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Research Application Summary

Transforming African economies through university-led innovations: A concept note

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Abstract

African economies are under pressure to grow at a higher rate in order to raise the living standards and create sufficient jobs for its bulging youthful population through application of science, technology, and innovation as articulated in Africa Union Commission's Agenda 2063, and Science, Technology, and Innovation Strategy for African 2024 (STISA-2024); as well as Comprehensive Africa Agriculture Development Plan (CAADP); putting into consideration the UN Sustainable Development Goals 2030. African universities are being looked to for leadership and are called to change their mandate from the traditional focus on teaching to include research, extension, and commercialisation of research output. In other words, to become "innovation universities." This Concept Note attempts to describe the framework within which African universities might be transformed into innovation universities. While it does not provide specifics answers to specific questions as to how this might be achieved, the paper reviews the literature on the evolution of innovation as a key feature underpinning growth and economic competitiveness, as well as highlighting the significance of national innovation systems as vehicles for driving innovation in many countries around the globe. Firstly, based on a cursory review of the literature on growth theories, it is noted that the term "innovation" has increasingly replaced "technological progress" in the development policy circles as the main driver of economic growth. This led to a focus on broader definition of innovation as the creation of "a new combination" from existing sources of knowledge, capabilities, and resources. Second, while acknowledging entrepreneurship as key force or agency driving innovation process, it is pointed out that increasingly innovation is likely to happen in a networked environment in which different economic actors such as firms, research institutions, and universities interact within the so called national innovation systems. Noting that an entrepreneurial entity can be individual, firm, public for-profit or non-profit organisation, or state. Third, the success of Japan and other Asian economic latecomers is seen as providing lessons on the dynamics of technological catchup to be taken on board, particularly on the importance of translative adaptation of international best practices to fit the national contexts; as well as management of the tensions that are bound to arise between economic modernisation on the one hand; and political, social, and cultural change on the other. Finally, a cursory analysis points to existence of strong links between the world's most innovative universities, world-class top ranked universities, and economic success of the countries hosting them. This means a framework such as Washington Accord and Multi-Objective Integrated Model for the development of World Class universities can guide the transformation of African universities into innovation universities.

Keywords: African universities, innovation, economic transformation

Résumé

Les économies africaines sont destinées à croître à un rythme élevé afin de relever le niveau de vie et de créer suffisamment d'emplois pour la jeunesse, et ceci à travers l'application de la science, de la technologie et de l'innovation, comme décrit dans l'agenda 2063 de la commission de l'Union Africaine ; dans la Stratégie 2024 pour la Science, la Technologie et l'Innovation en Afrique; ainsi que dans le Plan Détaillé pour le Développement de l'Agriculture en Afrique (PDDAA); tout en considérant les objectifs de développement durable d'ci 2030 des Nations Unies. Les universités en Afrique sont appelées à faire preuve de leadership et à changer leur mandat de l'enseignement classique afin de prendre en compte la recherche, la vulgarisation et la commercialisation des résultats de la recherche, en d'autres termes, elles sont appelées à devenir des «universités de l'innovation». La présente note conceptuelle vise à décrire le cadre de travail dans lequel les universités africaines pourraient être transformées en universités d'innovation. Bien qu'il ne réponde pas de façon spécifique aux questions spécifiques sur la manière d'y parvenir, le document présente une revue de littérature sur l'évolution de l'innovation comme élément clé de la croissance et de la compétitivité économique et souligne l'importance des systèmes nationaux d'innovation dans la promotion de l'innovation dans de beaucoup de pays au monde. Premièrement, sur la base d'une revue sommaire de la littérature sur les théories de la croissance, il est à noter que le terme «innovation» a de façon graduelle remplacé le «progrès technologique» dans les cercles politiques de développement, comme principal facteur de la croissance économique. Ceci a conduit à mettre l'accent sur une définition plus large du terme innovation comme étant la création d'une «nouvelle combinaison» à partir des connaissances, de capacités et de ressources existantes. Deuxièmement, tout en considérant l'esprit d'entreprise comme moteur d'innovation, il est probable que l'innovation sera créée de façon progressive dans un environnement de réseau où différents acteurs économiques tels que les entreprises, les instituts de recherche et les universités interagissent, au sein des systèmes nationaux d'innovation. Notant qu'une entité entrepreneuriale peut être individuelle, une entreprise, une organisation publique à but lucratif ou non, ou un état. Troisièmement, le succès du Japon et d'autres pays asiatiques peut servir de leçons sur la dynamique du réajustement technologique à prendre en compte, en particulier l'importance de l'adaptation des meilleures pratiques internationales aux contextes nationaux; ainsi que la gestion des tensions qui émergeront de la modernisation économique, des changements politique, social et culturel. Enfin, une analyse sommaire révèle l'existence des relations fortes entre les universités les plus innovantes, les universités les mieux classées au monde et le succès économique de leur pays. Ceci signifie qu'un cadre de travail tel que l'Accord de Washington et le modèle intégré à objectifs multiples pour le développement des universités de première classe, peuvent servir de guide pour la transformation des universités en Afrique en universités innovantes.

Mots-clés: Universités africaines, innovation, transformation économique

Introduction and Background

African economies are under pressure to grow at a rate fast enough to raise the living standards and provide jobs for the continent's rising young population. The question is how? Based on new economic growth theory, also referred to as exogenous growth theory (Abramovitz 1956; Solow 1957), the source of national economic growth can be explained better by nations' technological and scientific progress, as opposed to what the neoclassical economists once suspected; namely, that the level of economic growth was dependent on nation's capital, land, and labour endowment (Solow, 1956).

Increasingly, however, the term "innovation" has replaced "technological progress" in the development policy circles as the main driver of economic growth (Fagerberg, 2016). In a narrow sense, innovation is the process of finding real world applications to new knowledge or using old knowledge to solve new problems; or improving an existing process in such a way as to improve the quality of the products or raise production efficiency, or improve products' competiveness on the market; a phenomenon that was first described by Joseph Schumpeter as 'creative destruction' (Schumpeter, 1934). In a broader sense, innovation means the generation of "a new combination" from existing sources of knowledge, capabilities, and resources (Mazzucato, 2011, pp. 49).

The agents involved in leading the innovation process are called entrepreneurs (Schumpeter, 1934). Entrepreneurial agents come in different shapes and forms such as individuals, private firms, public enterprises, not-for-profit organisations, or governments (Mazzucato, 2011, pp. 70)[1].

The factors driving innovation may not necessarily be found in a single firm or by isolated individuals locked away in their garages (as often portrayed in popular press about Silicon Valley entrepreneurs turned-billionaires), but often come about as a result of interaction of firms or individuals with external players such as other firms, research institutions, and universities (Fagerberg, 2016).

A linear, albeit now abandoned, view of innovation that equates high R&D spending with high probability of successful innovation (Reinganum, 1984) has been challenged by the fact that innovation process is characterised by great uncertainty of the outcomes and strong feedback loops of influences at play between innovation itself, growth, and market structure (Mazzucato, 2011, pp. 65).

This in turn has led to system's view of innovation process as more likely to take place in a networked arrangement, currently referred to as national innovation systems. Consequently, the goal of innovation policy instruments that are designed and implemented by many countries has been to bring together different parts of the economic system to engage in innovation (Fagerberg, 2016). This can be in form of industrial clusters in a locality; or national, regional, or global innovation networks.

[1] In her pamphlet, The Entrepreneurial State, Mariano Mazzucato argues against Washington consensus that governments' role should solely be confined to creating conducive conditions for innovation to thrive while letting the private sector to lead, in favour of an entrepreneurial state where the government takes a more activist and envisioning role in order to create new markets by spending in uncertain but new technologies with high growth potential. This, she argued can make innovations occur at a much higher rate than would have been possible under free market conditions.

Strong and mutually supportive complementarities must exist between different parts of innovation system, and the innovation policy instruments. Efforts must constantly be exerted to monitor and identify complementarities that are lacking, or that may hinder innovation; and providing them in order for innovation system to deliver desired outcomes. The following section looks at Nordic experience with national innovation systems that may help provide understanding on basic concepts underlying national innovation systems.

Nordic experience with National Innovation Systems

A national innovation system defines the interaction of national economic system with political system and national institutions. By reviewing the experience of three Nordic countries: Sweden, Norway, and Finland with setting up of national innovation systems (Castellacci *et al.,* 2015; Fagerberg, 2016), a common concept that is shared is that of setting up of knowledge infrastructures that takes care of the needs of important industries (such as mining, fisheries, forestry, agriculture, and maritime sectors). This knowledge infrastructure is composed of interacting entities such universities, technical specialised institutes; specialised public funding bodies targeting R&D in some sectors including small and medium size enterprises; technical research councils; public research organisations (PROs); research institutes; ministries of science and technology and trade and industry that coordinate activities of national innovation systems; holistic innovation polices; and centres of excellence co-financed by government and industry that are located at universities. Different innovation policy instruments as well as national innovation strategies were also developed in three Nordic countries to support development of specific priority industries. In Norway, for example, government supported firm-level R&D with tax credits. Prominent in the Nordic experience with innovation knowledge infrastructure is the improvement in the quality and increase in size of tertiary education to world class level, especially in the Finland (which boasts one of the best educated labour force in the world). Furthermore, efforts have been exerted to strengthen public-private interactions in order to make it more effective and increase funding of R&D, paying special attention to social innovation and both demand-driven and user-driven innovations. Of late, Finland has pushed for establishment of top world class ranking universities that would function as global magnets of skills and resources (Fagerberg, 2016)[2]. It has to be noted that while university is closely embedded in Swedish innovation model, in Norway and Finland innovation happens outside the university. That is, in public institutes (PROs). Finally, expressed in Nordic national innovation systems is the critical role of political will and commitment of adequate resources in achieving results. For instance, a multi-stakeholder body named Research and Innovation Council is chaired by the Finish Prime Minister. Its membership consists of relevant ministries, important firms, and business associations. Its function is to act as advisory and coordinating body for research, technology, and innovation policy in Finland. The next section will consider other factors that influence countries ability to modernise their economies: the dynamics and concept underlying technological catchup that must be born in mind when embarking on the path of economic modernisation.

[2]Examples include the formation of Aalto University by merger of Helsinki University of Technology, Helsinki Business School, and University of Arts and Design.

Dynamics of technological catch up

The fact that African economies are characterised by low productivity specially in agriculture and food production, provides ample opportunities for rapid technological advancement and productivity catchup with the rest of the world (Abramovitz, 1986, pp. 386).[3] However, for this to happen, the continent must develop sufficient social capability in order to succeed in exploiting and harnessing existing technologies for productivity gains and increased economic output. Variation in social capability from country to country is believed to explain the observed productivity differentials amongst countries as it affects their ability to absorb new technologies or apply new ideas for economic advancement. A nation's social capability is partly dependent on population's technical competence as provided by its education system, and the restrictions imposed by the existing institutional arrangements on nations ability to make technological choices in response to pressures for change. Countries with experience in organization and management of large-scale enterprises, and with functioning financial institutions, and markets that can mobilise large capital to fund individual firms are said to enjoy more social capability.[4] With less developed institutions, and mostly rural social structures, catchup presents many challenges to African nations, but also provides opportunities for structural changes. Hence, the concept note tries to learn from Japan's path to industrialisation in the section below.

Experience of Japan with industrialisation

Japan's successful experience in modernisation of its economy as a latecomer, and the development path charted by other Asian economies in 1990s, can guide Africa's technological catchup with the developed world. In the task of modernisation, some scholars of Japan's economic history (Maegawa, 1998; Ohno, 2006) describe the catchup process as involving the integration or absorption of latecomer into the existing world economic system through the transfer of "best practices" to the developing country. In order to take ownership and preserve national identity and ensure social continuity, this process is never passive, but takes place within the framework of translative adaptation. It means the developing country on the receiving end can and should decide the terms of integration by modifying foreign ideas and systems to fit the local context. Furthermore, Maegawa divides the task of modernisation in the Japanese context, and possibly elsewhere, as simultaneously affecting four subsystems:

- Economic modernisation through industrialisation
- Political modernisation (democratisation and building of institutions of governance)
- Social modernisation involving a shift from closed rural communities to open urban communities
- Cultural modernisation (harmonising traditional customs and values with scientific and rational thinking that befit an industrialised society)

While it is relatively 'easier' to achieve economic modernisation, Maegawa (1998) recognises that political, social, and cultural modernisation/change proceed at much slower pace and are in constant tensions with economic modernisation. The tension between the four components of modernisation needs to be managed effectively by the government and the people of the developing country in order to ensure success (Ohno, pp. 6).

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[3] Moses Abramovitz (1986) convincingly argued that countries that are backward in levels of productivity have the potential for rapid advance and catch up with 'leader' countries by "leapfrogging" (the adoption of frontier and best-practice technologies with less resistance from the vested interest, and replacing antiquated capital stock as well as established practices).

[4] Ibid. Abramovitz recognises the challenge of defining 'social capability' precisely and contents by giving as example the post-World War II growth achieved by Europe and Japan (which were until then technologically behind relative to the US but socially advanced).

Other aspects that can be gleaned from Japanese industrial success include:
• Expansion of higher education and secondary technical education throughout the country which facilitated the absorption of technology in all economic sectors
• Spread of Confucian values through education system
• The sending of high-level official mission to Europe and US to gain insights of Western technology and systems (Iwakura Mission, 1871-1873)
• Starting with light industries around Japans' main export product (silk and later cotton and textile) and moving along the value chain, from producing intermediate products through to production of finished aprons and garments.
• Reorganisation of farming communities
• Institution and collection of rice tax
• Establishment of agricultural research centres
• Holding of trade fairs
• Sending of Japanese students to study in the West to acquire expertise in targeted areas of relevance to Japanese economy, especially textile machinery and shipbuilding and later heavy machinery and railway locomotives and carriages
• Hiring of foreign experts to work as advisors in factories and ministries
• Domestic industries for import substitution
• Promotion of industries at local level
• Active export promotion by MITI (Ministry of International Trade and Industry)
• Licensing of foreign technologies and signing strategic alliances with technology foreign companies
• Protection of nascent industries against competition
• Subsidies by the government of targeted industries
• Establishment of state owned enterprises (SOES) in heavy machinery, railway, and shipbuilding
• Building of financial institutions that allowed internally funded growth (no external debts)
• Imitation/modification/complete adoption of Western technologies
• Agriculture commodity exchange market and development of distribution networks in support of farmers
In the light of the above background, we turn to the concept of Africa innovation universities.

African innovation universities

An analysis of the world's top 100 most innovative universities conducted by Intellectual Property and Business department of Thomson Reuters (see Thiveaud, 2017), showed that about 50 or half of the top most innovative universities are based in the United States (See Fig. 1 below and Table 1). The ranking assessed published papers and quantified university's collaboration with industry, its levels of activity, and success and influence in patenting.

The Thomson Reuter's findings correlates well with US' undisputable technological and economic leadership in the world. Furthermore, it may also explain why 48 of US's universities are listed amongst the top 100 QS' World Class Universities Ranking for

2016/2017 (see QS Ranking for 2017 and compare with Table 1). These two related aspects combined to support the call to African universities need to redefine their mandates and transform their institutions into innovation universities in order to accelerate the continent's economic transformation; namely, the achievement of Africa Union Commission Agenda 2063, STISA-2024, Comprehensive Africa Agriculture Development Plan (CAADP), and UN SDGs 2030 (Juma, 2016). By so doing, it is equally implied that more African universities will also climb the ladder of world-class high ranking universities.

To count as innovation universities, African universities are required to combine teaching with research, extension, and commercialisation activities of research results and patents (Juma, 2016). Universities cannot do this in isolation but must be important components of local, national, regional, and possibly global innovation systems. African innovation universities can learn from the experiences of industrialised economies to design, and participate in the implementation of national innovation strategies (Mazzucato, 2011; Fagerberg, 2016), while helping governments to manage the tensions arising from modernisation of continent's economies from experiences of Japan and other Asian economies (Maegawa, 1998; Ohno, 2006).

Given sufficient financial backing, and with the right kind of leadership, African innovation universities can facilitate technology transfer to vital economic sectors. This will help accelerate the pace of technological diffusion, absorption, and adaptation on the continent (see Fagerberg 2016 on definition of innovation policy in the Nordic context).[5] The overriding goal for the new orientation of the African innovation universities is to raise economic output, improve productivity in the economic sectors such as agriculture in which the continent enjoys great comparative advantage through the application of science, technology, and innovation to improve productivity and add value, and create agricultural products-based industries.

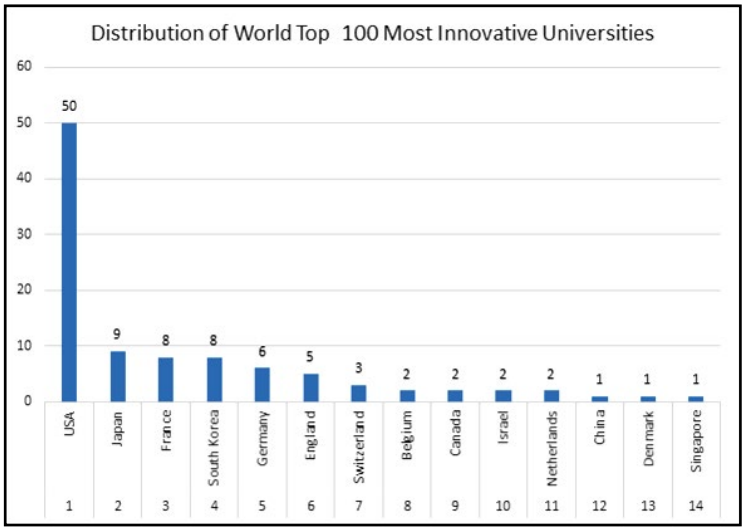

Figure 1. Distribution by Country of the World 100 Most Innovative Universities (Intellectual Property and Business unit of Thomson Reuters)

[5]In the Nordic context, innovation policies are defined as those policies affecting the diffusion of technology in an economy so as to enhance labour productivity and improve economic returns to the stakeholders. This definition should guide the framing of the mission and goals of African innovation universities.

Table 1. Top world's 24 most innovative universities

Rank	University	Country
1	Stanford University	USA
2	Massachusetts Institute of Technology (MIT)	USA
3	Harvard University	USA
4	University of Washington	USA
5	University of Michigan System	USA
6	Northwestern University	USA
7	University of Texas System	USA
8	University of Wisconsin System	USA
9	University of Pennsylvania	USA
10	Korea Advanced Institute of Science and Technology (KAIST)	South Korea
11	Imperial College London	England
12	Pohang University of Science and Technology (POSTECH)	South Korea
13	University of California System	USA
14	University of Southern California	USA
15	University of North Carolina, Chapel Hill	USA
16	KU Leuven	Belgium
17	Duke University	USA
18	Osaka University	Japan
19	Johns Hopkins University	USA
20	California Institute of Technology	USA
21	University of Illinois System	USA
22	Kyoto University	Japan
23	Georgia Institute of Technology	USA
24	University of Tokyo	Japan

Source: Intellectual property and business unit of Thomson Reuters)

Furthermore, since most world top innovation universities are also top ranked world class universities as the case of US, some of the reforms needed to climb the rank of world class universities can be used to transform current African universities into innovation and world class universities based on Washington Accord and Multi-Objective Integrated Model for development of world-class universities (see Dharaskar, 2014).

Amongst the many strategies African universities can follow to transform include (in no particular order of importance and not meant to be exhaustive):

1. Delivering academic programmes that build social capital necessary for institutional transformation to facilitate rapid technological absorption and adaptation through diffusion of management, and entrepreneurial, business, finance, and ICT education
2. Collaborating with TVET institutions to develop specialised training programmes in specialised relevant technologies
3. Push for hybridisation of vocational training and higher education by borrowing from current research on the topic (see for example, Graf, 2013).
4. Interacting with policy makers to promote innovation policies
5. Entrepreneurship and small business training programmes

6. Business schools
7. Innovation policy research centres
8. Postgraduate studies at master level in innovation and technology management
9. Multidisciplinary, interdisciplinary, and transdisciplinary research and programmes
10. Public policy research centres
11. Out of class experiential earning
12. Internship
13. Production of highly employable graduates
14. Students and staff exchange programmes
15. Fully residential campuses
16. Strong high quality postgraduate and research graduate
17. Technology assisted learning
18. Commercialisation of academic research
19. Technological adaptation
20. Extension services
21. Collaborative research
22. Innovation policy monitoring, analysis, and advisory service
23. Innovation policy research and advocacy
24. Establishment of centres of excellence around national or regional products
25. Membership of innovation networks
26. Transfer of technologies to relevant sectors
27. Small business research units
28. Strong university-industry linkages
29. Science and business parks
30. Affiliation of technically specialised universities and TVET Colleges
31. Establishment of centres for research on skill formation and labour markets
32. Establishment and upgrading of technical institutes connected with line ministries to innovation universities
33. Development of curricula responsive to the needs of industry

Finally, the following section highlights an example where a single innovation university has made such an impact on a nation's economic and scientific advancement through innovation.

Experience of Israel with technology transfer through university

Further insights could be gained to guide the setting up of African innovation universities by reviewing Israeli's approach to university-led innovation, especially the contribution of Technion-Israel Institute of Technology to country's technological progress (see Sener and Senger 2011; Frenkel *et al.,* 2012). It was noted that Thomson Reuters's ranking of the world's most innovative universities puts Israel in the tenth place together with Belgium, Canada, and Netherlands, each contributing 2 universities in the top 100. Technion was established in Haifa and teaching began in 1923 as a technical school training plumbers, electricians, and construction workers for Jewish Palestine; and for retraining Jewish emigrants fleeing WWI to settle in the then Palestine. Later, it trained civil engineers

and architects who literally built the Jewish nation. It also supported agriculture with technical expertise needed as well as building the capability of Israel Defense forces when the country came under French arm embargo after 1967 war, and is currently involved in cutting edge missile shield defense programme with global partners such as US, and two Nobel Prize laureates in chemistry under its belt. At its hundredth year anniversary, some 67,000 Technion graduates hold a total of 90,000 Technion degrees, 60,000 still in living age of whom 25% are either CEOs or VPs of companies, and 41% holding management positions, and 25% of graduates at one time worked or started a new company, 15% of its female graduates have launched businesses and 12% work in research. Furthermore, 50% of all Technion graduates are employed in jobs that produce, create, or design goods and services (Frenkel *et al.,* 2012). Notable about Technion are:

- Responsiveness to needs of the economy and national security
- Strong connection with hands on vocational training (has its own technical secondary school)
- Ability to raise funds from Jewish Diaspora
- Strong collaboration with government
- Hosting of science parks and business incubators
- Located in Haifa that attracted massive FDI by global high-tech companies
- Provision of broad based science education to its graduates
- Built-in entrepreneurship and business training to its science and engineering graduates
- Strong links to industry and follow up on its Alumni

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