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The Comparative Economics of Knowledge Economy in Africa: Policy Benchmarks, Syndromes and Implications

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Abstract

The paper complements the scarce literature on knowledge economy (KE) in Africa by comparing KE dynamics within Africa in order to assess best and worst performers based on fundamental characteristics of the continent's development. The five dimensions of the World Bank's knowledge economy index (KEI) are employed, notably: education, information and communication technology, innovation and, economic incentives and institutional regime. The empirical evidence is based on a five-step novel approach with data from 53 African countries for the period 1996-2010. Limitations of the beta catch-up approach are complemented with the sigma convergence strategy. Based on the determined fundamental characteristics, computed dynamic benchmarks, policy syndromes and syndrome free scenarios we establish that: Landlocked, Low-income, Conflict-affected, sub-Saharan African, Non-oil-exporting and French civil law countries are generally more predisposed to lower levels of KE whereas; English common-law, Notlandlocked, Conflict-free, North African and middle-income countries are characteristics that predispose certain nations to higher KE. Broad and specific policy implications are discussed in detail.

JEL Classification: O10; O30; O38; O55; O57
Keywords: Knowledge economy; Benchmarks; Policy syndromes; Catch-up; Africa

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1. Introduction

The relevance of knowledge economy (KE) in twenty first century development is now a widely accepted consensus. It has been a dominant discourse in leading development reports (World Bank, 2007; Weber, 2011). While Europe & North America have remained dominant in the pursuit of KE and Asian & Latin American countries have been witnessing a significant progress (Dahlman, 2007; Lee, 2009; Chandra & Yokoyama, 2011; Kim, 2013; Tran, 2012; Tchamyou, 2014), Africa's knowledge index has dropped in the period 2000 to 2009 (Anyanwu, 2012).

In critically reviewing African growth and development strategies, Babatunde (2012) has broadly recommended more regional integration and investing in KE. We provide a five-step novel approach to assessing whether African economies are integrated in the latter by: first defining the fundamental characteristics of African development; second, presenting benchmarks in KE dimensions corresponding to these fundamental features; third, examining the gaps in KE among various fundamental characteristics; fourth, deriving 'policy syndrome' and 'syndrome free' countries[2] and; finally providing policy implications based on the syndromes established. The above five-point positioning is broadly consistent with a strand of recent KE-based studies that has emphasized a greater need for catch-up in the phenomenon (Aubert, 2005; Britz et al., 2006; Makinda, 2007; AfDB, 2007; Bizri, 2009; Amavilah, 2009; Chavula, 2010; Lightfoot, 2011; Andrés & Asongu, 2013ab; Asongu, 2013a; Nyarko, 2013a; Andrés et al., 2014).

The scope of this study starkly deviates from the mainstream discourses of African-dominant KE literature[3]. By using the five-step methodology outlined above in the second

[2] According to the author, such syndromes are thought to have considerably contributed to the deplorable post-independence economic prosperity of the African continent. Within the framework of this study, 'policy syndrome' refers to unappealing trends or positive KE deviations between benchmark and frontier fundamental characteristics. Therefore growing dispersions in a given KE component reflects 'policy syndromes' (PS) while a tendency showing reducing dispersions is qualified as a 'syndrome-free' (SF) trend.

[3] As far as we have reviewed, the current extant of literature has focused on, amongst others: broad discussions on KE (Rooney, 2005; Lin, 2006; Anyanwu, 2012); information & communication technologies (Butcher, 2011); education (Ford, 2007; Weber, 2011; Wantchekon et al., 2014); institutional regime & economic incentives (Cogburn, 2003; Letiche, 2006; Saxegaard, 2006; Andrés & Asongu, 2013a; Nguena & Tsafack, 2014); innovation (Oyelaran-Oyeyinka & Sampath, 2007; Carisle et al., 2013); intellectual capital & economic development (Wagiciengo & Belal, 2012; Preece, 2013); research & development (German & Stroud, 2007; Sumberg, 2005); indigenous knowledge systems (Raseroka, 2008; Lwoga et al., 2010); intellectual property rights (Zerbe, 2005; Lor & Britz, 2005; Myburgh, 2011; Andrés & Asongu, 2013ab; Andrés et al., 2014; Asongu, 2013a); KE in the transformation of space (Moodley, 2003; Maswera et al., 2008); spatiality in knowledge production (Bidwell et al., 2011; Neimark, 2012) and catch-up in KE in light of the East Asian miracle (Lucas, 1988, 1993; Bezmen & Depken, 2004; Andrés et al., 2014; Kim et al., 2012; Andrés & Asongu, 2013ab).

paragraph, we clearly steer clear of the last strand (catch-up in KE) which is the stream in the literature closest to the focus of the present paper. This goes a short-way to extending another interesting stream of works on achieving development success with strategies and lessons from other developing countries (Wa Gĩthĩnji & Adesida, 2011; Fosu, 2013a)[4].

The four dimensions of the World Bank's Knowledge Economy Index (KEI) are used, notably: education, innovation, information & communication technology (ICT) and economic incentives & institutional regime. In order to ensure that our investigations are robust, we employ *beta* and *sigma* convergence empirical strategies. The former investigates three main issues: evidence of catch-up or KE gaps, the rate or speed of catch-up and the time needed for full catch-up. The latter complements the former (beta catch-up) because it is a necessary but not a sufficient condition for convergence to take place. The analysis is based on thirteen panels. In essence, the richness of the dataset enables us to disaggregate sampled countries into fundamental characteristics of KE according to: legal origins, income-levels, openness to sea, political stability, petroleum-exporting and regional proximity.

In light of the above, the contribution of this paper to the literature is threefold. First, it provides a diagnosis of KE in African peripheral panels with respect to leading or core fundamental characteristics in the continent. The catch-up dynamics and convergence evidences from *beta* and *sigma* specifications therefore inform policy on the measures needed to bridge gaps in KE. The decomposition of countries into fundamental characteristics of income, legal origin, landlockedness, political stability, regional proximity and natural resources allow for greater subtlety in the policy implications. Second, the corresponding derivation of 'policy syndrome' and 'syndrome free' countries presents to the best of our knowledge the first decomposition of Africa into core and peripheral countries based on KE dimensions. This second contribution also informs policy on the effectiveness of regional integration efforts in KE dimensions. Third, based on the KE dispersions and policy syndromes, we are able to provide the much needed policy guidance on measures needed to bridge the KE gaps.

[4] Learning from the past (Fosu, 2010), Fosu (2012, 2013a) has substantially documented lessons and strategies on achieving development success. Such lessons are drawn from: the emerging Asian giants of China & India (Singh, 2013; Yao, 2013; Santos-Paulino, 2013); East Asia & the Pacific (Lee, 2013; Jomo & Wee, 2013; Warr, 2013; Thoburn, 2013; Khan, 2013); sub-Saharan Africa (Robinson, 2013; Subramanian, 2013; Lundahl & Petersson, 2013; Fosu, 2013b; Naudé, 2013); Latin America & the Caribbean (De Mello, 2013; Solimano, 2013; Trejos, 2013; Pozo et al., 2013; Cardoso, 2013) and; the Middle East & North Africa (Looney, 2013; Baliamoune-Lutz, 2013; Nyarko, 2013b; Drine, 2013).

The remainder of the study is organized in the following manner. Section 2 discusses the intuition, theoretical underpinnings and details of the literature highlighted above. The data and methodology are covered in Section 3. Section 4 focuses on the empirical analysis, discussion of results and policy implications. We conclude with Section 5.

2. Intuition, theoretical underpinnings and KE literature

The theory and intuition underpinning this assessment of KE catch-up is broadly in accordance with income convergence literature that have been substantially documented in the context of neoclassical models of growth which have also been extended to other domains of development economics (Swan, 1956; Barro, 1991; Solow, 1956; Baumol, 1986; Mankiw et al., 1992; Barro & Sala-i-Martin, 1992, 1995; Fung, 2009; Mayer-Foulkes, 2010; Narayan et al., 2011; Andrés & Asongu, 2013ab; Bruno et al., 2012; Asongu, 2014abc, 2013abc). It is in this perspective that the theoretical underpinnings have motivated the intuition backing the timing/modeling/harmonization of intellectual property rights (IPRs) against the piracy of software (Andrés & Asongu, 2013b; Asongu, 2013a), common initiatives in the battle against capital flight (Asongu, 2013d, 2014d), future trends in KE (Asongu, 2013e,f,g) and the health of financial markets and currency areas (Narayan et al., 2011; Bruno et al., 2012; Asongu, 2013bch, 2014bc).

To the best of our knowledge, the current extant of African-dominated KE literature can be discussed in twelve main streams, inter alia: general postulations on KE, KE in the transformation of space, spatiality in knowledge production, IPRs, research and development (R&D), indigenous knowledge systems, intellectual capital and economic development, institutional regime and economic incentives, innovation, ICT, education, and KE catch-up in light of the East Asian Miracle (Asongu, 2014d; Tchamyou, 2014).

General discussions about KE are presented in the first strand. The principal discourses about society, knowledge, economy and technology are analyzed by Rooney (2005) to conclude that technocracy and understanding of KE are limited in a number of dimensions. In rethinking the nexus between KE and growth Lin (2006) has discussed some important and neglected areas, notably: the important role of knowledge in easing inclusive growth and environmental sustainability. The general state of knowledge in the continent has been examined by Anyanwu (2012) who has established that Africa is substantially lagging relative to other regions and

advanced economies. According to the author, the knowledge index in Africa fell during the period 2000 and 2009.

The second strand is devoted to KE in the transformation of space. In this stream, Moodley (2003) has investigated the importance of (e)-business in South Africa's apparel sector. The author, inter alia discusses the challenges, risks and opportunities of e-business. Maswera et al. (2008) have also assessed the rate at which the tourism organization is adopting e-commerce via websites in the continent to conclude that while such sites may be informative, they are also substantially lacking-in interactive facilities that are essential for good e-transactions.

The spatiality of knowledge production is the object of the third strand. Here Bidwell et al. (2001) have accomplished quite a stride in investigating how rural community needs and heritages can be adapted to technology. Their study furnishes interesting insights into how these communities spatially and temporarily manage the flow of information. The political economy of bio-prospecting has been critically assessed and discussed by Neimark (2012) on Madagascar.

IPRs are covered in the fourth strand. Timelines for IPRs harmonization at the global and African levels have been respectively presented by Andrés and Asongu (2013b) and Asongu (2013a). Given the instrumentality of IPRs, the control of corruption is the best weapon in the battle against software piracy (Andrés & Asongu, 2013a) and enforcement of IPRs via formal governance mechanisms are not sufficient conditions for KE (Andrés et al., 2014). Here Lor and Britz (2005) have investigated tendencies in knowledge, coupled with their impact on international information flow to provide three ethical poles with which to explain such flows: human rights, common good and social justice. The Legislation of the African Union meant for the protection of indigenous knowledge has been assessed by Zerbe (2005) who conclude that it meets the needs and requirements of member states by defining a fine balance between the monopoly rights and rights of the indigenous/local population. In the same vein, the legal processes required in plant-related digital knowledge protection have been reviewed by Myburgh (2011): an IPR lawyer who has presented his/her views on recent changes in the upholding of traditional knowledge that is plant-based.

R&D is embodied in the fifth strand. Here German and Stroud (2007) have tried to understand the application of R&D and presented types, lessons and implications of learning approaches. Accordingly, this stream is consistent with the need for more investment in R&D

(African Development Bank, 2007; Chavula, 2010; Anyanwu, 2012), especially to limit the monopoly of scientific knowledge/publications by Western countries (Asongu, 2013fg).

In highlighting 'indigenous knowledge systems' in the sixth strand, Roseroka (2008) presents a case for the comparative advantage of oral knowledge after examining mechanisms by which to save the space of indigenous know-how. In the same vein, after applying knowledge management approaches to indigenous KE, Lwoga et al. (2010) have concluded that knowledge management schemes can be employed to manage indigenous knowledge when distinct characteristics are controlled.

The seventh strand on 'intellectual capital and economic development' is principally focused on discussing lifelong learning and information disclosure. Wagiciengo and Belal (2012) have investigated intellectual capital disclosure to establish that intellectual capital is growing in African corporations. The relationship between development assistance and lifelong learning is assessed by Preece (2013) to conclude that international aid priorities have a negative effect on the choice of domestic governments and their incidence on lifelong learning. While Asongu and Nwachukwu (2015) have not confirmed the Preece hypothesis from demand-side empirics in Africa, using the same measurements of lifelong learning, they have established its positive role on political stability and non-violence (Asongu & Nwachukwu, 2016).

In the interesting eighth strand on 'economic incentives & institutional regime', Cogburn (2003) has tried to elucidate the transition in international communications regimes and provided more valuable insights into best practices and lessons for other developing countries. Behavioral economics has been employed by Letiche (2006) to comprehend the success stories of economic transitions and disclosed a valuable analysis on how economies with different customs, traditions, inter alia, go through transition. Corruption-control is the best good governance dynamic in fighting software piracy (Andrés & Asongu, 2013a) and the enforcement of IPRs through good governance mechanisms is not a sufficient condition for KE (Andrés et al., 2014). Over-liquidity in African financial institutions is also standing on the way to proper economic incentives because economic operators are not given the means to finance their investment opportunities/plans (Saxegaard, 2006; Fouda, 2009; Nguena & Tsafack, 2014; Tchamyou, 2014).

In the ninth strand, there is growing recognition that innovation is a principal engine for modern economic prosperity and industrial productivity. This thesis is sustained by Oyelaran-Oyeyinka and Sampath (2007) in their interesting work on 'innovation in African development'.

After examining innovation for tourism, Carisle et al. (2013) have established that institutions have a critical role in consolidating best practices, networking and transfer of knowledge. In essence, the imperative of innovation in African development has been substantially documented in this stream (Anyanwu, 2012; Asongu, 2013eh; Tchamyou, 2014).

In the tenth strand on ICT, the African Partnership Forum (2008) has established that the continent is on the right track and ICTs are substantially contributing to improving economic prosperity and reducing poverty. The narrative sustains that ICTs create new income generating avenues, improve governance, ameliorate efficiency, provide more leverage for the poor to voice themselves and enable access to novel markets and services. This narrative is consistent with the bulk of ICT-focused literature (Chavula, 2010; Butcher, 2011; Asongu, 2013i; Aker & Mbiti, 2010; Demonbynes & Thegeya, 2012; Maurer, 2008; Merritt, 2010; Jonathan & Camilo, 2008; Ondiege, 2010; Penard et al., 2012; Thacker, & Wright, 2012; Tchamyou, 2014).

Concerning the eleventh strand on education, the state and crucial challenges for Africa in the digital age have been examined by Ford (2007). The production and value of doctoral theses have been assessed by Amavilah (2009) who concludes that more investment is essential for education to sustainably drive KE. Weber (2011) investigates the essence of education in KE and establishes that education diversifies the economy, preserves integrity of cultures and ends illiteracy. The positive externalities of education in human capital have been examined by Wantchekon et al. (2014). In response to the August 15th 2013 Shanghai university rankings publication, Asongu (2013f) has investigated the future of scientific monopoly to conclude that African nations are failing to catch-up.

The last strand concerns catch-up in KE and the East Asian Miracle. An elaborate discussion on the debate over the miracle (which is not the scope of this paper) has been substantially covered by Asongu (2014d) with an interesting plethora of literature (Lucas, 1988, 1993; Bezmen & Depken, 2004; Kim et al., 2012; Lee, 2009; Kim & Lee, 2009; Amsden 1989; Chang 1994; World Bank 1993; Utterback, 1975; OECD, 1992; Hobday, 1995; Dahlman et al., 1985; Andrés & Asongu, 2013a; Andrés et al., 2014; Asongu, 2013g, 2014g). What is interesting however for the scope of this study is how the literature has influenced KE catch-up studies. There has been a growing stream of African oriented works devoted to this miracle, inter alia: the use of governance channels in the enforcement of IPRs for KE in the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) (Andrés et al., 2014); timelines for the

battle against software piracy (Andrés & Asongu, 2013b; Asongu, 2013a); corruption being the greatest deterrent to KE by fueling piracy (Andrés & Asongu, 2013a); the relevance of IPRs in the KE-finance relationship (Asongu, 2013h); the future of KE (Asongu, 2013e) and catch-up in research for scientific publications (Asongu, 2013fg); dynamics of KE and competition in the financial sector (Asongu, 2014ef); the relevance of IPRs protection channels and KE in the piracy fight (Asongu, 2014g), the pro-poor quality of piracy in Africa (Asongu, 2014h) and, fresh South Korean KE lessons to Africa (Asongu, 2014d).

The twelve strands above have one common denominator: the need for more KE in Africa. We extend the plethora of studies by using a five-step methodology outlined in the second paragraph of the introduction. Among studies in the engaged literature, Asongu (2014d) is the closest to the present line of inquiry. While the underline paper is based on a 'between' assessment (South Korea versus African countries), the present line of inquiry is based on a 'within assessment' (Benchmark African fundamentals versus African fundamentals).

Consistent with Asongu (2013g), it is logical to expect convergence in KE for several reasons. The availability of skilled workers and teachers, migration of technical experts from leading nations and students trained abroad are imperative in enabling a conducive atmosphere for catch-up in KE (Kim & Nelson, 2000; Mowery & Sampat, 2005; Morrison et al., 2009). Accordingly, what is essential today in the catch-up phenomenon is that applied and basic quests for knowledge, along with other KE ingredients are keys to providing inputs for growth and innovation (Morrison et al., 2009; Balconi et al., 2010). In the same vein, Mazzoleni and Nelson (2007) have presented two justifications on which to expect catch-up in KE: the changing nature of science and technology (D'Este & Patel, 2007) and; the effect of globalization on the diffusion of know-how. In a nutshell, catch-up in KE for twenty-first century development is a widely accepted consensus (Albuquerque, 2000; Esler & Nelson 1998; Jelili & Jellal, 2002; Wolff & Jellal, 2003; Murray & Stern, 2005; Mowery & Sampat 2005; Mazzoleni, 2008).

3. Data and methodology

3.1 Data

The study investigates a panel of 53 African countries with data from World Development Indicators and Principal Component Analysis (PCA) for the period 1996-2010. The starting date is 1996 because good governance indicators only date from there. Consistent with the underpinning literature (Andrés et al., 2014; Asongu, 2013b), the World Bank four KEI variables

are employed, notably: innovation, education, ICT and economic incentives & institutional regime. The means by which the KE variables are aggregated by PCA is discussed in the methodology section below.

Consistent with Asongu (2014d), we devote space to clarifying the choice of fundamental characteristics in KE. These include: openness to sea (landlocked versus (vs) not landlocked), legal origins (English common law vs French civil law), regional proximity (North Africa vs sub-Saharan Africa), political stability (conflict-affected vs stability), income-levels (low- vs middle-income) and natural resources (non-petroleum vs petroleum exporting) countries. This segmentation is consistent with recent literature on KE (Asongu & Andrés, 2013b).

First, legal origin has been substantially documented to affect openness, economic growth and education (Agbor, 2011), the quality of institutions (La Porta et al., 1998, 1999) and adaptation to changes in and evolution of economic conditions (Beck et al., 2003). It has been established that English common law countries provide for more economic incentives and better educational facilities that reward them with higher levels of economic prosperity, relative to French civil law countries. The thesis that English common law countries are better in institutional quality, documented by La Porta et al. (1998, 1999) has been validated in Africa (Asongu, 2012ab). The intuitive premise for this category is that the institutional web of formal rules, informal norms and enforcement characteristics substantially affect the institutional regime dimension of KE. We used La Porta et al. (2008, p. 289) in selecting countries in this category.

Some issues of selection may arise with categorizing the 'conflict-affected' strand. Accordingly, a practical concern affects the assignment of a country to this category in a non-arbitrary and exclusive manner, essentially because: (1) one would hardly find a country that does not experience some degree of internal strife and; (2) classification should be constrained by the periodicity of instability and degree of significance in the strife. In light of the above, we present this category in two-groups. The first consists of countries that have actually experienced 'civil war', notably: Sudan, Somalia, Burundi (1993-2005), Côte d'Ivoire (1999 coup d'état, 2002-2007 civil war, rekindled in 2011), Sierra Leone (1991-2002), Angola (1975-2002), Central African Republic (the 2004-2007 Bush War and the wave of aborted coup d'états between 1996-2003), Chad (2005-2010), Congo Democratic Republic and, Liberia (1999-2003). In the second group, we include Nigeria and Zimbabwe due to the severity of their internal strife in the sampled

period. The underpinning logic for this categorization is that political strife/conflicts are unfavorable for KE.

In the third category on 'petroleum exporting countries', two concerns also arise. First, owing to a decline in production or a recent discovery of oil, a nation can qualify only for a portion of the sampled periodicity. Second, certain countries like Botswana could display macroeconomic features that are consistent with those of countries exporting oil. In order to address these constraints, we take a minimalistic strategy and choose countries only on the basis that their exports have been oil-dominated over the past decade. These countries include: Angola, Algeria, Cameroon, Chad, Gabon, Equatorial Guinea, Nigeria, Libya, Congo Republic and, Sudan.

The fourth category on wealth-effects is selected on the basis of income-levels for two main reasons. First of all, economic prosperity should intuitively be associated with higher levels of KE. Second, the wealth of African countries has been recently documented to be instrumental to the institutional regime component of KE (Asongu, 2012c). Borrowing from Asongu (2014i), we use the Financial Development and Structure Database (FDSD) of the World Bank in presenting countries for this category in terms of low- and middle-income.

The distinction between Sub-Saharan and North African countries in the fifth category has two principal motivations. First, in line with Boyce and Ndikumana (2008), this distinction is in accordance with the World Bank's regional categorization, essential for more policy implications. Second, from intuition, proximity to more advanced economies (e.g Europe) is more likely to affect a regional move towards KE.

It is logical to assume in the sixth category that being 'open to the sea' has a comparative KE advantage. Accordingly, landlockedness may deprive some countries from essential components of KE such as openness and lower competitive costs. These assumptions are broadly in line with the institutional cost of being landlocked (Arvis et al., 2007). On a balanced note, landlockedness could also predispose some countries to put more KE efforts (e.g Rwanda).

Before we dive into the methodology section, it is important to highlight that some nations have qualified for many categories in the above classification. Hence, in contrast to Weeks (2012), no categorical priorities have been imposed. Thus, a nation could quality for many categories as long as it has the categorical features of the selection criteria. The categories are clearly defined in Appendix 4. Moreover, the variables are defined in Appendix 1, the summary

statistics presented in Appendix 2 and Appendix 3 displays the correlation matrix, which is a prerequisite for the PCA.

3.2 Methodology

While the categorization of countries above has been the first phase of the five-step procedure outlined in the second paragraph of the introduction, this methodology section handles the second and third phases, notably: presenting benchmarks in KE dimensions corresponding to the defined fundamental characteristics and examining gaps in KE among various fundamental characteristics. The last-two steps (policy syndromes and implications) are detailed in the presentation of results (see Section 4.3).

Principal component analysis (PCA) is first used to reduce dimensions in the plethora of KE variables (Section 4.1). The gaps in KE are subsequently investigated by means of absolute *beta* and *sigma* convergence estimation strategies. The latter estimation technique is employed as a complementary strategy for two main reasons: the possibility of multiple equilibria (Asongu, 2014a: Monfort, 2008, p. 4-5) and the fact that the former is a necessary but not a sufficient condition for convergence to actually occur (Islam, 2003).

4. Empirical Analysis

4.1 Principal Component Analysis

In accordance with the discussed KE literature (Asongu, 2013eh, 2014ef), we use PCA to reduce the dimensions of KE indicators because constituents of the dimensions could be correlated with one another. Therefore given high degree of substitution, there is redundancy of information. This concern is addressed with PCA which is a standard technique employed to reduce highly correlated sets of indicators into a smaller set of less correlated indicators called principal components (PCs). These PCs represent a substantial portion of the variation in the initial dataset. We use the Jolliffe (2002) and Kaiser (1974) criterion which recommends that only PCs with eigenvalues greater than unity (or the mean) should be selected. The criterion is chosen because it summarizes highly correlated variables into a single composite indicator and has been employed in recent African KE literature (Tchamyou, 2014; Andrés et al., 2014). The retained eigenvalues correspond to the eigenvectors that denote a significant variation in the initial data.

From Table 1 below, it can be observed that the education index (*Educatex*) which is the first PC of primary school enrolment (PSE), secondary school enrolment (SSE) and tertiary school enrolment (TSE) account for more than 65% of information in the constituent variables and has an eigenvalue of more than one (1.975). In the same vein, moving vertically downwards: *ICTex*, accounts for about 73% of the variability; *Innovex*, more than 91%; *Creditex*, about 65% and; *Instireg*, more than 77%.

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

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

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 Benchmarks

After determining the fundamental characteristics and reducing the dimensions of the KE components, deriving benchmarks is indispensible for the empirics. Essentially, while the fundamental characteristics are 'peripheral', the benchmarks are 'core' in the assessment of KE gaps. The benchmarks presented in Table 2 are derived from Appendix 5. They are defined (for each period and KE dimension) as the fundamental characteristic with the highest mean value. An important question that may concern a curious scientific mind is why higher values in PCs within a fundamental feature (and for a given KE dimension) should reflect higher values in KE. In other words, what is the intuition for such an attribution?

The intuition is consistent with the *de jure* (KAOPEN) measurement of capital account openness by Chinn and Ito (2002). Accordingly, KAOPEN is defined as the first PC of four

binary indicators of the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) and it takes higher values for financial regimes that are more open[5].

Table 2: Derivation of Dynamic Benchmarks

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Educatex	Mid.I	Mid.I	Mid.I	NA	NA	Mid.I	Oil	NA	NA	NA	NA	Mid.I	Mid.I	NA	Mid.I
ICTex	Mid.I	Mid.I	Mid.I	Mid.I	Mid.I	Mid.I	Mid.I	Mid.I	NA	NA	NA	NA	NA	NA	NA
Innovex	Mid.I	Mid.I	Mid.I	Mid.I	Mid.I	NOil	Mid.I	Mid.I	Eng	Eng	Eng	Eng	Mid.I	Mid.I	Mid.I
Instireg	LL	---	Mid.I	---	Mid.I	---	Mid.I	Mid.I	Mid.I	Mid.I	Eng	Eng	Eng	Eng	Eng
Creditex	Con	Con	Con	Con	Con	Con	NLL	Con	Con	Con	NLL	NLL	NLL	NLL	Con

Educatex: Education index. ICTex: Information & Communication Technology (ICT) index. Innovex: Innovation index. Instireg: Institutional Regime. Creditex: Economic Incentives. Mid. I: Middle Income countries. Eng: English Common law countries. Oil: petroleum exporting countries. NOil: Non-petroleum exporting countries. LL: Landlocked countries. NLL: Not Landlocked countries. Con: Conflict affected countries. NA: North Africa. (---): not available due to missing data.

It can be observed from the table above that, consistent with intuition and the predictions of economic theory (discussed in Section 3.1), Middle-Income, North African and English Common law countries are overwhelming benchmarks in the first-four KE components. On the other hand the provision of credit facilities (relative to GDP) may substantially increase in post-war economies, which partly explains the dominance of Conflict-affected countries in the last KE component (*Creditex*).

4.3 Knowledge Economy Gaps

4.3.1 Absolute Beta Convergence

4.3.2.1 Catch-up specification

Consistent with recent literature (Fung, 2009; Asongu, 2014ad), catch-up is estimated with the two equations below:

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

[5] We have provided theoretical justifications for the PCA in Section 4.1. However, in light of this benchmarking justification, it is also relevant to highlight some empirical intuition for the PCA. The KE indexes are better representations of the KE dimensions because they may have different dynamics. For instance many studies have recently been complementing KAOPEN with *de facto* capital openness or Foreign Direct Investment (FDI) because the former may not quite account for the flow and actual ebb of cross border capital and its impact (Aizenman et al., 2009). And very recently studies have found that China is *de facto* (FDI) open despite being *de jure* closed. This has been object of discussions in research circles (Prasad & Wei, 2007; Aizenman & Glick, 2009; Shah & Patnaik, 2009; Batuo & Asongu, 2014).

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

Such that $a = 1+\beta$, $Y_{i,t}$ is the measure of a KE dimension at period t in country i. $W_{i,t}$ is a vector of KE determinants, ξ_t is a time-specific constant, η_i is a country-specific effect and $\varepsilon_{i,t}$ an error term. With respect to the theory on exogenous growth, a negative coefficient of β in Eq. (1) implies that nations are relatively close to their steady-state or equilibrium in KE will witness a slowdown in the phenomenon, known as beta catch-up (Narayan et al., 2011, p. 2773). Within the same perspective, in accordance with Fung (2009, p. 59), if $0 < |a| < 1$ in Eq. (2), then $Y_{i,t}$ is dynamically stable around the course with a growth rate the same as that of W_t, and with a level relative to the height of W_t (Asongu, 2014ad). The vector of $W_{i,t-\tau}$ and the individual-effect η_i appreciate the long-term level KE is converging to. In essence, the country-specific effect η_i proxies for other determinants of a country's steady state not captured by $W_{i,t-\tau}$. For convergence to occur, $W_{i,t}$ has to exhibit strict exogeneity. Eq. (3) below (in first difference) which eliminates the individual-specific effect is used to partially address this concern.

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

We prefer the system (Arellano & Bover, 1995; Blundell & Bond, 1998) to the difference (Arellano & Bond, 1991) GMM estimator in accordance with Bond et al. (2001, pp. pp. 3-4). Moreover, a *two-step* specification is preferred to a *one-step* procedure because it controls for heteroscedasticity.

Given the fact that yearly spans are inappropriate for assessing convergence because short-term disturbances may substantially loom, we use three year non-overlapping intervals (NOI). Therefore, τ is set to 3. Hence to calculate the implied convergence rate, we compute 'a/3' or '1+β/3' because 3 NOI have been employed to absorb short-term disturbances. The condition for convergence to occur is the following information criteria: β<0 or $0 < |a| < 1$. We choose the latter in a bid to avoid arithmetic gymnastics[6]. In line with this narrative, when the absolute value

[6] Accordingly, in line with Asongu (2014ad) , in a standard dynamic GMM approach, the estimated lagged value is a from which 1 is subtracted to obtain β (β= a-1). In this context, the information criterion for *beta*-convergence

of the estimated lagged coefficient is greater than zero but less than one ($0 < |a| < 1$), evidence of convergence is confirmed. Therefore past variations have a less proportionate impact on futures differences or the left hand side of Eq. (3) is decreasing over time because the country is approach its steady state or equilibrium. The Arellano & Bond autocorrelation (AR(2)) test and Sargan overindentifying restrictions (OIR) test are employed to investigate the absence of autocorrelation and validity of the instruments respectively.

4.3.2.2 Presentation of absolute beta catch-up results

In the first estimation procedure documented in this section, three concerns are investigated: (1) evidence of catch-up; (2) the rate of catch-up and; (3) the period of time needed for full catch-up. The findings of Table 4 are summarized in Table 3 below. Due to the shortcoming of conditional *beta* catch-up, we are only concerned with absolute or unconditional *beta* convergence[7]. Therefore this form is assessed in the absence of $W_{i,t}$: i.e, with only the lagged value of the endogenous indicator as exogenous variable.

As highlighted in the preceding section, two tests have used to examine the validity of the models: the AR(2) and Sargan OIR tests. The former examines the null hypothesis for the absence of autocorrelation in the residuals while the latter assesses the null hypothesis for the absence of correlation between the instruments and the error terms. Therefore, failing to reject the null hypotheses of either test is necessary for model validity. From the results presented in Table 4 below, the nulls of the two tests are rejected overwhelmingly.

Before we dive into the discussion of results, it is important to elucidate how the numbers in Table 3 are arrived at. In the case of *Innovex* (oil exporting countries), given an initial lagged value of 0.89 (consistent with the information criterion: $0 < |a| < 1$), the rate of catch-up is 29.66% per annum ((0.89/3)*100) and the corresponding period required to achieve 100% or full catch-up is 10.11 years (300%/29.66% per annum).

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is $\beta < 0$. Thus, in a bid to limit the arithmetic gymnastics, a could directly be reported and the second information criterion ($0 < |a| < 1$) used to determine convergence. This interpretations are consistent with recent convergence literature (Prochniak & Witkowski, 2012a, p. 20; Prochniak & Witkowski, 2012b, p. 23; Asongu, 2013a, 2014a).

[7] Conditional convergence is contingent on the variables we choose and empirically test which may not reflect all the changes necessary for conditional convergence to occur. It should be noted that this form of catch-up is that in which countries differ in macroeconomic and institutional characteristic that determined the endogenous variable.

Based on the results summarized in Table 3, the following conclusions could be drawn. First, there is an overwhelming absence of catch-up in education, ICT and economic incentives. Second, some scanty evidence of convergence is visible in innovation and institutional regime. The catch-up rate ranges from 23.66% (Conflict category of institutional regime) to 30.66% (Landlocked strand of innovation) with corresponding periods to full (100%) catch-up of 12.67 years and 9.78 years respectively.

Table 3: Summary of sigma convergence 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)	No	No	No	No	No	No	No	No	No	No	No	No	No
Rate of C (%)	---	---	---	---	---	---	---	---	---	---	---	---	---
Time to FC (Yrs)	---	---	---	---	---	---	---	---	---	---	---	---	---

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)	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No	No	No
Rate of C (%)	27.00	---	---	---	29.66	---	30.66	---	30.00	---	---	---	---
Time to FC (Yrs)	11.11	---	---	---	10.11	---	9.78	---	10.00	---	---	---	---

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)	No	No	No	No	No	No	No	No	Yes	No	No	No	No
Rate of C (%)	---	---	---	---	---	---	---	---	23.66	---	---	---	---
Time to FC (Yrs)	---	---	---	---	---	---	---	---	12.67	---	---	---	---

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	No	No	No	No	No	No	No	No	No	No
Rate of C (%)	---	---	---	---	---	---	---	---	---	---	---	---	---
Time to FC (Yrs)	---	---	---	---	---	---	---	---	---	---	---	---	---

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 4: 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	0.293	-0.021	**1.07*** **	16.872	0.800	**1.17*** **	-0.512	-9.265	0.393	1.518	1.503	0.657	1.574
	(0.700)	(0.982)	**(0.000)**	(0.644)	(0.523)	**(0.000)**	(0.669)	(0.365)	(0.305)	(0.211)	(0.389)	(0.352)	(0.215)
AR(2)	**(0.330)**	**(0.567)**	**(0.427)**	na	**(0.560)**	**(0.262)**	**(0.316)**	**(0.249)**	**(0.318)**	**(0.437)**	**(0.807)**	**(0.389)**	**(0.341)**
Sargan	**(0.997)**	**(0.999)**	**(0.996)**	**(1.000)**	**(0.995)**	**(0.993)**	**(0.999)**	**(1.000)**	**(0.997)**	**(0.989)**	**(0.986)**	**(0.988)**	**(0.993)**
Wald	0.147	0.0004	**21.0*** **	0.212	0.407	**12.68*** **	0.182	0.820	1.051	1.560	0.742	0.864	1.534
	(0.700)	(0.982)	**(0.000)**	(0.644)	(0.523)	**(0.000)**	(0.669)	(0.365)	(0.305)	(0.211)	(0.389)	(0.352)	(0.215)

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	3.014	**3.13*** **	-1.202	8.855	**5.457***	1.368	2.434	2.176	3.490	5.617	0.027	**2.44*** **	4.348
	(0.192)	**(0.000)**	(0.728)	(0.266)	**(0.055)**	(0.897)	(0.101)	(0.107)	(0.195)	(0.213)	(0.981)	**(0.000)**	(0.221)
AR(2)	**(0.314)**	**(0.639)**	**(0.246)**	**(0.490)**	**(0.443)**	**(0.466)**	**(0.320)**	**(0.354)**	**(0.312)**	**(0.711)**	**(0.286)**	**(0.412)**	**(0.510)**
Sargan	**(0.996)**	**(0.998)**	**(0.994)**	**(0.999)**	**(1.000)**	**(0.960)**	**(0.997)**	**(0.999)**	**(0.998)**	**(0.999)**	**(0.998)**	**(1.000)**	**(0.999)**
Wald	1.699	**11.2*** **	0.120	1.236	**3.662***	0.016	2.684	2.597	1.675	1.546	0.0005	**45.8*** **	1.491
	(0.192)	**(0.000)**	(0.728)	(0.266)	**(0.055)**	(0.897)	(0.101)	(0.107)	(0.195)	(0.213)	(0.981)	**(0.000)**	(0.221)

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	**0.81*** **	**1.629***	**1.28*** **	-0.034	**0.89*** **	0.577	**0.92*** **	0.489	**0.90*** **	0.667	0.029	-0.919	-2.189
	(0.001)	**(0.063)**	**(0.000)**	(0.984)	**(0.000)**	(0.501)	**(0.000)**	(0.690)	**(0.000)**	(0.460)	(0.990)	(0.797)	(0.832)
AR(2)	**(0.332)**	**(0.271)**	**(0.316)**	**(0.340)**	**(0.317)**	**(0.165)**	**(0.317)**	**(0.171)**	**(0.317)**	**(0.174)**	**(0.272)**	**(0.167)**	**(0.240)**
Sargan	**(0.995)**	**(0.991)**	**(0.998)**	**(0.993)**	**(0.962)**	**(0.994)**	**(0.962)**	**(0.984)**	**(0.963)**	**(0.994)**	**(0.985)**	**(0.991)**	**(0.986)**
Wald	**10.5*** **	**3.445***	**284*** **	0.000	**65.7*** **	0.452	**80.6*** **	0.158	**70.83*** **	0.544	0.000	0.065	0.045
	(0.001)	**(0.063)**	**(0.000)**	(0.984)	**(0.000)**	(0.501)	**(0.000)**	(0.690)	**(0.000)**	(0.460)	(0.990)	(0.797)	(0.832)

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	0.209	0.551	-1.774	-0.134	1.242	0.695	**-2.84***	**1.30***	**0.71***	0.178	**1.04*** **	0.019	**1.13*** **
	(0.798)	(0.444)	(0.491)	(0.894)	(0.206)	(0.614)	**(0.076)**	**(0.086)**	**(0.068)**	(0.837)	**(0.000)**	(0.982)	**(0.001)**
AR(2)	**(0.621)**	**(0.246)**	**(0.795)**	**(0.355)**	**(0.821)**	**(0.337)**	n.a	**(0.190)**	**(0.498)**	**(0.262)**	**(0.287)**	**(0.227)**	**(0.304)**
Sargan	**(0.999)**	**(0.994)**	**(0.999)**	**(0.999)**	**(0.969)**	**(0.962)**	**(1.000)**	**(0.992)**	**(0.994)**	**(0.989)**	**(0.992)**	**(0.999)**	**(0.989)**
Wald	0.065	0.584	0.472	0.017	1.597	0.253	**3.135***	**2.930***	**3.324***	0.042	**46.0*** **	0.000	**9.97*** **
	(0.798)	(0.444)	(0.491)	(0.894)	(0.206)	(0.614)	**(0.076)**	**(0.086)**	**(0.068)**	(0.837)	**(0.000)**	(0.982)	**(0.001)**

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	2.235	**1.86*** **	**1.59*** **	**1.39***	-0.378	0.172	-3.506	-0.553	-0.244	**1.51*** **	1.994	-1.450	**1.68*** **
	(0.514)	**(0.038)**	**(0.000)**	**(0.060)**	(0.753)	(0.910)	(0.400)	(0.669)	(0.850)	**(0.006)**	(0.507)	(0.568)	**(0.048)**
AR(2)	**(0.290)**	**(0.361)**	**(0.322)**	**(0.310)**	**(0.252)**	**(0.693)**	**(0.224)**	**(0.280)**	**(0.239)**	**(0.231)**	**(0.470)**	**(0.604)**	**(0.310)**
Sargan	**(0.990)**	**(0.993)**	**(0.997)**	**(0.995)**	**(0.999)**	**(0.997)**	**(0.999)**	**(0.995)**	**(0.998)**	**(0.995)**	**(0.973)**	**(0.999)**	**(0.997)**
Wald	0.425	**4.283*** **	**9.47*** **	**3.51***	0.098	0.012	0.705	0.182	0.035	**7.52*** **	0.439	0.325	**3.889*** **
	(0.514)	**(0.038)**	**(0.002)**	**(0.060)**	(0.753)	(0.910)	(0.400)	(0.669)	(0.850)	**(0.006)**	(0.507)	(0.568)	**(0.048)**

*,**,**: 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. na: not applicable due to issues in degrees of freedom.

As earlier discussed in the methodology section, *beta* catch-up is a necessary but not a sufficient condition for the occurrence of convergence. In this light, the phenomenon can be fully

appreciated by *sigma* convergence. Hence, we complement the former with an appreciation of trends in the reduction of dispersions or tendencies with *sigma* convergence. For this purpose, both graphical and tabular disclosures of standard deviation patterns are essential to properly appreciate the policy syndromes. This is essentially because curves in the graphs may overlap and render the appreciations of tendencies difficult. Hence, the tabular and graphical presentations increases the subtlety and hence robustness of the policy syndromes.

4.3.2 Sigma convergence: tabular and graphical KE dispersions

The tabular representations are presented in Table 5 below. These are dispersions (or standard deviations) between benchmarks and fundamental characteristics. Panels A, B, C, D & E show dispersions in education, ICT, innovation, institutional regime & economic incentives respectively.

Table 5: 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	1.391	0.000	0.537	1.208	0.785	0.981	1.044	0.888	1.134	0.931	1.147	0.130	0.956
1997	1.902	0.000	0.569	1.180	1.897	0.816	1.876	0.643	1.897	0.816	1.255	0.041	0.951
1998	1.088	0.000	0.240	0.709	1.290	0.409	1.248	0.283	1.290	0.409	0.885	0.044	0.605
1999	1.656	0.582	0.900	1.259	0.996	1.164	1.300	1.071	1.366	1.088	1.337	0.000	1.139
2000	1.476	0.615	0.604	1.432	1.364	1.071	1.334	1.003	1.248	1.104	1.216	0.000	1.126
2001	1.407	0.000	0.326	1.073	1.179	0.726	1.071	0.515	1.683	0.676	0.863	0.160	0.767
2002	2.317	0.672	1.482	1.567	0.000	1.760	2.009	1.275		1.530	1.848	0.385	1.530
2003	2.182	0.636	1.319	1.551	0.800	1.648	2.037	1.134	2.119	1.416	1.840	0.000	1.484
2004	1.711	0.346	0.940	1.268	0.963	1.210	1.564	0.958	1.658	1.116	1.430	0.000	1.174
2005	1.500	0.327	0.734	1.179	0.775	1.070	1.441	0.793	1.485	0.980	1.189	0.000	1.031
2006	1.178	0.147	0.442	0.902	0.935	0.740	1.094	0.502	1.284	0.725	0.855	0.000	0.749
2007	1.438	0.000	0.487	1.167		1.060	1.611	0.738	1.432	1.016	1.212	0.248	1.060
2008	1.457	0.000	0.540	1.173	1.328	1.043	1.600	0.600	1.560	0.943	1.183	0.142	1.073
2009	1.751	0.058	1.147	1.381	0.736	1.450	1.863	0.961	1.808	1.239	1.572	0.000	1.348
2010	0.890	0.000	0.486	0.620	0.500	0.638	0.827	0.335	0.758	0.563	0.597	0.838	0.612

Panel B: Information and Communication Technology (ICTex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	0.316	0.000	0.089	0.262	0.245	0.179	0.290	0.142	0.319	0.147	0.206	0.016	0.188
1997	0.341	0.000	0.099	0.275	0.287	0.189	0.315	0.157	0.347	0.159	0.219	0.077	0.204
1998	0.388	0.000	0.104	0.310	0.335	0.209	0.355	0.181	0.393	0.182	0.246	0.093	0.231
1999	0.476	0.000	0.132	0.367	0.361	0.259	0.430	0.219	0.482	0.219	0.305	0.070	0.278
2000	0.585	0.000	0.179	0.441	0.442	0.319	0.523	0.270	0.594	0.268	0.372	0.105	0.342
2001	0.682	0.000	0.214	0.510	0.531	0.368	0.614	0.314	0.698	0.311	0.435	0.112	0.399
2002	0.761	0.000	0.251	0.563	0.572	0.416	0.690	0.348	0.773	0.349	0.493	0.072	0.445
2003	0.836	0.000	0.239	0.622	0.635	0.446	0.770	0.366	0.840	0.387	0.540	0.040	0.482
2004	1.088	0.080	0.367	0.809	0.801	0.617	1.026	0.498	1.083	0.548	0.740	0.000	0.653
2005	1.457	0.288	0.671	1.106	1.023	0.935	1.407	0.763	1.450	0.831	1.080	0.000	0.953
2006	1.736	0.406	0.830	1.318	1.143	1.138	1.697	0.916	1.693	0.997	1.298	0.000	1.139
2007	2.013	0.518	1.117	1.559	1.318	1.410	1.976	1.162	2.000	1.214	1.570	0.000	1.392
2008	2.441	0.718	1.476	1.878	1.602	1.755	2.406	1.458	2.415	1.524	1.946	0.000	1.726

2009	2.793	1.013	2.004	2.124	1.757	2.152	2.746	1.796	2.759	1.890	2.365	0.000	2.081
2010	2.957	0.928	1.657	2.335	1.883	2.153	2.962	1.737	2.875	1.936	2.392	0.000	2.105

Panel C: Innovation (Innovex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	1.311	0.000	0.347	0.804	0.914	0.564	1.298	0.195	1.265	0.447	0.643	0.513	0.596
1997	1.678	0.000	0.463	1.592	1.379	0.731	1.767	0.654		0.839	0.731	1.379	0.839
1998	1.538	0.000	0.258	0.895	1.219	0.485	1.651	0.423		0.577	0.540	0.638	0.577
1999	1.555	0.000	0.454	1.101	1.409	0.567	1.680	0.649	1.572	0.664	0.836	0.602	0.778
2000	1.732	0.000	0.194	1.154	1.452	0.459	1.721	0.351	1.626	0.595	0.808	0.580	0.742
2001	2.265	0.427	0.594	1.095	1.987	0.000	2.265	0.427	2.192	0.445	0.594	1.095	0.795
2002	1.766	0.000	0.058	1.281	1.518	0.453	1.830	0.578	1.648	0.609	0.786	0.685	0.757
2003	1.759	0.000	0.107	1.239	1.554	0.434	1.850	0.571	1.768	0.585	0.810	0.613	0.754
2004	1.759	0.113	0.000	1.169	1.493	0.476	1.833	0.573	1.740	0.586	0.744	0.707	0.730
2005	1.907	0.094	0.000	1.238	1.571	0.508	2.010	0.597	1.852	0.620	0.809	0.715	0.774
2006	2.120	0.161	0.000	1.751	1.726	0.710	2.216	0.798	2.039	0.827	0.895	1.263	1.000
2007	2.302	0.205	0.000	1.705	1.995	0.892	2.365	0.983	2.229	1.000	1.197	1.017	1.137
2008	2.301	0.000	0.249	1.285		0.767		0.767		0.767	0.817	0.668	0.767
2009	3.000	0.000	0.084	1.944		1.200		1.200		1.200	1.129	1.307	1.200
2010													

Panel D: Institutional Regime (Instireg)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	0.767	0.058	0.068	0.728	1.873	0.071	0.000	0.608	2.157	0.064	0.495	0.241	0.460
1997													
1998	1.243	0.000	0.102	1.075	2.035	0.452	0.765	0.717	2.393	0.326	0.768	0.458	0.731
1999													
2000	1.164	0.000	0.203	0.947	1.928	0.418	0.787	0.642	2.581	0.222	0.731	0.340	0.685
2001													
2002	1.110	0.000	0.222	0.888	1.718	0.425	0.863	0.565	2.439	0.217	0.712	0.210	0.653
2003	1.069	0.000	0.141	0.895	1.642	0.412	0.803	0.556	2.505	0.171	0.691	0.166	0.629
2004	1.019	0.000	0.072	0.887	1.614	0.382	0.727	0.546	2.446	0.149	0.666	0.102	0.599
2005	1.027	0.000	0.035	0.915	1.659	0.378	0.708	0.561	2.391	0.168	0.666	0.142	0.604
2006	1.077	0.077	0.000	1.029	1.775	0.428	0.759	0.627	2.322	0.261	0.702	0.396	0.666
2007	1.076	0.080	0.000	1.029	1.806	0.421	0.754	0.629	2.341	0.257	0.708	0.344	0.666
2008	1.113	0.049	0.000	1.043	1.818	0.430	0.728	0.653	2.383	0.258	0.705	0.450	0.675
2009	1.112	0.064	0.000	1.051	1.785	0.444	0.728	0.660	2.258	0.296	0.707	0.480	0.680
2010	1.101	0.188	0.000	1.121	1.888	0.476	0.687	0.741	2.225	0.359	0.724	0.735	0.725

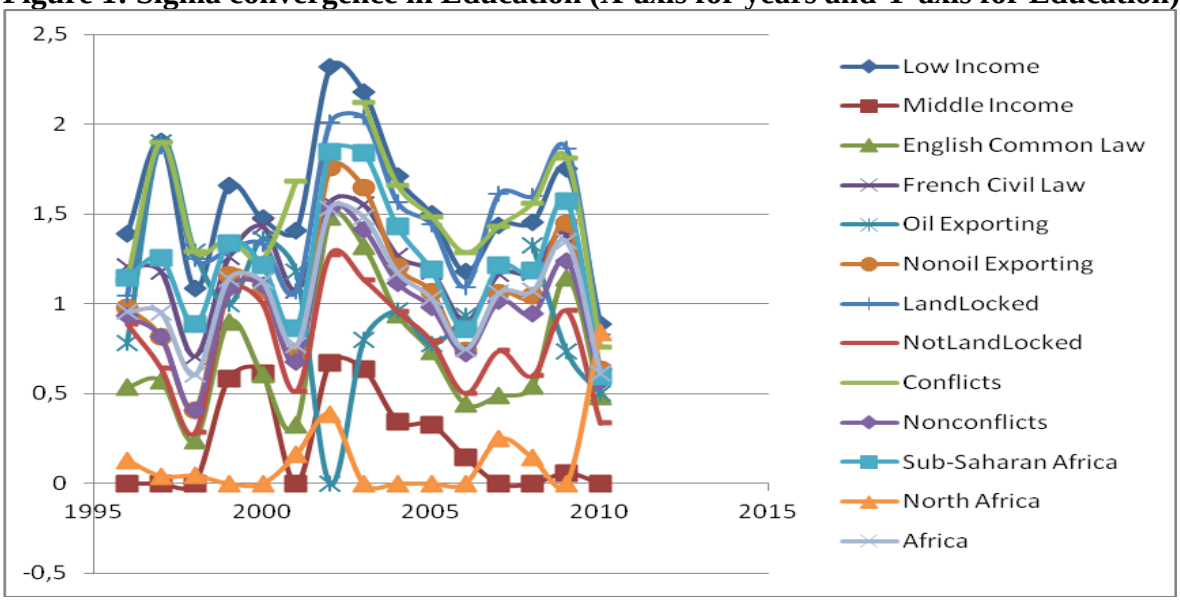
Panel E: Economic Incentives (Creditex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa
1996	0.271	0.609	0.615	0.266	0.126	0.552	0.396	0.972	0.000	0.525	0.411	0.637	0.434
1997	0.096	0.466	0.380	0.182	0.027	0.375	0.124	0.355	0.000	0.348	0.261	0.438	0.281
1998	0.078	0.516	0.379	0.226	0.045	0.381	0.107	0.344	0.000	0.362	0.254	0.557	0.297
1999	0.233	0.633	0.533	0.345	0.097	0.555	0.268	0.704	0.000	0.519	0.386	0.734	0.433
2000	0.349	0.713	0.636	0.439	0.115	0.682	0.374	0.684	0.000	0.637	0.476	0.883	0.531
2001	0.247	0.665	0.551	0.372	0.093	0.588	0.260	0.321	0.000	0.547	0.400	0.815	0.456
2002	0.310	0.724	0.604	0.457	0.236	0.641	0.316	0.000	0.076	0.610	0.460	0.854	0.523
2003	0.308	0.680	0.610	0.409	0.175	0.633	0.308	0.043	0.000	0.596	0.437	0.824	0.500
2004	0.268	0.687	0.622	0.376	0.146	0.639	0.291	0.225	0.000	0.589	0.437	0.842	0.491
2005	0.240	0.723	0.617	0.370	0.124	0.629	0.279	0.155	0.000	0.592	0.442	0.785	0.490
2006	0.236	0.754	0.618	0.395	0.219	0.647	0.293	0.000	0.137	0.584	0.500	0.629	0.515
2007	0.229	0.889	0.756	0.362	0.287	0.671	0.331	0.000	0.143	0.668	0.542	0.749	0.559
2008	0.412	1.244	0.977	0.605	0.685	0.854	0.539	0.000	0.395	0.937	0.822	0.889	0.828
2009	0.394	1.307	1.050	0.575	0.799	0.889	0.561	0.000	0.429	0.994	0.876	0.868	0.875
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.

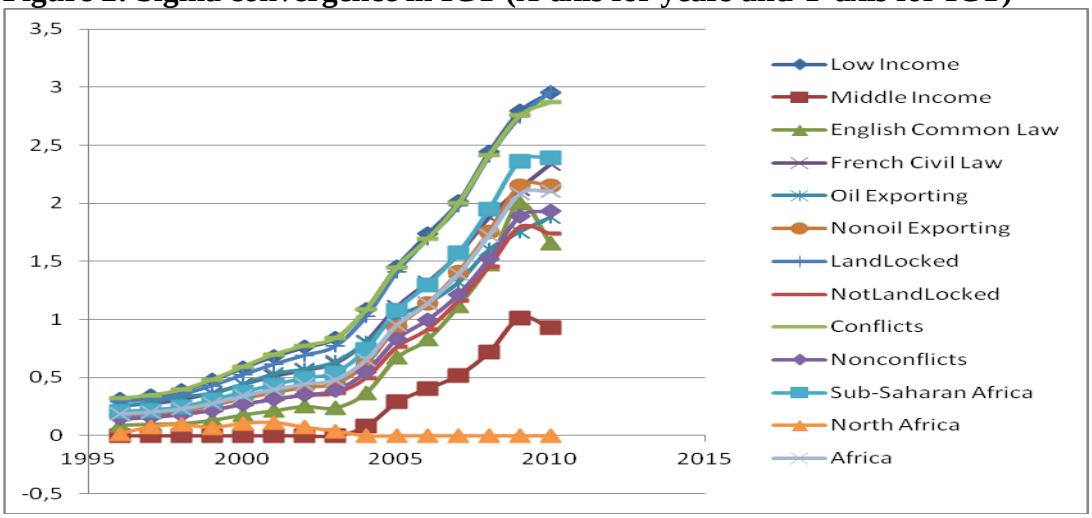
Panels A to E above are respectively translated into Figures 1 to 5 below. As highlighted earlier, both graphical and tabular representations are needed for a holistic calibration of the 'policy syndromes'.

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



It can be observed from Figure 1 above that the gaps in education across fundamental characteristics with respect to benchmarks remain substantial. It should be noted that fundamental characteristics reflecting zero dispersions at some points in time simply indicate the selected benchmarks. Hence, benchmark fundamental characteristics naturally experience the low dispersions. These are the cases of North African and Middle income countries for the most part. Beside this specific remark, it is generally noticeable that the other fundamental characteristics consistently follow the same patterns in dispersions; with the highest (lowest) dispersions experienced by low-income (English common law) countries.

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



In Figure 2 above, the patterns are similar. As expected, Middle income and North African countries are benchmarks. They also interchangeably display the lowest dispersions when they are not benchmarks. English common law and Non-conflict affected countries closely follow in an increasing order of lowest dispersions while, sub-Saharan and Conflict-affected countries consistently reflect the highest dispersions. Generally from 1996, the dispersions increased steadily until 2004 after which they have increased steeply. This is a warning signal that policy measures are urgently needed to mitigate such growing gaps in ICTs.

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

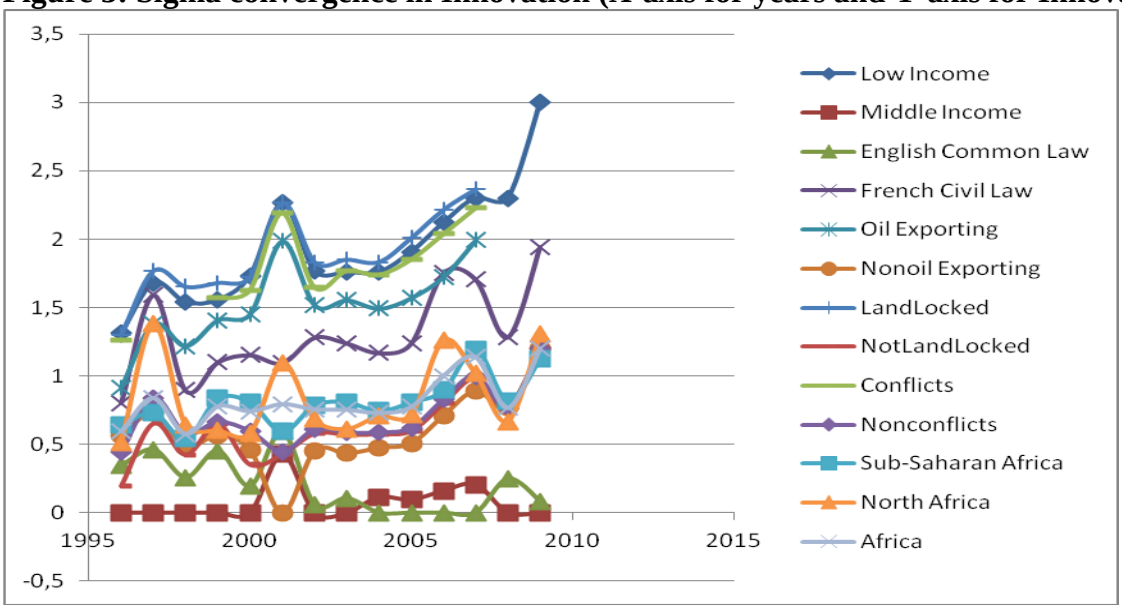


Figure 3 above depicting dispersion patterns in innovation also shows that gaps are growing more than ever with Low income, Conflict-affected and Landlocked countries in the driver's seat. Countries with the lowest dispersions (i.e benchmark nations) are Middle income and English common law nature.

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

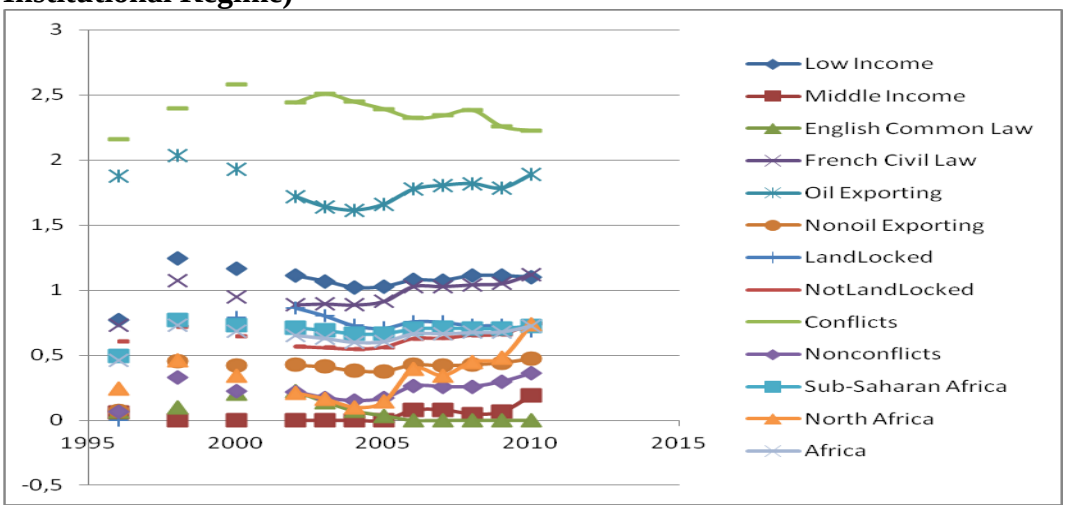
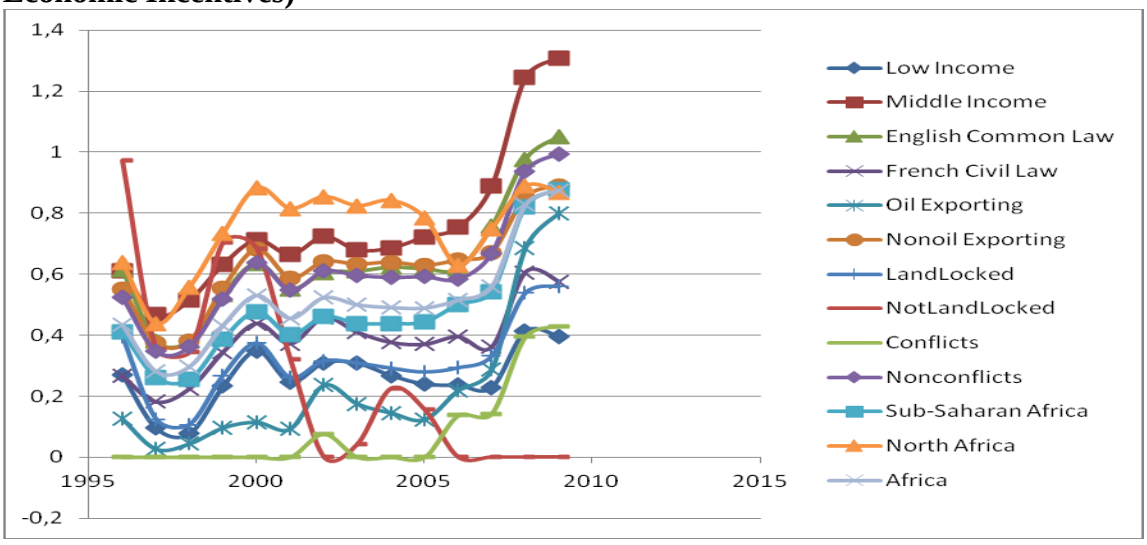


Figure 4 above shows uniform-like patterns in the dispersions of institutional regime. The breaks consistently experienced in the beginning are due to missing data in the periods 1997, 1999 and 2001. Middle income and English common law countries have the lowest dispersions whereas Conflict-affected and Oil-exporting nations witness the highest dispersions.

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



The ‘economic incentives’ dispersion patterns in Figure 5 above are broadly similar and higher deviations are experienced towards to end of the curves. This is an indication that the substantial surplus liquidity issues in African financial institutions may only be growing. Conflict-affected countries experience the lowest dispersions whereas Middle-income and North African countries display the highest deviations.

4.4. Policy syndromes

This section is concerned with the fourth-stage of the five-step procedure outlined in the introduction. ‘Policy syndromes’ are defined by Fosu (2013c) as situations that are not favorable to growth, such as, inter alia: ‘state breakdown’, ‘suboptimal inter temporal resource allocation’ ‘state controls’ and ‘administered redistribution’. Situations with the absence of such syndromes are qualified as ‘syndrome free’. According to the author, such syndromes are thought to have considerably contributed to the deplorable post-independence economic prosperity of the African continent. Within the framework of this study, ‘policy syndrome’ refers to unappealing trends or positive KE deviations between benchmark and peripheral fundamental characteristics. Therefore growing dispersions in a given KE component reflects ‘policy syndromes’ (PS) while a tendency showing reducing dispersions is qualified as a ‘syndrome-free’ (SF) trend.

Table 6 below depicts the PS and SF tendencies obtained from the graphical and tabular representations above. While the right-hand-side of the table shows SF (or low dispersion panels), the left-hand-side depicts PS (or high dispersion panels). The information criteria are based on averages in dispersions of the last two years. From the patterns, there is a kind of symmetry in the first-four KE dimensions, with overwhelmingly similar fundamental characteristics on the left and right sides of the African panel. On the other hand, it is also interesting the note that in the last KE dimension (Creditex), the SF panels in the first-four dimensions are potentially the most PS. An interesting explanation for this difference lies in the definition and appreciation of economic incentives in the context of this study. We have defined and appreciated economic incentives in terms of credit facilities due to the substantially surplus liquidity issues in African financial institutions documented in recent literature (Nguena & Tsafack, 2014; Saxegaard, 2006; Fouda, 2009). Therefore based on the findings, conflicted-affected countries are predisposed to more credit facilities in post-war periods. Overall, we have found that Landlocked, Low-income, Conflict-affected, SSA, Non-oil-exporting and French civil

law countries are generally more predisposed to lower levels of KE whereas; English common-law, 'openness to sea', absence of conflicts, North African location and middle-income are characteristics that predispose certain nations to higher KE.

Table 6: 'Policy Syndrome' and 'Syndrome Free' Information Criteria

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

We propose and discuss catch-up policies relevant to PS in each dimension of KE in the following section. However, it is important to highlight that such policy measures are not limited to PS scenarios. Implying SF fundamental characteristics are not exempted from the policy initiatives because, though some are benchmarks, they may also be PS when compared with more advanced nations in KE outside Africa. Hence the concept of PS is relative and not absolute. We now move the last phase of the five-step procedure: policy implications.

4.5 Policy implications

4.5.1 Implications for education and innovation

Despite the growing consensus that local innovation and KE are essential to construct national absorptive capacity and support indigenous capabilities, it would also be interesting that this locally tailored innovation be disseminated as wide as possible. This could improve human capital externalities (Wantchekon et al., 2014), especially if incentives for innovation are targeted towards directly developing local communities. Therefore, validation and encouragement of activities focused on regional and local initiatives to advance the development of innovating business ventures and 'exchange and transfer' of best practices are necessary. Such initiatives

will depend on an enabling environment for innovation and should be focused preferably on: trans-regional cooperation to ease the development of innovation and research; in close coordination with regional inclusive-friendly policies, initiation and strategies of activities involving local actors should be tailored and; great emphasis placed on the participation of 'policy syndromes' when it comes to the transfer of schemes with success stories from national and local levels.

While some negative effects of brain drain could be balanced with remittance (Ngoma & Ismail, 2013; Osabuohien & Efobi, 2013) and Nyarko & Gyimah-Brempong (2011) have suggested that in the long-term, education could be a more important channel of social protection than cash transfers. Hence, African countries that are putting measures in place for the return of nationals trained abroad may be predisposed to higher levels of KE (*Education*). Indeed human capital is an essential factor for the improvement of technology, science and the economy. Returning scientists, if given proper incentives to research should obviously strengthen scientific capabilities and improve innovation conditions.

In this fight against brain drain, increased investment in education is needed to consolidate the educational dimension of KE in the continent (Amavilah, 2009). Accordingly, there is a solid African background of outdated curricula, limited support for R&D and a blur relationship between science and industry (Kamara, 2007; Asongu, 2014d; Tchamyou, 2014). In order to change the pattern of Africa's downward course in KE (Anyanwu, 2012), policy makers need to reinvigorate technology and science, higher education and innovation. First, bold step are needed to increase enrolment rates in colleges as well as the R&D/GDP ratio. Essentially, education strengthens a country's capacity to acquire novel know-how and technology. It also procures some broad tacit knowledge needed for technological learning. Second, frontier fundamental characteristics or policy syndrome nations may have to consider reverse engineering and less tight property rights that are needed for the copying of commodities that are technology-intensive. Such informal mechanisms of technology transfer may be essential in the early stages of innovation and industrialization. Third, workers would also need to continuously adapt to changing and evolving technological conditions. Hence policy syndrome countries need to provide more vocational and technical trainings institutions. They also need to encourage corporations to follow suit in the continuous training of their employees. With the advancement of nations, technological competence becomes crucial and education positively affects

industrialization and technological learning, which ultimately increase the return of and demand for education.

Given the policy syndromes on education, the relevance of the policies is as follows in increasing order: Middle-income, North African, Oil-exporting, Not Landlocked, English common law, Non conflict-affected, Africa, French civil law, Non oil-exporting, sub-Saharan African, Conflict-affected, Low-income and Landlocked countries. A quasi-similar policy relevance pattern with regard to innovation can also be found in Table 6 above.

4.5.2 Implications for ICTs

In Figure 2 above, we have found burgeoning gaps in ICT between benchmarks and peripheral fundamental characteristics. We use the examples of Kenya, Ghana and Rwanda to highlight how frontier panels should be focusing on and investing more in ICTs. First, Ghana is moving to become the West African region's high technology hub with an ambitious ten billion USD ICT university in Hope City, first launched on the 4th of March 2013 by President Mahama John. Second, Kenya in January 2013 also uncovered its plan to construct 'Africa's Silicon Savannah' in a span of 20 years. The 14.5 billion USD 'Konza Technology City' project is estimated by 2030 to create about 200 000 jobs (Tchamyou, 2014). Third, President Paul Kagame's ambitious project of creating a Silicon Valley cannot be left out of the examples. Consistent with the International Telecommunication Union report (ITU, 2012), the country is among the leading developing countries with strong dynamic ICT markets because it is quickly catching-up and bridging the so-called 'digital divide'. The other countries being: Bahrain, Brazil, Saudi Arabia, Ghana and Kenya. The benefits for enhancing ICTs include, inter alia: increased synchronization of business operations within Africa and reduced cost of acquiring technology. Massive investment in ICTs should be coupled with an IT strategy that combines KE-friendly industrial, regulatory and competitive policies. Hence, 'policy syndrome' countries can emulate the eloquent examples of Ghana, Kenya and Rwanda.

Policy implications are relevant in increasing order as follows: North African, Middle-income, Not landlocked, Oil-exporting, English common law, Non conflict-affected, Africa, Non oil-exporting, French civil law, sub-Saharan African, Conflict-affected, Landlocked & Low-income countries.

4.5.3 Implications for Institutional regime

While institutions are crucial for the emergence of economies in Africa (Fosu, 2013d), the continent's economic prosperity has been seriously infringed by capital flight and poor institutions (Fofack & Ndikumana, 2009; Boyce & Ndikumana, 1998, 2001, 2003, 2008, 2011). Figure 4 above shows that, low-income, conflict-affected and landlocked countries are more predisposed to low levels of institutional quality while middle-income and English common law countries are benchmarks. The landlocked (Arvis et al., 2007), legal origin (La Porta et al., 1998, 1999; Asongu, 2012a) and income-level (Asongu, 2012c), hypotheses are consistent with the predictions of economic theory. This also confirms the position that institutions are endogenous to the wealth of nations or economic prosperity (Ortmann, 2012; Anyanwu & Andrew, 2014; Asongu & Aminkeng, 2013).

Market focused institutions will liberate the competitive forces needed to move peripheral countries towards KE. Transparency in financial markets is also a weapon against capital flight. Accordingly, transparency in financial markets, a plain playing field and government accountability are essential in averting capital flight. Credible institutions are also essential for liberalized peripheral countries in times of crises like political strife. On the thorny institutional issue of corruption by political elites (Garoupa & Jellal, 2007; Jellal & Bouzahzah, 2013) which is the third most important African development issue (after poverty and unemployment), governments should work towards recuperating the stolen funds by more pragmatic means. The funds could then be reinvested in import-substitution industries like President Park did with South Korea (Tran, 2011; Asongu, 2014d; Tchamyou, 2014).

Overall, governments of policy syndrome countries should be aware that governance effectiveness is imperative for the success of KE and the achievement of broader long-run development objectives. In essence, the appealing role of governance in KE is a holistic approach that requires amongst others: a pragmatic leadership and enabling a favorable macroeconomic environment for growth of KE (mass education, access to modern infrastructure, assimilation of foreign technologies, domestic R&D, inter alia). Priority in the relevance of these implications can be found in Table 6.

4.5.4 Implications for economic incentives

Economic incentives are imperative to address the investment needs substantially documented in African business literature (Rolfe & Woodward, 2004; Bartels et al., 2014; Bartels et al., 2009; Tuomi, 2011; Darley, 2012). It is within this line of thought that we have used credit facilities as a proxy for economic incentives. For the identified policy syndrome frontier nations, measures of fighting surplus liquidity target, inter alia: voluntary and involuntary keeping of surplus liquidity (Asongu, 2014l, p. 70).

First, measures against voluntary holding of surplus cash by financial institutions include, amongst others: facilitating the issues confronted by financial institutions in tracing their positions within the central bank which could obliged them to hold reserves above limits imposed by the law; consolidation of institutions that would facilitate interbank lending in a bid to ease the borrowing among banks for emergency needs and; improvement of financial infrastructure so that bank branches in remote areas do not have to keep excess reserves owing to problems of transportation.

Second, policies devoted to combating involuntary excess liquidity could entail, inter alia: mitigating bank inability to lend, especially when interest rates are subject to regulation; creation of conditions conducive for sustaining spreads between bonds and reserves, such that surplus liquidity can be invested by commercial banks in bond markets; reducing the reticence of financial institutions for expanding lending by mitigating information asymmetry and lack of competition and; development of stock markets to enlarge opportunities of investment for commercial banks.

Overall Small and Medium Size Enterprises that need more capital and are prone to more risks, have to be helped by government funded research institutions which should provide them with knowledge with respect to collaborative R&D projects and spinoff firms. An export-led or extensive development strategy exposes frontier countries to more competition. Fiscal incentives at the early stages of industrialization are also important (Tchamyou, 2014).

On a final note, in the drive towards KE, policy makers would have to nurture highly qualified scientists that are competent in handling development on the frontiers of technology and science. Education and industrialization should complement one another and be tailored towards a lifelong learning development strategy. For domestic industries to remain competitive and substantially assimilate the technological know-how and innovations needed to remain

competitive, policy makers should support the establishment of communication platforms and joint works among peripheral and benchmark countries at the regional level. Such measures can only be effective if they move 'hand in glove' with considerable improvements in policy and institutional environments, among others, the autonomies and capacities of domestic governments.

5. Conclusion

Using a five-step novel approach, we have dissected with great acuteness and presented the comparative economics of knowledge economy (KE) in Africa. The World Bank's five KE components have been employed, notably: education, innovation, ICT and economic incentives and institutional regime. Absolute *beta* and *sigma* estimation strategies have been used to assess the dispersions between the determined fundamental characteristics and computed dynamic benchmarks. The empirical evidence is based on 53 countries with data for the period 1996-2010. We have found an overwhelming absence of convergence using the beta catch-up approach. Motivated by its methodological shortcoming, notably that *beta* catch-up is a necessary but not a sufficient condition for the occurrence of convergence, our policy recommendations have been based essentially on sigma convergence. For this purpose, both graphical and tabular disclosures of standard deviation patterns have been provided from which we have extrapolated policy syndromes. Based on the policy syndrome and syndrome free scenarios, we have established that Landlocked, Low-income, Conflict-affected, sub-Saharan African, Non-oil-exporting and French civil law countries are generally more predisposed to low levels of KE whereas; English common-law, openness to sea, absence of conflicts, North African and middle-income are characteristics that predispose certain nations to higher KE. Broad and specific policy implications have been discussed in detail.

It is also important to discuss some cautions and caveats relevant to the empirics and catch-up dynamics. Whereas we have computed the convergence rates that have been overwhelmingly insignificant, the policy syndrome and syndrome-free fundamental characteristics have not been based on this absolute beta convergence specification. This is due to the multiple equilibria in this form of catch-up which makes it a necessary but not sufficient for convergence to take place. Future research could focus on case studies for country-specific policy implications.

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)

Appendix 5: Derivation of Benchmarks

Panel A: Education (Educatex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa	Bmark	Panel
1996	-1.315	0.653	-0.106	-1.056	-0.457	-0.735	-0.824	-0.604	-0.952	-0.664	-0.970	0.469	-0.700	0.653	Mid.I
1997	-1.857	0.834	0.028	-0.836	-1.849	-0.321	-1.820	-0.076	-1.849	-0.321	-0.941	0.776	-0.512	0.834	Mid.I
1998	-1.216	0.323	-0.017	-0.679	-1.502	-0.255	-1.441	-0.077	-1.502	-0.255	-0.928	0.261	-0.532	0.323	Mid.I
1999	-1.216	0.303	-0.146	-0.654	-0.283	-0.519	-0.712	-0.389	-0.805	-0.412	-0.765	1.126	-0.484	1.126	NA
2000	-0.899	0.319	0.335	-0.836	-0.739	-0.326	-0.698	-0.229	-0.575	-0.372	-0.530	1.189	-0.402	1.189	NA
2001	-1.116	0.874	0.412	-0.643	-0.793	-0.153	-0.640	0.146	-1.506	-0.082	-0.347	0.647	-0.211	0.874	Mid.I
2002	-0.806	1.521	0.375	0.255	2.471	-0.018	-0.371	0.668	---	0.307	-0.143	1.927	0.307	2.471	Oil
2003	-0.900	1.285	0.319	-0.009	1.054	-0.146	-0.696	0.580	-0.812	0.183	-0.417	2.185	0.086	2.185	NA
2004	-0.761	1.169	0.328	-0.136	0.296	-0.053	-0.554	0.303	-0.687	0.079	-0.364	1.658	-0.003	1.658	NA
2005	-0.658	1.000	0.424	-0.204	0.367	-0.051	-0.575	0.341	-0.638	0.077	-0.219	1.463	0.005	1.463	NA
2006	-0.425	1.034	0.617	-0.034	-0.081	0.194	-0.306	0.532	-0.575	0.216	0.031	1.241	0.183	1.241	NA
2007	-0.390	1.644	0.955	-0.007	---	0.145	-0.635	0.600	-0.382	0.207	-0.070	1.293	1.291	1.644	Mid.I
2008	-0.395	1.665	0.902	0.005	-0.214	0.189	-0.598	0.817	-0.542	0.331	-0.008	1.464	0.147	1.665	Mid.I
2009	-0.304	2.091	0.550	0.219	1.132	0.122	-0.463	0.813	-0.384	0.420	-0.051	2.172	0.267	2.172	NA
2010	-0.452	0.807	0.120	-0.070	0.100	-0.095	-0.363	0.333	-0.265	0.010	-0.037	-0.378	-0.058	0.807	Mid.I

Panel B: Information and Communication Technology (ICTex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa	Bmark	Panel
1996	-0.971	-0.524	-0.651	-0.895	-0.870	-0.777	-0.934	-0.726	-0.976	-0.732	-0.816	-0.547	-0.790	-0.524	Mid.I
1997	-0.968	-0.486	-0.626	-0.875	-0.892	-0.753	-0.931	-0.708	-0.977	-0.711	-0.795	-0.594	-0.775	-0.486	Mid.I
1998	-0.962	-0.413	-0.561	-0.852	-0.887	-0.710	-0.915	-0.669	-0.970	-0.671	-0.761	-0.545	-0.740	-0.413	Mid.I
1999	-0.950	-0.277	-0.464	-0.796	-0.787	-0.643	-0.885	-0.586	-0.958	-0.586	-0.708	-0.376	-0.670	-0.277	Mid.I
2000	-0.928	-0.101	-0.354	-0.724	-0.727	-0.551	-0.840	-0.483	-0.940	-0.480	-0.627	-0.249	-0.584	-0.101	Mid.I
2001	-0.898	0.066	-0.237	-0.656	-0.686	-0.455	-0.802	-0.378	-0.921	-0.375	-0.550	-0.093	-0.498	0.066	Mid.I
2002	-0.849	0.227	-0.127	-0.569	-0.581	-0.361	-0.749	-0.266	-0.866	-0.267	-0.470	0.126	-0.402	0.227	Mid.I
2003	-0.786	0.397	0.059	-0.483	-0.501	-0.234	-0.692	-0.121	-0.791	-0.150	-0.367	0.340	-0.285	0.397	Mid.I
2004	-0.720	0.706	0.300	-0.326	-0.314	-0.054	-0.632	0.115	-0.713	0.043	-0.228	0.819	-0.105	0.819	NA
2005	-0.628	1.025	0.483	-0.132	-0.014	0.109	-0.558	0.353	-0.618	0.257	-0.094	1.432	0.085	1.432	NA
2006	-0.460	1.420	0.821	0.130	0.379	0.386	-0.405	0.700	-0.399	0.585	0.159	1.995	0.384	1.995	NA
2007	-0.310	1.805	0.957	0.332	0.673	0.544	-0.257	0.894	-0.292	0.820	0.317	2.537	1.646	2.537	NA
2008	-0.060	2.378	1.306	0.738	1.128	0.911	-0.010	1.332	-0.023	1.237	0.640	3.393	0.952	3.393	NA
2009	0.159	2.676	1.274	1.105	1.624	1.065	0.225	1.569	0.207	1.436	0.765	4.109	1.166	4.109	NA
2010	0.578	3.448	2.416	1.458	2.098	1.715	0.570	2.304	0.694	2.023	1.378	4.760	1.784	4.760	NA

Panel C: Innovation (Innovex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa	Bmark	Panel
1996	-0.637	1.217	0.726	0.080	-0.076	0.419	-0.619	0.942	-0.573	0.584	0.307	0.491	0.374	1.217	Mid.I
1997	-0.531	1.843	1.189	-0.409	-0.108	0.809	-0.656	0.919	---	0.656	0.809	-0.108	0.656	1.843	Mid.I
1998	-0.526	1.649	1.284	0.383	-0.075	0.963	-0.687	1.050	---	0.833	0.885	0.747	0.833	1.649	Mid.I
1999	-0.474	1.726	1.083	0.168	-0.267	0.924	-0.650	0.808	-0.498	0.786	0.543	0.875	0.626	1.726	Mid.I
2000	-0.641	1.809	1.535	0.178	-0.244	1.161	-0.625	1.313	-0.490	0.968	0.667	0.990	0.759	1.809	Mid.I
2001	-0.658	1.940	1.704	0.995	-0.266	2.544	-0.658	1.940	-0.556	1.914	1.704	0.995	1.420	2.544	NOil
2002	-0.481	2.017	1.935	0.206	-0.129	1.377	-0.570	1.200	-0.313	1.157	0.906	1.049	0.947	2.017	Mid.I
2003	-0.480	2.008	1.857	0.255	-0.190	1.394	-0.608	1.200	-0.492	1.181	0.862	1.141	0.942	2.008	Mid.I
2004	-0.485	1.842	2.002	0.350	-0.109	1.329	-0.590	1.192	-0.459	1.173	0.950	1.002	0.969	2.002	Eng.
2005	-0.464	2.099	2.233	0.481	0.010	1.514	-0.610	1.388	-0.387	1.356	1.088	1.221	1.138	2.233	Eng.
2006	-0.428	2.343	2.570	0.094	0.130	1.565	-0.564	1.442	-0.314	1.400	1.304	0.784	1.155	2.570	Eng.
2007	-0.411	2.554	2.844	0.432	0.023	1.583	-0.501	1.453	-0.309	1.429	1.151	1.406	1.236	2.843	Eng.
2008	-0.279	2.975	2.623	1.158	---	1.891	---	1.891	---	1.891	1.821	2.031	1.891	2.975	Mid.I
2009	-0.264	3.979	3.860	1.230	---	2.282	---	2.282	---	2.282	2.382	2.131	2.282	3.979	Mid.I
2010	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Panel D: Institutional Regime (Instireg)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa	Bmark	Panel

1996	-0.307	0.696	0.681	-0.252	-1.871	0.678	0.777	-0.083	-2.273	0.686	0.078	0.437	0.126	0.777	LL
1997	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1998	-0.665	1.093	0.949	-0.427	-1.785	0.454	0.011	0.079	-2.291	0.632	0.007	0.445	0.059	1.093	Mid.I
1999	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2000	-0.566	1.081	0.793	-0.259	-1.647	0.489	-0.032	0.172	-2.569	0.766	0.047	0.600	0.112	1.081	Mid.I
2001	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2002	-0.489	1.081	0.767	-0.176	-1.349	0.480	-0.140	0.281	-2.369	0.773	0.074	0.784	0.157	1.081	Mid.I
2003	-0.500	1.012	0.812	-0.254	-1.310	0.429	-0.124	0.225	-2.531	0.770	0.035	0.778	0.123	1.012	Mid.I
2004	-0.485	0.956	0.855	-0.299	-1.326	0.416	-0.072	0.184	-2.502	0.746	0.015	0.812	0.109	0.956	Mid.I
2005	-0.601	0.852	0.803	-0.442	-1.494	0.317	-0.149	0.059	-2.530	0.614	-0.090	0.651	-0.003	0.852	Mid.I
2006	-0.479	0.936	1.045	-0.410	-1.465	0.440	-0.028	0.159	-2.239	0.675	0.053	0.485	0.104	1.045	Eng.
2007	-0.444	0.965	1.078	-0.377	-1.476	0.482	0.011	0.188	-2.232	0.714	0.076	0.591	0.136	1.078	Eng.
2008	-0.474	1.030	1.099	-0.376	-1.472	0.491	0.070	0.176	-2.270	0.734	0.103	0.463	0.145	1.099	Eng.
2009	-0.495	0.986	1.077	-0.410	-1.447	0.449	0.047	0.143	-2.116	0.659	0.077	0.398	0.115	1.077	Eng.
2010	-0.438	0.852	1.119	-0.466	-1.551	0.446	0.147	0.071	-2.028	0.611	0.095	0.079	0.093	1.119	Eng.

Panel E: Economic Incentives (Creditex)

Years	Low.I	Mid.I	Eng.	Frch.	Oil	NOil	LL	NLL	Con	NCon	SSA	NA	Africa	Bmark	Panel
1996	0.388	-0.091	-0.099	0.395	0.593	-0.010	0.210	-0.604	0.771	0.029	0.190	-0.130	0.156	0.771	Con
1997	0.290	-0.233	-0.111	0.169	0.388	-0.103	0.250	-0.076	0.426	-0.066	0.058	-0.192	0.029	0.426	Con
1998	0.299	-0.321	-0.128	0.090	0.346	-0.130	0.258	-0.077	0.409	-0.103	0.050	-0.378	-0.011	0.409	Con
1999	0.278	-0.288	-0.146	0.119	0.470	-0.178	0.228	-0.389	0.607	-0.127	0.061	-0.430	-0.005	0.607	Con
2000	0.245	-0.269	-0.161	0.118	0.575	-0.225	0.210	-0.229	0.739	-0.162	0.065	-0.510	-0.012	0.739	Con
2001	0.251	-0.340	-0.180	0.074	0.468	-0.231	0.232	0.146	0.600	-0.173	0.034	-0.553	-0.044	0.600	Con
2002	0.230	-0.355	-0.186	0.022	0.334	-0.238	0.222	0.668	0.560	-0.194	0.018	-0.539	-0.072	0.668	NLL
2003	0.205	-0.321	-0.221	0.062	0.393	-0.254	0.206	0.580	0.641	-0.202	0.022	-0.524	-0.066	0.641	Con
2004	0.242	-0.350	-0.259	0.089	0.415	-0.283	0.209	0.303	0.621	-0.213	0.003	-0.569	-0.074	0.621	Con
2005	0.222	-0.461	-0.312	0.037	0.385	-0.329	0.167	0.341	0.561	-0.276	-0.065	-0.550	-0.132	0.561	Con
2006	0.198	-0.535	-0.342	-0.027	0.222	-0.383	0.118	0.532	0.338	-0.294	-0.175	-0.358	-0.197	0.532	NLL
2007	0.276	-0.657	-0.469	0.088	0.195	-0.349	0.131	0.600	0.398	-0.345	-0.166	-0.459	-0.190	0.600	NLL
2008	0.234	-0.943	-0.564	-0.039	-0.152	-0.390	0.055	0.817	0.258	-0.507	-0.345	-0.441	-0.354	0.817	NLL
2009	0.255	-1.035	-0.671	0.000	-0.316	-0.444	0.021	0.813	0.206	-0.592	-0.425	-0.414	-0.424	0.813	NLL
2010	---	---	---	---	---	---	---	0.333	---	---	---	---	---	---	---

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. Bmark: Benchmark.

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