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Building Knowledge Economies in Africa: A Survey of Policies and Strategies

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Abstract

Compared to other regions of the world, Africa is lagging in its drive toward knowledge-based economies. This study surveys the literature in order to highlight the policies and strategies with which African countries can accelerate their current drive towards knowledge economies. These are discussed in terms of the four pillars of the World Bank's knowledge economy framework. They are the indices for: (i) education and skilled population, (ii) information and communication technology, (iii) economic incentives and institutional regime and (iv) innovation systems.

JEL Classification: O10; O30; O38; O55; O57*Keywords:* Knowledge economy; Development; Africa**1. Introduction**

It is a hard fact that in this contemporary époque, for nations to survive the challenges of globalisation, they need knowledge-based economies (KBE) (Tchamyou, 2016; Asongu & Nwachukwu, 2016a). KBE which are essential for competition in the 21st century have been at the centre of key policy reports from the Organisation for Economic Co-operation and Development (OECD) and the World Bank during the past decade (see Tchamyou, 2016; Amavilah et al., 2017; Weber, 2011; World Bank, 2007). It is within this policy framework that the relevance of KBE has been mastered by North America, Japan and Europe which have inexorably been determining the pattern of economic development in the international arena. While other developing countries in Latin America and Asia have been catching-up

with calculated moves that emphasise the importance of KBE in the pursuit of their regional and national goals (see Tchamyou, 2016; Chandra & Yokoyama, 2011; Dahlman, 2007)¹, the overall index of knowledge economy (KE) in Africa has been decreasing since the beginning of the third Millennium (see Anyanwu, 2012).

In order for African countries to brace the challenge of globalisation, appropriate policies are needed to catch-up with frontier countries (see Asongu, 2016a). Unfortunately, the existing literature has failed to provide a logical structure for the policies and strategies with which to enhance the knowledge economy in Africa. This paper bridges the underlying gap by summarising what we know so far about measures with which African countries can accelerate their march toward KBE.

The existing KE literature has focused on specific themes, most notably : education (Wantchekon et al., 2014; Weber, 2011; Chavula, 2010; Ford, 2007; Amavilah, 2009); innovation (Carisle et al., 2013; Oyelaran-Oyeyinka & Sampath, 2007; Anyanwu, 2012); information and communication technology (Butcher, 2011; Chavula, 2010; African Partnership Forum, 2008); economic incentives and institutional regime (Andrés et al., 2015; Andrés & Asongu, 2013a; Saxegaard, 2006; Letiche, 2006; Cogburn, 2003); research and development (Sumberg, 2005; African Development Bank (AfDB), 2007; German & Stroud, 2007); indigenous systems of knowledge (Raseroka, 2008; Lwoga et al., 2010); intellectual property rights (Asongu, 2013a; Andres et al., 2015; Andrés & Asongu, 2013ab; Myburgh, 2011; Zerbe, 2005; Lor & Britz, 2005); spatiality in the production of knowledge (Neimark, 2012; Bidwell et al., 2011); KE in space transformation (Maswera et al., 2008; Moodley, 2003) and lessons from frontier KE countries to peripheral nations (Asongu, 2017a).

For the most part, while focusing on KE specific dimensions, the above strands in the literature have highlighted the need for more scholarly research on KE policies in order to reduce the gap between backward countries and benchmark nations (see Lightfoot, 2011; Chavula, 2010; Bizri, 2009; AfDB, 2007; Makinda, 2007; Britz et al., 2006; Aubert, 2005). Unfortunately, no study has systematically surveyed the existing KE literature in order to provide policy makers with the much needed policies and strategies essential for the catch-up

¹It is important to note that the historic route set by Japan has paved the way for the Newly Industrialised Economies of Asia (Taiwan, South Korea, Singapore and Hong Kong) including China and Malaysia. These nations have been witnessing a tremendous progress from post-industrialization 'product-based economies' to the era of 'knowledge-based economies'.

process. Consequently, the aim of this study is to bridge the identified gap by organising what is known so far in the KE literature on catch-up lessons and strategies.

In the light of the foregoing, the research question answered by this inquiry is: what evidence is documented in the recent literature with regards to policies and strategies with which the progress towards knowledge-based economies can be consolidated in Africa? The knowledge economy policies and strategies are structured along the four main pillars of the World's Bank knowledge economy index: education and skilled population, economic incentives and institutional regime, information and communication technology (ICT) and innovation. The rest of the study is organised in the four main dimensions of the World Bank's Knowledge Economy Index. The methodology of the survey is provided in Section 2. Section 3 and Section 4 are focused respectively on education and information and communication technology. Section 5 discusses economic incentives and institutional regime whereas the innovation dimension is covered in Section 6. We conclude in Section 7 with future research directions.

2. Methodology of literature survey

This survey involves studies collected between July 2016 and January 2017 after an extensive search from multiple scientific sources, namely: Economic Papers, Science Direct, Economic Literature (Econlit), Google Scholar, the mainstream Google search engine and Research Papers in Economics (RePEc). Selected studies largely focus on Africa and were cross-checked to identify other references; regardless of methodological underpinning. The outcome of this examination is the identification of the relevant articles which articulate lessons and strategies from the perspective of education and skilled population, economic incentives and institutional regime, ICT and innovation systems.

During the selection of relevant references, for the most part, studies published over the past ten years are considered. Some foreign publications are not taken into account because corresponding English versions are not available. Moreover, in order to articulate the “conceptual independence” approach in literature surveys, we neither reject studies that assess different countries with the same methodology nor studies devoted to a particular group of nations with different methodological underpinnings (Asongu & Nachukwu, 2017).

It is relevant to clarify the fact that there is yet no consensus in the literature on the manner in which studies within the framework of a literature survey should be collected. While some authors in the literature include all information from a given study (see Florax et

al., 2003), one preferred observation per study is adopted by others (see Stanley, 2001). The analytical approach adopted by this study consists of combining both approaches. This is essentially because while we articulate quantitative/direct contributions to the literature from the surveyed papers, qualitative/indirect contributions are also worthwhile. Therefore, in this paper, an indirect contribution to the literature is construed as a study which guides policy on building knowledge economies without establishing a causal empirical relationship. In the same vein, a direct contribution reflects an empirical investigation that culminates in the establishment of an effect from which knowledge economy policies can be derived.

In the light of the above, three main steps were employed for the survey. *First*, a two-week pilot study was engaged during which insights into a tentative structured were gained by the researchers. The corresponding insights into elements of knowledge economy include: increasing educational quality; balancing general education with technical education; increasing Research and Development; lifelong learning; ICT; economic incentives; institutional regime; innovation, intellectual property rights (IPRs) regimes; patents; trademarks; innovation; scientific publications; traditional PhD versus PhD by Publication; the digital economy and contemporary industrialisation. *Second*, the a review of strategies and solutions to driving KE in Africa are classified into the four main themes or pillars of the World Bank's knowledge economy index, notably: (i) education and skilled population, (ii) economic incentives and institutional regime, (iii) ICT and (iv) innovation systems. At this stage, a detailed literature survey is carried-out and the relevant references and main arguments are classified into the dominant themes. This leads to word count of above 20 000. *Third*, the main arguments are compared and contrasted across and within the main themes in order to limit repetition as much as possible and hence to improve clarity of expression and readability. The outcome of this step is a synthesised narrative of about 50 percent of the initial "word count".

3. Education and Skilled Population

This knowledge economy dimension is concerned with the ability of the educated and skilled population to create, disseminate and use knowledge efficiently. Shortages in educational investment and growing brain drain have been documented to represent the major concerns limiting the drive toward KE in Africa (Ford, 2007; Kamara et al., 2007; Amavilah, 2009; Chavula, 2010; Weber, 2011; Anyanwu, 2012; Andrés et al., 2015; Asongu, 2017b; Tchamyou, 2016). The underlying literature is consistent with the depleting background on

knowledge infrastructure, burgeoning brain drain, limited research and development (R&D), outdated curricula and the restricted relationships between industry and science. In essence, African economies are in a slippery KE path (see Anyanwu, 2012) and could substantially lose the new drive toward KBE unless bold policies are taken to reinvent technology and science, higher education and innovation (Kamara et al., 2007).

On this dimension, economies in Africa need to take ambitious policy measures towards increasing, *inter alia*: quality educational enrolment; technical education that is substantially outweighed by general education and expenditure in R&D. Moreover, a culture of lifelong-learning is needed so that workers are trained to adapt to challenging and evolving technological conditions. Policy makers need to establish mechanisms with which to provide on-the-job vocational and technical trainings. Such policies should move hand-in-glove with incentives for workplace training by corporations. Countries should rely on the importation of very expensive technology that its research units cannot afford and its R&D platforms should be more indigenously-oriented and tailored towards local needs like food security and food self-sufficiency (Asongu, 2016a).

3.1 Increasing educational quality

It is important for African countries to engage in bold steps with the aim of boosting qualitative college enrolments. For such policies to be effective, they should be tailored in conjunction with considerable ameliorations in complementary institutional environments which include the autonomy and capacity of higher learning institutions. In essence, education boosts a country's ability to gain novel knowledge and technology. Education also produces the tacit knowledge of individuals which is needed in buttressing technological learning blocks. It is within this framework that governments in African nations have to implement the necessary measures with the target of promoting essential human resource development (see Tchamyou, 2016). Recent literature on policy measures that can be tailored toward increasing educational quality in Africa can be discussed in four main strands. They are: (i) a social justice framework, (ii) outcome based education, (iii) pedagogical renewal for qualitative universal primary education and (iv) the internationalization of higher education. These are presented chronologically.

First, from a social justice framework, Tikly and Barret (2011) have discussed an approach founded on a theory of capabilities and social justice. The study involves an understanding of how the quality of education is explained within the framework of how it

improves essential capabilities that are valuable to communities, individuals and the society as a whole. Three inter-related dimensions of educational quality are analysed from a perspective of social justice. (i) the first element articulates the various factors that grease the enhancement of learner capabilities (e.g. limiting institutional and cultural barriers) and consolidates learning processes from different groups; (ii) the second aspect is focused on the degree by which externalities on education are held in high esteem by their communities and in line with development priorities from a global perspective and (iii) the dimension of democracy envisages how educational quality decisions are governed as well as the nature of participation of learners in local, national and global debates.

Michealowa (2001) assessed the most efficient mechanisms by which learning competencies for a substantial number of children can be ensured. The author laid emphasis on four key policy options for efficiency. They comprised: (i) working towards addressing cross-country contextual settings and constraints in initial conditions of the educational systems; (ii) optimizing the mix of educational inputs through among others the availability of more text books in homes and the provision of access to public libraries and opening of mobile libraries in rural communities; (iii) enhancing the capacity to transform inputs into effective learning through institutional and motivational factors and (iv) re-evaluating the cost of input characteristics.

Second, with regard to outcome based education (OBE), according to Botha (2002), OBE is an academic philosophy that was introduced in South Africa in the post-apartheid era to tackle demands for a work force that is increasingly skilled. The OBE are curriculum-related reforms that were issued by South Africa's government after the first democratic elections in 1994 in order to make education more readily available and eliminate educational inequalities that existed in the apartheid era (Jansen, 1998). This system is based on the assumption that it would improve education quality attained by South African learners in school. Therefore, OBE is a theory in education that is founded on the educational goals or outcomes. With regard to the outcome of the educational experience, a goal should be achieved by each student. There is not a one size fits all teaching or examination in OBE. According to the narrative, assessments, opportunities and classes should instead enable all students to achieve specific goals. The essence of this narrative is to adapt to trainer, mentor, facilitator and targeted results.

Consistent with Lomofsky and Lazarus (2001), it is also important to note that, policy development within this framework has been oriented by universal tenets of human rights to

equality, education and acknowledgement of democratic rights within broader contexts (including all learners, teachers and people with disabilities). The authors have articulated that some policy reforms in education have recommended a shift in the understanding of ‘special needs and support services’ in a nation vis-à-vis an inclusive training and education system.

Third, within the framework of pedagogical renewal for universal primary education of quality, Dembélé and Lefoka (2007) have recommended reforms in both teacher development and pedagogical renewal as means of improving universal primary education in Sub-Saharan Africa. Open-ended institutional practices and bilingualism are suggested as some promising strategies. Moreover, improvement in coordination, decentralisation and privatisation of education are important. According to Geo-Jaja (2004) such schemes have resulted in no educational developments in some countries like Nigeria.

Fourth, from the measurement of globalisation and/or internalisation, Albach (2007) maintained that internationalization involves practices and policies that are engaged by individuals and academic systems/institutions in order to meet challenges imposed by the global academic environment. Some drivers of internationalisation entail *inter alia*: the boosting of curriculum with international content, acquisition of knowledge and new languages and commercial advantages. Moreover, efforts devoted toward ensuring quality and monitoring of international initiatives are part and parcel of the global environment of education.

According to Oyewole (2009), the internationalisation of higher education has the promise of enhancing the quality of curriculum, programs of students, facilities and staff in systems of higher education. Unfortunately, in some African regions where appropriate regulatory channels are not in place, higher education can be threatened by internationalisation via activities of questionable learners and foreign providers.

3.2 Balancing general education with technical education

There is a consensus in the literature that general education substantially outweighs technical training in African countries (Oketch, 2007; Lewis, 2009). Thus, the imperative of balancing technical education with general education was adopted as part of the African Union’s (AU’s) policies (see AU, 2006). According to the narrative, technical and vocational education which for the most part is concerned with preparing citizens for the job market is the area of schooling that has to be emphasised in Africa in order to address growing concerns of unemployment and poverty in the sustainable development agenda (Brixiová, 2010, 2013;

Brixiová et al., 2015). This description is supported by the recent literature on the need for technical skills in entrepreneurship. Most notably, Mensah and Benedict (2010) observed the long-term poverty-reducing consequences of training for entrepreneurship instead of government hand-outs for survival while Gerba (2012) remarked on the positive relationship between entrepreneurial lessons in schools and doing business.

The foregoing argument is consistent with the position that a knowledge economy in the 21st century is characterised by changing labour market demands which require technical and vocational education and training (TVET) to regularly adapt to the needs of students to secure employment. In theory, TVET which should be a core part of everybody's education is a mechanism where-by individuals in both rural and urban areas are empowered to take control of their lives. A sustainable TVET programme incorporates, *inter alia*: a sound system of general education; specialised technical training, a conducive introductory/general technical education and avenues of credit transfer to consolidate training and education.

It is important to note that in the absence of avenues of employment, formal- and 'non-formal' TVET-related programmes that are consolidated (e.g. by counselling, career guidance and entrepreneurship training) could enable citizens to become self-employed. Whereas TVET also substantially offers opportunities with which to emerge from disasters and civil conflicts, it also endows the possibility of making a transition from the informal to the formal economy.

In the light of the above, a quality technical and vocational education and training (TVET) that responds to the requirements of the labour market needs to be created by educational institutions in collaboration with future employers. Such programmes are acknowledged as imperative for providing equipment to the growing number of young citizens finishing basic schooling. Moreover, TVET also provides opportunities of preserving and boosting cultural practices and indigenous knowledge, for example by means of enhancing traditional crafts and arts. Considering the high proportion of young people that have not gone through a formal educational process, the complementarity between TVET programmes and consolidated non-formal learning can be immensely beneficial for women and girls. Ultimately, these benefits are associated with positive externalities on African community wellbeing. In summary, TVET needs to be aligned with demands from the local market and R&D channels that seize advantages of avenues offered by the phenomenon of globalisation. An interesting strand of policy measures on how to improve TVET in Africa which is available in Table 5 of the AU (2006) report includes: equitable access to TVET;

quality and relevance of national TVET programmes and systems; non-formal education; capacity building; financing TVET and the employment of network strategies.

3.3 Increasing Research and Development

As suggested in recent African KE literature (Asongu & Nwachukwu, 2016ab), it is important for countries to rely on the importation of overpriced technology that is very expensive for its research units to accommodate and tailor their research platforms toward affordable indigenous-focused research like food self-sufficiency and security. Some policy recommendations for increasing R&D in Africa include: (i) incentives for indigenous-oriented scientific research, (ii) measures against brain drain, (iii) encouragement of regional collaborative R&D and (iv) amelioration of communication channels between experts and policy makers.

First, while a consensus has been reached in the literature on the relevance of locally-tailored research in the consolidation of indigenous and national absorptive capacities (see Asongu & Nwachukwu, 2016b), the setting of research standards is crucial for locally-oriented research. Peer review enables scientific rigour in the process and more importantly, the outcome substantiates the suitability of research that is underpinned by local interest and implementation. In addition, the connection between research and industrial development can be increased by encouraging researchers to have their scientific products peer-reviewed and published. Doing so in top tier journals entails some additional charge (especially in terms of submission fees), substantial incentives should be provided to researchers who are willing to contribute to knowledge in areas of academia that are closely linked to industrial development. This policy direction is supported by the literature. This suggests that the low rate of research published on Africa is fundamentally traceable to the lack of finance and inadequate inducements (Zezeza, 2005; Ondari-Okemwa, 2007).

Second, from the perspective of the brain drain, in order to increase R&D at local and national levels, researchers that are based abroad need to collaborate/connect with their peers working in their countries of origin. These partnerships of international nature could include, among others mentoring of youth in research and insights into channels via which research findings can be associated with the development of the local/national industry. It is important for governments in the African continent to also take essential measures to see to it that qualified scientists that are leaving in search for better working conditions and greener pastures constantly keep-in-touch with national/local universities. This measure is particularly

important because with growing standardization of diplomas and university certificates, most researchers in less developed countries that receive the relevant research training abroad, seldom return to their home countries/universities to contribute to knowledge by means of research and development. Genuine efforts devoted to stemming the tide should not be exclusively country-specific, but be tailored through international and regional policy initiatives.

Third, the promotion of regional research and innovation is important in order to enable lagging nations to catch-up their frontier counterparts in terms of R&D. Such a promotional venture could focus on, among others, validating and encouraging activities that lay emphasis on local/regional initiatives in the promotion of new businesses. The ventures could also entail the cross-country construction of appealing environments for collaboration in R&D. The corresponding networks may border around the following ideas: (i) cooperation from a transitional setting with the purpose of facilitating catch-up in science and R&D; (ii) orientation of R&D programs to involve regional policy makers and local actors and (iii) integration of and emphasis on nations in the continent that have achieved more development (e.g. poverty and income-inequality reductions) by enhancing R&D.

Fourth, cross-country policy initiatives in the three categories above can be enhanced in the presence of adequate information and communication facilities between researchers, industries and policy makers. Building complementary/joint platforms and networks of communication is a means of enhancing such correspondence between various stakeholders. Moreover, lessons from successfully implemented projects need to be properly communicated and documented in order to serve as role models for other R&D networks. Such communication and documentation should encompass clear data and statistical indicators on which existing and potential collaborative networks can leverage upon in order to promote R&D.

An example of a collaborative initiative that is meant to fight brain drain, promote research and cross-country policy measures is the ‘African Diaspora Support to African Universities’ that is tailored by the Council for the Development of Social Science Research in Africa (CODESRIA) (see CODESRIA, 2014). The initiative aims to mobilize African researchers in the diaspora to contribute towards: consolidating African universities, revitalizing social sciences, filling gaps in teaching, strengthening PhD programmes and mentoring young researchers in social sciences. More generally, the CODESRIA scheme aims

to boost relations between African universities and African academics in the diaspora and their institutions.

In summary R& D platforms are essential for building Knowledge-Based Economy because while exemplary countries like South Korea imported a considerable amount of its technology from more developed countries, about 3 percent of its GDP was allocated for R&D purposes (Suh & Chen, 2007; Tchamyou, 2016).

3.4 Lifelong learning

In the process of building African knowledge economies, a culture of lifelong learning is vital in order for workers in particular and society in general to continually adapt to the evolving and challenging conditions of the labour market. It would be important for policy makers to provide channels that enable on-the-job vocational and technical trainings. Such measures should be tailored hand-in-hand with incentives for training in the work place.

To be sure, in order for workers to adapt to evolving technological conditions, governments in Africa would need to provide vocational and technical training as well as engage the necessary steps toward encouraging training in work places. The motivation behind the underlying strategy is that as countries develop, technological competence becomes even more critical to sustain this economic progress. In order for such measures to be successfully implemented, it is relevant for policy makers to nurture high calibre scientists and engineers that are able to manage the prosperity on science and technology frontiers. A case in point is the Korean experience in which education and industrialization are complemented in order to boost and sustain economic development. Accordingly, technological learning and industrialisation resulted from education on the one hand and on the other, industrialisation in turn increased the return on educational investment which further enhanced the demand for education (Suh & Chen, 2007; Tchamyou, 2016). In summary, as argued by Suh and Chen (2007), the relationship between human development and education was tailored into a lifelong learning strategy.

Such a lifelong learning strategy has been broadly articulated by the African Union's educational plan (AU, 2006). *“To re-align education systems in Member States so that young people are provided with compulsory basic education which imparts key generic competencies, skills and attitudes that lead to a culture of lifelong learning and entrepreneurship in order to empower individuals to live in peace and harmony, engage in the*

world of work, alleviate poverty and pursue further learning” (p. 9). The priority areas for policy intervention are discussed in Table 5 of the AU (2006) report.

4. Information and Communication Technology (ICT)

There are a multitude of benefits from ICT penetration in economic growth and sustainable development (African Partnership Forum, 2008; Chavula, 2010; Butcher, 2011; Asongu, 2016b). Such may include the fact that ICT facilitates the effective creation, dissemination and processing of knowledge. The economic importance of these benefits is more apparent when ICT penetration in Africa is compared to the rest of the world (see Penard et al., 2012). Indeed relative to other regions of the world, there is a higher penetration potential of ICT mechanisms in Africa. According to the narrative, while high-end countries in Asia, Europe and North America are currently experiencing points of saturation in ICT growth, there is substantial room for its penetration in Africa. The logical implication is that policy can leverage on the corresponding penetration potential to tackle development concerns.

In the light of the above, ICT has recently been documented to contribute to sustainable and inclusive human development, in terms of: gender empowerment (Maurer, 2008; Ojo et al., 2012); boosting of financial inclusion (Kirui et al., 2013; Singh, 2012); access to health care from the population in the low socio-economic strata (see Kliner et al., 2013); mitigation of the development divide between urban and rural areas (Qiang et al., 2011; Chan & Jia, 2011); purging of agricultural wastes as well as demand- and supply-side constraints/mismatches (see Muto & Yamano, 2009; Aker & Fafchamps, 2010); consolidation of business opportunities, especially for small and medium sized corporations (Asongu, 2015; Ondiege, 2010; Mishra & Bisht, 2013); informal financial sector development (Asongu, 2013b); household management efficiency (Al Surikhi, 2012) and promotion of inequality adjusted inclusive human development (Asongu & Nwachukwu, 2016cd). Despite the substantially documented positive development effects of ICT (also see Jonathan & Camilo, 2008; Ureta, 2008), Mpogole et al (2008) have cautioned that ICT should not be construed as a silver bullet for economic development. This implies that corresponding policies need to be carefully tailored to leverage the ICT potential, especially in development sectors that have proven success stories.

Whereas there is a wide consensus on the socio-economic rewards of ICT in African countries, some fundamental setbacks to access still persist like concerns about affordability

and absence of infrastructure. A relevant policy direction should be the implementation of measures which contribute toward improving the much required infrastructures for enhanced ICT penetration and/or universal access mechanisms. Furthermore, reverse ICT engineering could consolidate the base of ICT on the continent, reduce operational dependence as well mitigate the cost of acquiring technology. In East Asia for instance, leading countries like South Korea have fundamentally built their economies by synergising ICT with other policies, notably an active informatization policy with industrial measures that are combined with sound competitive and regulatory policies.

Accordingly, the ICT success of South Korea is hinged on massive investment in internet equipment, multimedia and telephone lines, *among others*. These investments considerably contributed to economic growth and human development. In accordance with Suh and Chen (2007) and recently Tchamyou (2016), the ICT policy of South Korea was clearly articulated along perspectives which encompassed three policy areas, namely: (i) an industrial policy (R&D, human resources and venture capital)’ (ii) a competitive and regulatory policy (market liberalisation and privatisation) and (iii) an active information policy (setting-up of electronic-government and construction of an advanced infrastructure). As substantiated by Asongu (2017b), integrating the three areas of policy measures within a complementary framework has been fundamental to South Korea’s successful ICT strategy. Therefore, African economies could build on insights into such policies which are the foundations of South Korea’s exceptional development in its knowledge economy. As discussed earlier, reverse engineering of imported ICT technology and less tight IPRs on ICT are steps in the right direction towards consolidating an African ICT base. Moreover, such policies could drive-down dependence on business operations and the cost of technological acquisition.

5. Economic Incentives and Institutional Regime

Economic incentives and institutional regimes are major concerns in the building of KE (Cogburn, 2003; Letiche, 2006). Good institutions are essential for the development of African economies. Moreover, this pillar of the knowledge economy is complementary to the institutional reforms which are needed to encourage entrepreneurship and for the efficient use of existing and new knowledge in African countries. These reforms may involve initiatives to reduce (i) poor governance (Andrés et al., 2015), especially the role of corruption in consolidating intellectual property rights (IPRs) (Andrés & Asongu, 2013a); (ii) excess

liquidity in African banking institutions that is limiting access to finance (Saxegaard, 2006; Triki & Gajigo, 2014).

5.1. Economic Incentives

Consistent with the narrative above, extensive (or export-led) development strategies would expose African economies to more competition. Whereas an outward-looking strategy could spur intensive programmes in R&D, fiscal inducements from domestic governments are relevant for the success of such strategies. Along the same line of thinking, measures of protectionism which are for the most part relevant at the early stages of industrial development should be curtailed in tandem with economic development. This is essentially because complacency in innovation is often the result of lack of exposure to competitive forces.

Private credit incentives and measures in the fight against excess liquidity are essential to address the substantially documented concerns of surplus liquidity (Saxegaard, 2006; Triki & Gajigo, 2014). This would require the consolidation of information sharing offices or credit bureaus that are required to mitigate information asymmetry between lenders and borrowers in the African banking industry (see Barth et al., 2009; Singh et al., 2009; Triki & Gajigo, 2014; Tchamyoun & Asongu, 2016; Asongu et al. 2016a). Tackling the concern of surplus liquidity would stimulate the private sector and address fears in the evolving literature on the need for investment (Anyanwu, 2007, 2009) and more financial access (Rolfe & Woodward, 2004; Bartels et al., 2009; Tuomi, 2011; Darley, 2012; Bartels et al., 2014) on the African continent.

Governments adopting extensive growth strategies should simultaneously provide incentives (e.g. fiscal incentives and subsidised R&D programmes) with which to protect African industries from foreign competition in the short run. Protectionist measures are welcome at the early stages of industrialisation because whereas industrialised nations used protectionist policies at the early stages of their industrialisation, the neoliberal economic model prioritised by the Washington consensus promotes private capitalism and free market competition.

Unfortunately, even by European and the United States' standards, the free market ideology is strategically designed to stifle free market competition that directly affects Africa's industrialisation process and its quest for knowledge-based economies. We substantiate this perspective with three examples. According to Joseph Stiglitz in 'Making

Globalisation Work', the United States would not be at the forefront of exporting cotton to the rest of the world, but for subsidies offered by the US government. The same narrative maintains that with a subsidy of 2 USD per cow/day in the European Union, it is better to be a cow in Europe than a human being in Africa where most of the population still lives with less than 2 USD/day. Above all, the principles of comparative advantage underpinning the neoliberal ideology can hardly be respected with a European Union that allocates about half of its budget subsidies to agriculture and the agri-foods industry that represent around 6 percent of its GDP.

In the light of the above, whereas protectionist policies are needed in Africa at this early stage of industrialisation, they should be ultimately curtailed in order to mitigate complacency in innovation. A means of providing incentives to small and medium sized corporations that are characterised with greater capital requirements and risks is to use government-run research institutes for collaborative R&D.

5.2 Institutional Regime

A fundamental cause of Africa's underdevelopment is poor institutional quality. Market-focused institutions are essential in the continent as a development strategy in order to substantially liberate competitive forces that are relevant in the drive toward knowledge-base economies. Hence, because a strategy that is market-oriented needs competitive forces, conditions for KE are also likely to be enhanced. Therefore, factors like government accountability, levelled playing fields for all participants in the market, liberalised trade and foreign investment regimes are essential for KE.

African economies can also consolidate their institutional regimes by designing policies that support institutions in: (i) asserting national credibility during crises; (ii) co-opting corrupt elites into investing in long run development projects; (iii) exposing African corporations to international competition as they mature and (iv) promoting avenues that liberate competitive forces that are indispensable in knowledge-based economies.

One of the appeals of developing credible institutional regimes is that it potentially mitigates capital flight and enhances foreign investment. For instance, with the South Korean experience after its 1997 crisis, policies implemented by the government were successful for the most part because the government had credible domestic and international institutions. Governments in Africa can leverage on such lessons especially the acknowledgement of long-run fiscal prudence by the government of South Korea which enabled it to put adequate post-

1997 reforms in place. The measures included removal of non-performing loans, recapitalization of financial establishments and provision of financial support for households with low-incomes and unemployment-related social programmes. Thanks to sound institutional regimes, fiscal prudence and financial credibility, the South Korean government could issue novel bonds in order to raise the funds needed to finance reforms. In the light of the above, African governments need to beware of the fact that their ability to successfully manage financial and economic crises is contingent on some amount of institutional reliability.

Another very relevant institutional issue in Africa is corrupt political elites (see Garoupa & Jellal, 2007; Jellal & Bouzahzah, 2013). Still building on the South Korean narrative, instead of cracking-down on the corrupt elite as was urged the government by the USA, the leader (Park) adopted a more practical approach of expropriating shares of the corrupt elite in banks and obliging that the elite invest in industries that favoured import-substitution (see Tran, 2011). This strategy of dealing with corruption is particularly relevant to African countries which on average lose about 25 percent of their annual GDP (see Asongu, 2014a). Generally speaking, the above narrative of the Korean approach is in line with the perspective that a credible government is essential for the successful implementation of KE strategies. As seen above, the pivotal role of the government of Korea has been very remarkable. The South Korean government has been visionary in ensuring effective leadership that enabled a favourable macroeconomic environment for KE: domestic R&D initiatives, access to modern infrastructure, training of the population, mass education, and the assimilation of foreign technologies among others.

6. Innovation Systems

This aspect of the index of knowledge economy is concerned with the ability of firms, research centres and institutions of learning including universities to efficiently tap into the growing stock of global knowledge, to adapt it to local needs and to create new technology. It is well documented that African countries are substantially deficient in these innovative systems (see Carisle et al., 2013; Anyanwu, 2012; Oyeyinka & Sampath, 2007). Generally speaking, these writers qualified innovation in terms of three main dimensions, namely: trademark applications, patent applications and scientific publications. As shown by Asongu (2016a), in order to enhance the catch-up process, innovation in the continent can be facilitated through engagements in reverse-engineering. This is essentially because investing

in new products and services are inappropriate given that the current technologies in these countries are by nature more imitative and adaptive (Bezmen & Depken, 2004; Asongu, 2017b; Tchamyou, 2016). According to these authors, the corresponding policy of industrialisation should be a progressive transition to innovation from imitation. Such is relevant for patent and trademark applications. With regard to scientific and technical publications, an academic curriculum in both secondary and higher education that is research-oriented should contribute to knowledge by means of scientific publications. A step in this direction is a gradual transition to PhD by Publication from the traditional/classical PhD option. As a matter of fact, promotions in academia (e.g. from Doctoral status to Professorship) should be skewed toward original contributions to knowledge instead of less competitive criteria like teaching and political associations. To this end, progressive replacement of traditional PhD programs with PhD by publication should enhance innovation and the transfer of technology (Asongu & Nwachukwu, 2016a).

6.1 IPRs regimes, patents, trademarks and innovation

There has been a recent stream of literature supporting the role of less tight IPR regimes in developing countries. Accordingly, in order to facilitate innovation and development, some scholars have argued that property rights should be less stringent in domains necessitating very heavy investment (Bezmen & Depken, 2004; Andrés & Asongu, 2016). The narrative maintains that IPRs regimes should be consolidated in tandem with development catch-up in order to avoid complacency. The argument has been most apparent in the pharmaceutical industry, especially in the production of life-saving drugs for diseases like HIV/AIDS that are more prevalent in African countries where extreme poverty has been growing since the mid-1990s (see Asongu & Nwachukwu, 2016e). Thanks to arguments for such relaxation in property rights on some humanitarian grounds, India is today producing significant quantities of life-saving generic drugs that were originally developed by patent holders in Western industries.

The discourse above is in accordance with the argument that the miracle in East Asia has been achieved through the copying of technology-intensive commodities from more advanced nations (see Kim, 1997; Lee, 2009; Kim et al., 2012; Kim & Kim, 2014). This debate aligns with Asongu (2014b) who has recently established that less tight IPRs can consolidate scientific innovation in the African continent. In summary, the arguments are within the perspective of Kim et al. (2012) who have conceived that alternative forms of

property rights in developing nations are needed to assimilate and boost adaptive innovation. The position of Kim et al. (2012) steers clear of the argument about the association between the stringency of IPRs and development catch-up. According to the authors, other mechanisms of IPRs like petit patent (or utility models) are needed to enhance minor and adoptive innovation in less developed countries. Indeed, it was noted by Kim (1997, p. 220) that it is very difficult for less developed countries to make the transition to industrialization by directly engaging in technological innovation due in part to the requirement for substantial Research and Development (R&D) investments.

Viewing the above dialog in the light of comparative knowledge economy literature, we may conclude that the process of industrialization in Korea was substantially built on imitation to innovation. Indeed, the perspective of the authors engaged above is that less stringent property rights and reverse engineering were essential to permitting the copying of commodities that are technology-intensive. Therefore lagging countries in Africa can adopt informal channels of technology transfer because they are adaptable to countries which are at the initial stages of industrialization. Hence, it is not necessary for African nations to continue to rely on the importation of costly technology that their research entities cannot afford financially. Furthermore, it is important for the various platforms of R&D on the continent to be focused on indigenous-related research especially on developments that are tailored toward local needs.

6.2 Scientific Publications: Traditional PhD versus PhD by Publication

The comparatively low contribution to knowledge by means of scientific publications (see Pailey, 2016; Asongu & Nwachukwu, 2016b) is partly traceable to the little production value of African doctoral dissertations (see Amavilah, 2009). According to the narrative, with regard to tackling pressing and long term development challenges, African doctoral dissertations are: neither substantially contributing to locally-tailored research nor to frontier research. There is a stream of recent literature that has responded to the low rankings of African universities in knowledge contributions by assessing whether the impressive growth experienced by ‘latecomers in the industry’ has been translated into contributions to knowledge by means of journal publications. Within this strand, Asongu (2013a) and Asongu and Nwachukwu (2016b) have established that developed countries will continue to dominate in knowledge economy through scientific publications because developing countries (especially African nations) are not catching-up.

As an extension of the above, Asongu (2017a) has examined how Africa's share in scientific publications can be boosted with the consolidation of IPRs mechanisms. The author has concluded that the enforcement of some IPRs mechanisms can enhance contributions to knowledge through scientific publications, namely: World Intellectual Property Organization treaties, main Intellectual Property law and Bilateral treaties. An earlier inquiry by Asongu (2014b) had suggested that some form of software piracy (especially econometrics software) can boost output in scientific publications from African nations because of the adaptive and imitative technological make-up in these countries.

The stream of literature has been extended by Asongu and Nwachukwu (2016a) who have presented an argument for PhD by Publication as opposed to the traditional/classical thesis. According to the authors, innovation and technology transfer can substantially accelerate the development catch-up process if the PhD degree is linked to scientific publications. Corresponding implications for policy have been discussed in three principal strands, namely: (i) the transformation of scientific publications into innovation that is economically beneficial (ii) proposals on how to boost contributions to knowledge through scientific publications and (iii) linkages between science, IPR regimes and innovation in developing nations. In the discussion that follows, we substantiate some of these components.

There is a plethora of avenues through which know-how can be exchanged between academic scientists and producers/researchers within the framework of transforming scientific knowledge into profitable economic innovation. Compared to the traditional thesis, a PhD by publication facilitates such a framework of collaboration. The common sense behind the argument is that traditional thesis is not closely related to a university's Technology Transfer Interface which determines the possibilities of transforming scientific findings into industrial development as well as protecting and managing patented innovations. In summary, the catch-up process in knowledge economy between Africa and frontier countries throughout the world can be enhanced by, *inter alia* (i) harmonizing scientific publications with PhD dissertations in order to improve the quality and design of existing commodities and (ii) ensuring that scientific output is better disseminated when doctoral dissertations are associated with peer-reviewed scientific publications. Furthermore, the PhD by Publication setting which focuses on industrial development can leverage on the engaged insights to boost locally-tailored research that can be beneficial for innovation and industrial development.

6. 3 The digital economy and contemporary industrialisation

There is now a consensus that contemporary industrialisation will be driven by the digital revolution and/or economy. This implies that there would be a comparative advantage in digital ‘know how’ and countries offering such digital services at low cost would have a higher propensity for economic growth (Acemoglu & Restrepo, 2016). As aptly documented by Schwab (2015), the world is standing on the brink of a revolution in technology that is going to fundamentally modify the way people work, live and interact with one another. According to the author, the sheer complexity, scope and scale of such transformation would be unprecedented in human history. While the manner in which such a transformation would unfold is not yet fully known, it is imperative for policy makers to develop comprehensive and holistic KE approaches which integrate a multitude of stakeholders from various walks of life, *including* civil society, global polity, public and private sector and academia. The challenges are more demanding for African countries because they are relatively less developed in information technology and electronics which are foundations of the fourth industrial revolution. Hence, policy makers in Africa would need to critically understand how the digital economy is potentially likely to impact business, government institutions and citizens. The key points are summarised below in chronological order.

First, in relation to the impact on business, there are four elements of the digital revolution that need to be progressively incorporated into a KE policy agenda, namely: organisational forms, collaborative innovation, product improvement and customer/business anticipations. It would be interesting to note within this framework that commodities are continuously being enhanced with the help of digital innovation. The emergence of international platforms and a plethora of novel models imply that many aspects like organisational forms, culture and talent would need to be re-designed completely. Policy makers would need to take measures that enable assets to be more resilient and durable. Moreover, data and analytics are constantly improving the way assets are consolidated. In addition, new avenues of collaboration are required for data-oriented services, customer experiences of global standard and analytical performance of data, especially in the light of how contemporary innovations are occurring.

Second, the effect on the government is also essential because, as the biological, digital and physical worlds are increasingly converging; novel platforms and technology would enable citizens to continuously engage governments in view of demanding accountability and increasing their voices. Unfortunately, there are down sides to this

dimension because governments may also be endowed with new measures of controlling digital infrastructure and increasing surveillance systems. Governments would also need to adopt new ways to engage public policy because of decentralisation power which is growing with increasing competition and new sources of technology.

Third, with regard to the impact on people, the following are among an endless list of concerns that need to be seriously considered by policy makers in order to create harmonious relations between the governments in place and citizens, *inter alia*: consumption patterns, ownership notions, direction of privacy, leisure and work time and means of nurturing relationships, meeting people, cultivating skills and developing careers. These dimensions that are changing who we are and what we do would have to be critically understood by African governments which will stand to gain more by making the transition to more democratic institutions and better governance standards.

7. Conclusion and future research directions

Compared to other regions of the world, Africa is lagging in its drive toward knowledge-based economies. This study has surveyed policies and strategies with which African countries can accelerate their current drive towards knowledge economies. These have been discussed in terms of the four pillars of the World Bank's knowledge economy index, namely: (i) education and skilled population, (ii) information and communication technology, (iii) economic incentives and institutional regime and (iv) innovation systems.

Whereas we have attempted to provide some policy directions which can enable lagging African countries to catch-up their more developed counterparts, the transition from product-based to the knowledge and/or digital economies remains the responsibility of all. This means that neither technology nor the corresponding disruption that is associated with it is exclusively exogenous to human control. Citizens through daily choices and activities can help in grasping opportunities that knowledge based economies are offering to create jobs and lift millions out of poverty. For this ends to be clearly understood by scholars and policy makers, it is worthwhile for future research to investigate empirically how knowledge based economies contribute towards creating jobs and reducing poverty. The further research recommendation is also motivated by projections that the population of Africa is estimated to double by 2036 and represent 20 percent of the population in the world by 2050 (UN, 2009). Moreover, as empirically demonstrated by Asongu (2013) the corresponding unemployment accruing from the underlying demographic change would be accommodated by the private

sector (vis-à-vis the public sector) which requires knowledge-based economy orientations for efficiency in organisation and production.

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