Innovation in African Development. Case Studies of Uganda, Tanzania and Kenya", A World Bank Study. http://info.worldbank.org/etools/docs/library/239730/InnovationInAfricaFinalPaper.pdf (Accessed: 22/03/2014).

Pozo, S., Sanchez-Fung, J., & Santos-Paulino, A. U., (2013). "Economic Development Strategies in the Dominican Republic", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Preece, J., (2013). "Africa and international policy making for lifelong learning: textual revelations", *International Journal of Educational Development*, 33, pp. 98-105.

Prochniak, M., & Witkowski, B., (2012a). "Beta convergence stability among "Old" and "New" EU countries: The Bayesian Model Averaging Perspective", Warsaw School of Economics.

Prochniak, M., & Witkowski, B., (2012b). "Real economic convergence and the impact of monetary policy on economic growth of the EU countries: The analysis of time stability and the identification of major turning points based on the Bayesian methods", Warsaw School of Economics.

Raseroka, K., (2008). "Information transformation Africa: Indigenous knowledge – Securing space in the knowledge society", *The International Information and Library Review*, 40, pp. 243-250.

Robinson, J., (2013). "Botswana as a Role Model for Country Success", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Rolfe, R. J., & Woodward, D. P., (2004). "Attracting foreign investment through privatization: the Zambian experience", *Journal of African Business*, 5(1), pp.5-27.

Rooney, D., (2005). "Knowledge, economy, technology and society: The politics of discourse", *Telematics and Informatics*, 22, pp. 405-422.

Santos-Paulino, A. U., (2013). "Country Role Model of Development Success: Lessons from China and India ", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

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

Singh, N., (2013). "Democracy, Diversity and Development: India's Strategy and Outcomes", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

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

Subramanian, A., (2013). "The Mauritian Success Story and Its Lessons", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Suh, J., & Chen, D. H. C., (2007). "Korea as a Knowledge Economy. Evolutionary Process and Lessons Learned", Korea Development Institute, https://www.usp.ac.fj/worldbank2009/frame/Documents/Publications_regional/409300PAPER0KR101OFFICIAL0USE0ONLY1.pdf (Accessed: 19/03/2014).

Sumberg, J., (2005). "Systems of innovation theory and the changing architecture of agricultural research in Africa", *Food Policy*, 30 (1), pp. 21-41.

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

Solimano, A., (2013). "Three Decades of Neoliberal Economics in Chile: Achievements, Failures and Dilemmas", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Tchamyou, S. V., (2014). "The Role of Knowledge Economy in African Business", Master Thesis. HEC-Management School, University of Liège.

Thoburn, J., (2013). "Vietnam as a Role Model for Development", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Tran, M., (2011). "South Korea: a model of development?", *The Guardian*, http://www.theguardian.com/global-development/poverty-matters/2011/nov/28/south-korea-development-model (Accessed: 14/03/2014).

Trejos, A., (2013). "Country Role Models for Development Success: The Case of Costa Rica", In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Tuomi, K. (2011). The Role of the Investment Climate and Tax Incentives in the Foreign Direct Investment Decision: Evidence from South Africa, *Journal of African Business*, 12(1), 133-147.

Utterback. J. M., (1975). 'A Dynamic Model of Process and Product Innovation', *Omega*, 3 (6), pp. 649-656.

Wagiciengo, M. M., & Belal, A. R., (2012). "Intellectual capital disclosure by South African companies: A longitudinal investigation", *Advances in Accounting*, 28 (1), pp. 111-119.

Wantchekon, L., Klasnja, M., & Novta, N., (2014). "Education and Human Capital Externalities: Evidence from Colonial Benin", Department of Politics, Princeton University.

Warr, P., (2013). “Thailand’s Development Strategy and Growth Performance”, In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Weber, A. S., (2011). “The role of education in knowledge economies in developing countries”, Procedia Social and Behavioral Sciences, 15, pp. 2589-2594.

Weeks, J., (2012), “Macroeconomic Impact of Capital Flows in Sub-Saharan African Countries, 1980-2008*”, Association of Concerned Africa Scholar Bulletin*, No. 87, pp. 1-7.

World Bank (1993). *The East Asian Miracle: Economic Growth and Public Policy*. New York: Oxford University Press.

World Bank, (2007). “Building Knowledge Economies. Advanced Strategies for Development”, World Bank Institute.

Yao, Y. E., (2013). “The Disinterested Government: An Interpretation of China’s Economic Success in the Reform Era ”, In *Achieving Development Success: Strategies and Lessons from the Developing World*, ed. Fosu, A., Oxford University Press.

Zerbe, N., (2005). “Biodiversity, ownership, and indigenous knowledge: exploring legal frameworks for community, farmers, and intellectual property rights in Africa”, *Ecological Economics*, 53, pp. 493-506.