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Innovation and technology transfer for enhanced productivity and competitiveness in Africa

Background paper

Theme: Industrialization for inclusive and transformative development in Africa

I. Introduction

1. The African growth narrative has changed significantly over the past decade and a half: economic growth is persisting across a large swathe of countries, independent of mineral resource endowments. Living standards and overall social indicators are improving, poverty rates are declining, energy consumption is increasing and urbanization rates are rising. Buoyed by these positive developments, by rising revenues from the commodity boom and by new discoveries of fossil fuels in commercial quantities in many countries on the continent, African leaders recognize that this moment presents a unique opportunity to transform the continent. To this end, the African Union is preparing a long-term perspective plan, Agenda 2063, for the development of the continent. Alongside this, Africa is also actively engaged in articulating the United Nations development agenda for beyond 2015, when the Millennium Development Goals come to an end.

2. However, this narrative of a rising Africa rests on the shaky foundations of low productivity and weak competitiveness relative to the rest of the world. The continent's growth has been driven largely by commodity exports and factor accumulation. According to the World Economic Forum's *Global Competitiveness Report 2013–2014*,[1] African countries as a whole are at the bottom of the ladder, with economies that are uncompetitive because of overall low productivity. This calls for a number of interventions to enhance the productivity of new and existing investments and thus improve competitiveness. One such intervention is innovation and technology transfer.

3. There are many definitions of technology transfer, each of which gives a somewhat different emphasis. For the purposes of this paper, technology transfer is defined as the process of deliberate and systematic acquisition/provision/sharing/licensing of equipment and machinery, technology, skills, knowledge, intellectual property rights, business and organizational processes, designs and facilities, for the manufacture of a product, for the application of a process or for the rendering of a service.[2] This definition differentiates transfer of technology from diffusion of technology.[3] It delineates technology transfer as the transfer of a system that includes hardware, software, procedures and skills, among other things, as a package, unlike a "product transfer" such as the sale of a tractor.

4. The economic and historical evidence[4] is clear that technology transfer has been and continues to be a means by which latecomers to the development process can accelerate their

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[1] The World Economic Forum defines competitiveness as the set of institutions, policies and factors that determine the level of productivity of a country. It identifies 122 pillars of competitiveness, among which are technological readiness (pillar 9) and innovation (pillar 12).

[2] This is a composite of various definitions. It underscores the fact that technology transfer must be deliberate and systematic, not ad hoc and episodic and unfocused.

[3] Technology diffusion is best seen as the non-commercial, sometimes involuntary and sometimes deliberate, dissemination of technology and skills, or the ability of the technology-importing country to learn from the acquired technology so that it can develop its domestic capabilities.

[4] For summaries of the evidence, see, for example: Ruttan, V.W. (2001). *Technology, Growth and Development: An Induced Innovation Perspective*, New York: Oxford University Press. Morris, I. (2010). *Why the West Rules – For Now: The Patterns of History, and What They Reveal About the Future*, New York: Farrar, Straus and Giroux. Acemoglu, D. and Robinson, J. (2012). *Why Nations Fail: The Origins of Power, Prosperity and Poverty*, New York: Crown Business.Oyelaran-Oyeyinka, B. and Gehl Sampath, P. (2010). *Latecomer Development: Innovation and Knowledge for Economic Growth*, New York: Routledge. Ferguson, N. (2011). *Civilization: The West and the Rest*, New York: Penguin Press.

own development by acquiring knowledge, experience and equipment that are known to have been successful in the more advanced countries. Technology transfer has helped to improve economic growth in developing countries and to transform lives. In the health-care and pharmaceutical sectors, for example, technology transfer affects productivity and competitiveness through its effect on the quality of human capital. A healthy labour force (with reduced absenteeism rates and health-care costs) not only lowers costs for incumbent firms and enhances their productivity; it also encourages new firms to enter into the country.

5. Furthermore, technology transfer has helped and continues to help to boost yields in African agriculture and to transform African agriculture/commodity trading. Green biotechnology is likely to result in a quantum increase in agricultural productivity, enabling Africa to tackle its food insecurity, reduce its dependence on food imports, and produce agricultural surpluses to drive industrialization and transformation, especially in countries poor in mineral resources. Finally, technology transfer has contributed to raising the average skill level of African economies and stemming the brain drain, by increasing the local availability of relatively high-wage, high-technology employment opportunities.[5]

6. Innovation – a broad term referring not only to technological innovations, but also to non-technological innovations such as improvements in skills and governance – is helping to drive the productivity and competitiveness of African economies, too. For example, innovations in the use of mobile telephony on the continent[6] have led to enormous investments in wireless communication infrastructure and services and have given impetus to firms to invest in innovative solutions.[7] For the purposes of this paper, "innovation" shall refer to technological innovations as the basis of industrial transformation, long-term productivity growth and improved competitiveness.[8]

7. The basic premise of this paper is that the keys to enhancing the productivity and competitiveness of African economies via innovation and technology transfer are industrialization, and the growth of the manufacturing sector – the engine of technical change and growth. The discussion in the paper will therefore focus on innovation and technology transfer in the industrial or manufacturing sector. There are other reasons for focusing on this

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[5] The present paper recognizes the possible negative consequences of technology transfer, such as its effect on local R&D, on innovation capacity and on indigenous knowledge and technologies. It nevertheless asserts that, on balance, technology transfer has done more good than harm.

[6] Kenya's M-Pesa is the best known. In addition, Nigeria's cashless economy policy has been made possible by the widespread use of mobile telephony and ICTs. Actions on a customer's account, with any bank, are reported almost instantaneously. Customers can transfer large amounts of money electronically. This innovation has had the effect of reducing the cost of carrying cash and the risks associated with it, thereby reducing fraud and corruption, as well as reducing the cost of printing currency. The policy has an income effect, too, insofar as bank customers will also earn more interest on their bank deposits. Finally, the innovation will dampen inflationary pressures and increase the amount of credit that banks can extend, and thus the money multiplier. Overall, these innovations in the financial sector, though subject to the law of diminishing returns, will have a positive effect on general economic activity.

[7] Nokia, for example, recognizing the blackout and brownout problem on the continent, introduced mobile handsets with flashlights. It is interesting to note that the latest Apple iPhone (the 5s) also comes with a flashlight.

[8] In the developed world, productivity growth and enhanced competitiveness come about largely through innovation.

sector, too, the most obvious being the theme of the present Conference, which is "Industrialization for inclusive and transformative development in Africa". Another reason, based on evidence from the endogenous growth literature in economics, is that manufacturing is the sector where the learning-by-doing that is so crucial to innovation takes place the most and where innovation yields greater benefits. Given the sector's links with other sectors of the economy, it is easy to conclude that raising manufacturing productivity will, ceteris paribus, raise productivity across the rest of the economy and enhance competitiveness.

8. This paper argues that technology transfer is not costless, but that if it is managed well, it will enhance the productivity and competitiveness of African economies. Furthermore, it contends that innovation, especially through learning-by-doing, can result in scaling-up of the productivity and competitiveness of African economies. To this end, African countries should take proactive measures to encourage transfer of technology to their countries, and to promote innovation. The rest of the paper is organized as follows: Section II provides context, by discussing trends in Africa with regard to innovation, technology transfer and industrial productivity. Section III identifies the leading issues and constraints with regard to innovation and technology transfer in Africa. Section IV discusses the creation of a favourable environment for innovation and technology transfer to enhance productivity and competitiveness. Building on sections III and IV, section V discusses the need to improve the environment for innovation and technology transfer. Section VI concludes with recommendations for consideration and adoption by African policymakers.

II. Trends in innovation, technology transfer and industrial productivity

9. This section sets out some facts about innovation and technology transfer in Africa's industrial sector, drawing on recent work by ECA and using data from a variety of sources. It aims to provide a premise both for discussing the constraints affecting Africa and for recommendations on ways forward. The section is in two parts; the first focuses on trends in technology transfer, with an emphasis on the channels through which it takes place, namely trade and foreign direct investment (FDI), while the second focuses on innovation.

A. Technology transfer

10. Technology transfer through trade may occur when domestic firms import capital goods; business, professional and technical services; and other forms of machinery and systems (such as software) that embody technologies; or when they purchase intellectual property rights. Similarly, technology transfer through FDI may take the forms enumerated above, and may include the import of machinery, marketing, and distribution management systems, which are required in order to successfully implement the investment projects.

11. The paragraphs that follow contain a brief discussion of recent trends in Africa with regard to the proxies generally used to measure technology transfer: FDI inflows, capital goods imports, the payment of royalties and licensing fees, and trade in high-technology products. Thereafter, technological innovation is discussed.

1. FDI inflows into Africa

12. Multinational corporations are responsible for most of the world's research and development (R&D) activities and own most of the patents. Therefore, FDI destination decisions by these corporations also imply transfer-of-technology decisions. When multinational corporations invest in a country, they transfer their technology to the country, thus allowing that country to profit from their advanced research. They also make technologies available to the country that would otherwise have been out of reach to it. This access helps to raise the average quality of domestic labour, create employment, and spur skills development through on-the-job learning. Arnold and Javorcik,[9] for example, found that in Indonesia, changes from domestic to foreign ownership led to improved firm performance.

13. Furthermore, the use of local raw materials and suppliers can provide stimulus to the broader economy, can promote the diffusion of other technologies, and can raise productivity and enhance competitiveness. Finally, with the increasing availability of talent and a growing domestic middle class in developing countries, multinational corporations are beginning to spend more of their research budget abroad, thus increasing innovation in these countries. A survey of the world's largest R&D investors, carried out in 2005 by the United Nations Conference on Trade and Development, indicated that the average investor was spending about 28 per cent of its R&D budget abroad.

14. The available data show that there has been a steep rise in private capital flows to Africa since the beginning of the twenty-first century. FDI inflows into Africa rose from $20 billion in 2003 to nearly $50 billion in 2007.[10] The leading destination in Africa for FDI is Nigeria, followed by South Africa. These flows reflect, in part, improvements in economic fundamentals. But they also reflect the elevated global interest[11] in Africa's abundant natural resources.[12] In addition to the traditional sources of private capital flows to Africa, China has become an important source. Table 1 shows that, contrary to widely held views, much of China's investment in Africa is in manufacturing, not in resource extraction.

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[9] Arnold, J.M. and Javorcik, B.S. (2009). Gifted kids or pushy parents? Foreign direct investment in Indonesia. Available at http://users.ox.ac.uk/~econ0247/Indo.pdf.

[10] Economic Commission for Africa, African Development Bank Group and African Union (2009). *African Statistical Yearbook 2009.*

[11] This has been described by many observers as the "new scramble for Africa". See, for example, www.afraf.oxfordjournals.org/content/111/443/332.extract.

[12] As finds expression in such formations as Turkey–Africa Cooperation, the Africa–EU Partnership, the Forum on China–Africa Cooperation, and Latin America and the Caribbean–Africa.

Table 1: China's investment in Africa and FDI flows to Africa, by sector

Sector/industry	Number of projects	Investment value (US$ millions)
Agriculture	22	$48
Resource extraction	44	$188
Manufacturing	230	$315
Services	200	$125
Other	3	$6

***Source**:* Accenture (2010). *Africa: The New Frontier for Growth.*

15. Western Europe and the United States of America remain the largest sources of FDI inflows into Africa. General Electric, for example, is setting up a $1 billion engineering service, manufacturing and assembly facility in Nigeria to produce equipment and machinery for the electricity sector. With the Obama Administration's Power Africa programme, FDI inflows into Africa from the United States are likely to rise in the near term. The rapid increase in FDI inflows from the West, particularly in view of those countries' superior technologies and strong culture of innovation, is likely to have a positive knock-on effect on the productivity and competitiveness of Africa's economies.[13]

2. Imports of capital goods

16. Capital goods are generally defined as high-value and durable agricultural, industrial and commercial machinery or tools, used in production or the delivery of services. In general, firms that depend heavily on imported capital goods (such as oil refineries) have fairly high technical competencies. There is significant evidence that imports of capital goods are a good indicator of technology transfer or the passing on of R&D benefits (technology spillovers) from the exporting countries to the importing countries.[14] However, the technological sophistication or knowledge content of capital goods may vary widely, even within the same class of machines (such as communications satellites), and as a result, their ability to serve as conduits for technology transfer may vary.[15]

17. Most African countries do not have a capital goods sector and therefore rely on foreign sources for the supply of capital goods. According to available data, Africa's import

[13] This discussion is not unaware of the downsides of FDI, such as transfer to and use of decommissioned, non-frontier equipment, transfer pricing, tax avoidance, and market segmentation. Furthermore, there is evidence that foreign investors use old technologies and carry out little or no R&D in joint venture projects but deploy new technologies in greenfield, wholly owned projects.

[14] Keller, W. (1998). Are international R&D spillovers trade-related? Analyzing spillovers among randomly matched trade partners. *European Economic Review,* 48: 1469–1481.

[15] Navaretti, G.B., Schiff, M. and Soloaga, I. (2003). The knowledge content of machines: North–South trade and technology diffusion, Flowenla discussion paper 22.

of capital goods changed little between 1995 and 2001 but almost tripled in value between 2001 and 2008.[16] Consequently, Africa registered faster growth in imports of capital goods between 2001 and 2008 than any other region.[17] About 19 out of the 32 African countries for which data are available saw their imports of capital goods more than triple over this period, while another 5 (16 per cent) of the countries saw their imports more than double.

18. South Africa, Nigeria, Egypt, Algeria and Morocco (in descending order) accounted for about 70 per cent of the total value of imported capital goods out of the 32 countries for which data are available. In about 14 of these countries, more than 20 per cent of the total merchandise import bill went on capital goods in 2008. Furthermore, 10 of the 32 countries had import bills that were equivalent to or exceeded 8 per cent of their gross domestic product (GDP).[18]

19. Clearly, the balance-of-payments, foreign exchange and debt problems that African countries faced in the 1980s and 1990s must have constrained their import of capital goods and limited the transfer of technologies and innovation. Moreover, a breakdown of the increased imports of capital goods shows that most of them are for the extractive sector, lending support to the view that there is strong global interest in Africa's abundant natural resources.

3. Royalties and licensing fees

20. Firms that are innovative often seek to bring existing, new and emerging products to market, or to improve their business processes. In most cases, they use technologies owned by others and may, as a consequence, be obliged to pay royalties or licensing fees to the technology owners. Such royalties and fees may be paid for the use of trade names or trademarks (such as Coca-Cola, Toyota or Aspirin), industrial designs (such as the mobile phone or television designs), patents (such as on drugs), breeders' rights (e.g. for hybrid seeds) or copyrights (such as on movies, music and publications).

21. At the global level, royalties and licensing fee payments grew from about $143 billion to $254 billion between 2005 and 2012 – representing a 77 per cent increase. Aggregate payments by African countries grew by about 75 per cent between 2005 and 2012, while payments by developing East Asia and the Pacific, and by Latin America and the Caribbean, grew by 162 per cent and 83 per cent respectively. As can be seen in table 2 below, Africa's share of payments relative to the world total has remained low and unchanged since 2005.

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[16] African Union-New Partnership for Africa's Development (2010). *African Innovation Outlook 2010*. Pretoria.

[17] United Nations Economic Commission for Africa (2010). *Economic Report on Africa 2010: Promoting High-Level Sustainable Growth to Reduce Unemployment in Africa.* Sales No. E.10.II.K.1.

[18] Ibid.

Table 2: Royalties and licensing fee payments, as a proportion of the world total (percentages), 2005–2012

	2005	2006	2007	2008	2009	2010	2011	2012
Africa	1.1	1.2	1.3	1.2	1.1	1.1	1.1	1.1
Developing East Asia and the Pacific	6.7	7.2	7.7	7.6	7.6	8.6	8.8	9.9
Latin America and the Caribbean	3.3	3.5	3.3	3.0	3.3	2.9	3.1	3.4
European Union	40.3	41.0	41.8	45.1	45.7	42.4	42.7	39.4
United States	17.8	16.6	15.6	14.1	14.5	14.3	14.2	15.7
Rest of the world	30.8	30.5	30.3	29.0	27.8	30.7	30.1	30.5

Source: ECA analysis, based on the World Bank's *World Development Indicators 2012.*

22. Looking at absolute values, royalty and licensing-fee payments by African countries amounted to $2.8 billion in 2012, which was considerably lower than the $3.8 billion paid by Thailand or the $16.5 billion paid by Singapore in the same year. More importantly, South Africa accounted for about 72 per cent of Africa's total payments for that year. This evidence suggests that increases in payments of royalties and licensing fees by developing countries are a function of advances in their stage of development. Moreover, it is consistent with the observed fact that the rate of transformation of Africa's economies is still very slow and the application of technologies on the continent is not widespread.

23. Nonetheless, a few countries have reported fast growth in their royalty payments. For instance, between 2005 and 2012, Nigeria's payments of such fees increased from about $67 million to about $252 million,[19] Egypt's from about $182 million to about $385 million, and Algeria's from about $2 million to about $137 million. Declines were observed in some countries, such as Kenya and Swaziland. The low proportion of licensing fees and royalties paid by African countries relative to the rest of the world is consistent with the view that licensing is directly related to the technological sophistication of an economy. Using a licence (disembodied technology) requires engineering and technical skills, which are in short supply in most African countries.

24. The evidence presented above suggests that African countries are acquiring mature technologies (such as machinery) rather than new and emerging technologies that involve payments for intellectual property rights and may lead to the export of high-technology products. But to be competitive with the rest of the world, and in order to explore export markets and increase their exports, African countries must increase their acquisition of new technologies and promote leading-edge innovations. To reduce the claim of royalties and licensing fees on foreign exchange revenues, and to promote growth, productivity and competitiveness, African countries are pursuing the acquisition of foreign technologies in

[19] These amounts may not all be legitimate payments for transferred technologies and processes. According to a report by ECA's Task Force on Illicit Financial Flows out of Africa, Nigeria is one of the leading sources of such flows out of the continent. According to the 2012 report by Global Financial Integrity entitled *Illicit Financial Flows from Developing Countries*, Nigeria lost $129 billion between 2001 and 2010.

tandem with promoting the transfer of technologies developed in publicly funded research institutions in Africa.

25. Due to limited R&D in the private sector, African governments are the main source of R&D funding on the continent, accounting for over 60 per cent of the total expenditure.[20, 21] Moreover, more than 70 per cent of the R&D activities are performed in government laboratories, public R&D institutions and institutions of higher learning. Therefore, identifying ways to ensure that technologies developed by domestic R&D institutions are transferred to end users will be key to driving industrial performance and competitiveness.

26. To this end, ECA in 2012 conducted a pilot survey of 28 carefully selected R&D institutions in three African countries – Ghana, Kenya and Zambia – to assess their performance on the transfer of technologies resulting from publicly funded research to the private sector. The survey found that there was little transfer occurring, for three main reasons: (a) a lack of clear guidelines and policies at the institutional level; (b) inadequate funding for technology transfer in the institutions and by governments; and (c) low prioritization of technology transfer as a core activity by the institutions themselves.

B. Technological innovations

27. Innovation[22] – the process of vesting an idea or an invention with commercial or market value, as a consequence of the practical application of the underlying idea – is classified variously depending on type, degree of novelty, and nature. The literature distinguishes four main types of innovation: product or service innovations, process innovations, marketing innovations, and organizational innovations, as well as three degrees of novelty: new to the firm, new to the market, and new to the world.

28. Data for assessing innovation trends do not exist in most African countries, because innovation surveys are very expensive to undertake. Weak capacity in national statistical offices is another constraint. As a consequence, innovation surveys in African countries are rare and episodic. In spite of the data problem, it cannot be said that innovation is not going on in Africa. A Kenyan innovation survey carried out in 2012 showed that innovation activity was reported by 89.9 per cent of the firms surveyed. Product and process innovation was reported by 50 per cent and 75 per cent respectively of the firms surveyed. Interestingly, in South Africa, a more industrialized economy, in a 2008 survey, only 65.4 per cent of the firms in the sample reported being engaged in innovation activity; 16.8 per cent reported being engaged in product innovation and 18 per cent reported being engaged in process innovation. For Nigeria, the story is not dissimilar. In a survey of technological innovation in selected indigenous oilfield servicing firms for the period from 2001 to 2010, organizational innovation was reported by 65 per cent of the firms in the sample; diffusion-based innovation

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[20] This includes donations from foreign countries to African research institutions through their governments. See reference in footnote 16.

[21] In the European Union, the business sector accounted for about 1.2 per cent of gross domestic expenditure on R&D as a percentage of GDP, while the government and higher education sectors accounted for 0.3 per cent and 0.5 per cent respectively. See http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Gross_domestic_expenditure_on_R&D.

[22] This discussion of innovation follows that of Jonas Mitasiunas in his 2013 paper entitled "Innovation and technology transfer", available at http://www.bonita-project.eu/papers/A02InnovationTech/.

was reported by 41 per cent of the firms, and product and process innovation were reported by 15 per cent and 28 per cent of the firms, respectively. In the Nigerian survey, process innovation took place essentially through the purchase and mastery of new machinery, while product innovation took place through the introduction of a new service. The survey found that innovation intensity was very low.

29. The African information and communications technology (ICT) sector has recorded significant innovations. These include the widely reported M-Pesa service, Phones for Health (P4H) which leverages mobile phone technology to strengthen health systems, open government and open data, and ICT-driven commodity exchanges.

30. In the absence of data, analysts also make use of investment in R&D, knowledge generated and inventions protected, as proxies. In this paper, knowledge production and high-technology exports are used as indirect proxies for innovation, bearing in mind that not all innovations are a result of R&D or are technological in nature.

1. Knowledge generation

31. Articles published in the science, engineering and technology fields, patents, and industrial designs are a proxy for R&D investment and knowledge production. Their impact is not observed in the short run. Nonetheless, they are likely to enhance industrial productivity and competitiveness in the long run. In this regard, the number of African articles on science, engineering or technology that have been published in peer-reviewed journals has grown faster than the world average. Countries such as Tunisia and Uganda registered a 900 per cent and 1,200 per cent increase, respectively, in the number of science, engineering and technology papers published between 1990 and 2008. Steadily growing investment in science and technology, the expansion of R&D institutions, and increased political support may account for the surge in the number of papers published by African countries.[23]

32. Despite this growth, Africa only contributes about 1.8 per cent of the global total of science, engineering and technology articles in peer-reviewed journals,[24] even though it accounts for about 2.4 per cent of the world's researchers. About 40 per cent of the science, engineering and technology articles are written with collaborators from outside Africa, while about 4.3 per cent are intra-African collaborations. Top-level international collaborations may provide access to the resources and technologies of partners in more advanced economies. However, such international collaborations may influence the domestic research agenda and discourage technological learning and creativity, especially when solutions are delivered, ready to use, by partners from outside the continent.

33. With regard to patents, Africa accounted for about 0.8 per cent of the world total of about 2.35 million patent applications in 2012. About three quarters of all applications reported by African countries were made by non-residents. In terms of filing patents abroad, the figures for 1990 to 2012 for South Africa – which accounts for the lion's share of Africa's

[23] See footnote 16.

[24] See footnote 16.

patent applications – remained almost unchanged at about 600, while those for China and India increased by about 8,200 per cent and 5,200 per cent respectively.

34. Regarding industrial designs (granted for new or original identifiable shapes, colours and/or lines of an article), based on data received from six sample countries,[25] the numbers both of resident and of non-resident applications and registrations have grown significantly. Unlike the case of patents, the numbers of industrial design applications and registrations by residents were higher than those by non-residents. ECA observed the same trend with respect to trade names and trademarks.[26]

2. Trade in high-technology products

35. Participation in the production of knowledge- and technology-intensive manufactures is key to transforming Africa into a global economic growth engine. Currently, Africa's high-technology exports constitute about 5 per cent of its total merchandise exports, whereas high-technology exports account for about 15 per cent of total merchandise exports in Latin America and the Caribbean and about 31 per cent in developing Asia. If the definition of high-technology products is limited to electronics and electrical parts and components only, then the share of such products in total merchandise exports is approximately 0.5 per cent for Africa; this compares with approximately 19 per cent for developing Asia and approximately 6.5 per cent for Latin America and the Caribbean.

III. Issues in innovation and technology transfer in Africa

36. This section identifies some issues in innovation and technology transfer in the African context. As was discussed in the previous section, although technology transfer decisions are firm-level decisions, government can play a role not only in respect of the overall policy framework but also regarding the type of public research that it funds and the transfer of innovations from that effort to the market. But in order for policy to be effective, it is useful to provide a typology of technology transfers and innovation. In order to do this, we may use a working typology, as follows. The first type of technology transfer is intra-firm technology, taking place between a foreign multinational and its subsidiaries in developing countries. The second type is inter-firm technology, where a subsidiary of a foreign company buys technology from another company (foreign or domestic) to enhance its competitive position in the market in which it is operating. The third type is technology transfer from government research institutes and laboratories to the private sector.

1. History, external environment and government policy

37. Government policy, the external environment and history (initial conditions) are important issues in innovation and technology transfer. The examples of two new industrial powerhouses – India and China[27] – help illustrate the role that the intersection of government focus, history and the external environment can play in innovation and technology transfer. We begin with India.

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[25] Ethiopia, Madagascar, Mauritania, Morocco, Seychelles and South Africa.

[26] See footnote 17.

[27] Israel and apartheid-era South Africa are other examples.

38. Post-independence India steered its education system towards science, engineering and technology. A close ally of the former Soviet Union, it received a considerable number of strategic technologies from that country, from metallurgy to machine tools. The war with Pakistan and the threat of war with China added greater impetus to its search for modern technologies. All of these were pursued in a strong national planning framework that identified key national priorities and deployed resources to achieve them. In recent times, the purchase of technology companies in the West, as well as other companies such as steel companies, by Indian multinational corporations has become a new channel through which technology and innovations have been strategically transferred to India. Indian multinationals such as Tata, ArcelorMittal, Infosys and Bharti Airtel,[28] to name a few, have acquired important technology companies and manufacturing companies in Europe and North America. Given the large size of its market and its growing middle class, foreign multinationals are also increasingly setting up or strengthening their subsidiaries in India, in the process transferring technology to, and promoting innovation in, Indian manufacturing. In addition, members of the Indian diaspora are playing an active role in innovation and technology transfer in their country of origin. Through return migration, many Indian expatriates have brought back with them to India critical technologies and innovation, giving added impetus to the country's innovation and technology drive.[29]

39. China has followed a path not unlike that of India. It benefited significantly by receiving technology from the Soviet Union and communist Eastern Europe in the years following its revolution. It built up a formidable defence industry in the light of border tensions with India and the Soviet Union and in the aftermath of the Korean war. In common with India, China built up enormous capacity in science, technology and innovation in the framework of its communist five-year economic planning, which identified national priorities and deployed resources to achieve them. When the Chinese leadership began to open up the economy to outside investors, there was an army of qualified engineers and technologists that foreign investors could hire. Equally important in this effort was the large number of educated and wealthy overseas Chinese, not just in Macao, Hong Kong and Taiwan Province of China, but also all across South Asia and the Americas, who did not hesitate to invest in China. The Chinese Government, like that of India, is building on this momentum. It recently issued a series of innovation policies with a view to establishing an enterprise-centred national innovation system and making China an innovation-driven nation by 2020.

40. The lessons from the experiences of the two countries outlined above are that leadership matters and that African governments have not placed necessary and/or sufficient emphasis on innovation and technology transfer as a strategic variable in their development

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[28] ArcelorMittal is the world's largest integrated steel producer. Tata is an Indian conglomerate founded in 1868 which operates in eight different sectors including automobile production and ICTs. It recently bought the United Kingdom's Land Rover Group. Infosys is a leading Indian multinational software development company that has 18 offices in the United States alone – a strategy that allows it to tap into advanced research and to draw from the rich pool of talent in the United States.

[29] For an empirical assessment of the contribution of returning expatriates to innovation in their countries of origin, see, for example: Liu, X. and others (2010). Returnee entrepreneurs, knowledge spillovers and innovation in high-tech firms in emerging economies. *Journal of International Business Studies*, 41(7): 1183–1197.

agenda, in spite of the lofty ambitions expressed in the Organization of African Unity's 1982 Lagos Plan of Action and Final Act of Lagos. By way of example, Adeola Adenikinju concluded in his 2005 study of productivity in Nigeria that "Nigeria's activities in the broad areas of technology transfer, research and development, and adoption of new technologies have been quite limited."[30]

41. The indigenization policies carried out in many African countries made the continent less attractive to invest in by many multinational corporations and resulted in the dominance of old and antiquated technologies in many, if not most, of the indigenized firms. There was little if any innovation in most of these firms. The cumulative consequence of this policy was low growth in the manufacturing sector together with low levels of productivity and competitiveness. It is not inconceivable that the policies of the past, in spite of the seeming triumph of neoliberal economic policies in many countries, continue to inform multinational corporations' decisions with respect to the degree to which they are willing to increase their exposure in African countries and also in the composition of that exposure.

2. Costs related to innovation and technology transfer

42. A leading issue in technology transfer is the assumption that technology transfer is costless: that all that needs to be done is to transfer the technology and turn the key. But evidence shows that this is often not true. There are costs involved with learning to use it, service it and maintain it, as well as training costs. Also, each technology comes with a very high degree of embodied and/or tacit knowledge and embedded relationships that arise from the culture and society in which it was produced. Therefore, making the best of transferred technology – adapting it to the local conditions and culture – usually requires active learning, which is not costless.

3. Firm size is important

43. The second issue is firm size. Most firms in Africa are family-owned and small. Their small size limits their ability to mobilize credit to undertake needed expansions and acquire modern technologies. Medium-sized firms and many foreign-owned firms have no fixed R&D operations. And very few firms, again due to cost and size, have explicit policies on learning new technologies and innovating on the basis of imported capital goods. Banks are unwilling to lend to small firms for a variety of reasons discussed in the literature, such as the high degree of risk, the low output volumes and the limited collateral. As a consequence, the African manufacturing landscape is dotted with small firms that are highly labour-intensive and where innovation does not occur as it does in large firms. However, this is gradually changing, as Africa's indigenous private sector, led by the Dangote Group in Nigeria,

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[30] Adenikinju, A. (2005). Productivity performance in developing countries: Nigeria. Available at http://www.unido.org/fileadmin/user_media/Publications/Pub_free/Productivity_performance_in_DCs_Nigeria.pdf. See also Nwuke, K. (1987). Policy environment and technical change in Nigeria. Mimeo. Center for Development Economics, Williams College, Williamstown, MA. The policy environment and situation in Nigeria have changed quite considerably. A new national science, technology and innovation policy was adopted in 2012. Many indigenous firms, for example Glo and the Dangote Group, are acquiring new technologies and innovating, and there is vigour at the subnational level, too. See, for example, www.innovatelagos.com.

Orascom in Egypt and MIDROC in Ethiopia mature and become important actors in the global arena.

4. Scarcity of talent

44. There is a scarcity of talent in many African countries, although this situation is attenuating. The brain drain limited the pool of talent in many African countries. This problem was exacerbated by the deliberate immigration policies of some advanced economies. In some African countries, the fact that much of the world's new knowledge and innovation is reported and codified in English is another problem. In this context, many small and medium-sized firms may be unwilling to import new technologies if there is no local talent to run, operate and service them.

5. Stronger enforcement of intellectual property rights

45. Protection of intellectual property rights (IPRs) in African countries is an important determinant of the composition and the knowledge content of FDI and thus of innovation and technology transfer. There is evidence that weak IPR regimes deter FDI. For example, Javorcik found that weak IPR protection deterred foreign investors from technology-intensive sectors that used patents extensively from investing in the former Soviet Union and Eastern Europe.[31] A weak IPR regime encourages investors to focus on distribution rather than on local production.

6. Governance

46. Weak governance may also matter for technology transfer, as it is likely to decrease effective protection of investors' intangible assets and lower the probability that disputes between investors and nationals will be adjudicated fairly. High levels of corruption in an economy shift firm ownership from foreign investors to local partners, reducing the incentive for foreign investors to commit to the plant by transferring technology to it. Many African governments have attempted to use joint venture projects as a means to acquire new technologies. However, due to some of the governance problems described above, multinational corporations transfer newer technologies to their wholly owned foreign subsidiaries rather than to joint venture firms.

IV. Creating a favourable environment for innovation and technology transfer to enhance productivity and competitiveness

47. The section above reviewed the trends and current status regarding innovation and technology transfer in Africa. Of course, this is a general description that obscures subregional and national differences. This section draws on the rich literature to identify a number of factors, based on country experiences, that are critical for successful innovation and technology transfer. The list is not exhaustive but it provides a basis for discussion. The most critical element in creating a favourable environment for innovation and technology transfer in Africa is the promotion of a culture of risk-taking and entrepreneurship. While there has been rapid growth in the ownership of small businesses, much of this has been

[31] Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward integration. *American Economic Review*, 94 (3): 604–627.

driven by the limited ability of Africa's fast-growing economies to create meaningful jobs. This rapid growth of small businesses is also resulting in a high degree of informalization of the economy, and a growing culture of entrepreneurship and innovation that needs to be fostered and supported by governments and all stakeholders in Africa's development.

48. The second factor is strong local consumer demand. A recognized consequence of African economies' more than two decades of growth is the emergence and growth of a middle class. This is gradually putting pressure on companies to innovate and acquire new technologies. Nowhere is this more visible than in the mobile telephony sector, where consumer demand is pushing the introduction of new products and services, innovations in pricing, and the acquisition of new technologies such as broadband.

49. In addition, political stability and good governance are necessary in order to create an enabling environment. In the past, geopolitical instability, general poverty and unbridled corruption – by influencing the planning horizon of businesses – made it difficult for African businesses to invest in technology acquisition or to innovate. The political instability and poor governance also made Africa unattractive to foreign firms as an incubator of new ideas and recipient of advanced technologies and innovations. These factors affected Africa's productivity and overall competitiveness. However, the situation has changed considerably in the recent past. Africa is now home to large offices of major technology firms such as Google, IBM and Microsoft.

50. The average quality of Africa's talent pool is improving, too. This is resulting in enhanced scope for innovation and technology transfer and better returns on technology acquisition. It is also creating a positive environment for innovation activities. Return migration in some large economies, such as Egypt, Kenya, Nigeria and Senegal, is contributing to this development. This has to be supported and nurtured. Clearly, without an increase in the average skill level, the responsiveness of output to even the best technologies is likely to be very limited. The possibilities and the promise of new technologies are seldom realized in the absence of serious learning, experimentation and adaptation to specific needs (such as the absence of financial services to which M-Pesa is a well-documented response).

51. The restrictive labour laws in some countries, inherited from an era when socialism was viewed as an attractive alternative to capitalism, need to be reformed in order to address factor market differentials. Flexible labour market laws create incentives for technology acquisition and induce innovation. The low level of innovation and technology transfer is due in large measure to the fact that African manufacturing is dominated by small firms. Since labour is relatively cheap in Africa, many manufacturing firms choose to be small in order to avoid falling under draconian labour laws that emphasize worker rights over employer rights, and choose labour-intensive technologies for the most part.

52. Other enabling conditions include developed (adequate) capital markets, strong intellectual property rights regimes as well as strong enforcement of the rights,[32] effective regulation, and strong and competent regulatory authorities. Strong collaboration between governments, the private sector and other actors is also important. But most importantly,

[32] There is strong empirical support for the argument that countries with strong IPR regimes and strong IPR enforcement are large recipients of FDI, including technology transfers and innovation.

these conditions must be set in the context of time-consistent national development priorities, and in a planning framework.

53. African governments can take a number of actions (or reinforce existing actions) to translate the conditions listed above into reality. Among the actions available to them is legislation on innovation and technology transfer. A good example, if the goal is to promote technology transfer from government-funded research institutions, is the Bayh-Dole Act enacted in the United States, which encourages universities to obtain patents on inventions resulting from research funded by the United States Government and to license such patents on an exclusive basis to the private sector. The expectation is that exclusive licensing will create the incentive for early commercialization of the invention, which will promote growth and enhance national economic competitiveness.[33]

54. Procurement is another instrument that governments can use. In most countries, the government is the largest procurer. It can, through its procurement decisions, affect the rate and the composition of technology transfer and innovation. Many African governments are using procurement policies and strategies to acquire needed technology from outside their borders. Some have established local content laws and raw materials development councils, both of which are promoting innovation and are requiring companies that seek government contracts to purchase raw materials and other inputs from local firms. The Nigerian Government, for example, has recently decided to purchase all automobiles from local manufacturers. In a complementary move designed to encourage local automobile manufacturing, it has also increased tariffs on imported automobiles.[34]

55. Many African countries are small markets, with small populations and a small middle class. Innovation and technology transfer for such countries will be much more profitable in the context of regional integration. African countries recognize this and have adopted policies to promote the regional dimension of innovation and technology transfer. To this end, it is important that governments ratify the related protocols and instruments, and deploy resources to achieve the objectives. These regional actions should also be complemented by broader international collaboration for innovation and technology transfer, including South–South cooperation. In addition, there should be a national industrial policy, as well as national technology and innovation policies, to provide a framework for action.

V. Conclusion and policy recommendations

56. The present paper, based on empirical evidence of the low productivity and poor competitiveness of African economies, has argued that Africa's current growth momentum must be reinforced through the deliberate deployment of innovation and technology transfer in order to achieve accelerated transformation of the continent. The paper has reviewed trends with regard to key measures of innovation and technology transfer in Africa. While the aggregate measures for the continent as a whole are not very encouraging, the paper recognizes that a breakdown of the measures may reveal more encouraging performance at

[33] Brazil, India and South Africa, for example, have enacted legislation similar to the Bayh-Dole Act.

[34] The Nigerian Government, according to media reports, has also decided to serve only cassava bread at official functions, in a move designed to promote innovation in the food sector.

the country level. Based on this, general recommendations may not always be useful for policy. Nonetheless, due to the common attributes of most African countries, some of the recommendations listed below could be generally helpful to all countries.

57. This paper is not unaware that many African governments are taking direct and active measures to harness innovation and technology transfer to enhance the productivity and competitiveness of their economies. The recommendations listed below are thus additional actions that African governments may take to further ensure that innovation and technology transfer enhance the productivity and competitiveness of their economies. The recommendations are not listed in order of importance.

58. African governments should use procurement as an additional instrument to promote innovation and steer technology transfer. This paper recognizes that except in cases where governments are the direct owners of firms and industrial establishments, technology transfer decisions are largely private, profit-maximizing decisions. However, because of the strategic importance of technology and innovation as important variables for transformation, decisions on innovation and technology transfer cannot be left exclusively to private individuals. Governments provide leadership and have a set of instruments, direct and indirect (including fiscal, industrial and procurement policies) at their disposal, with which they can influence private behaviour. One such important instrument is government procurement.

59. Markets are incentive mechanisms and are therefore another avenue through which governments can promote innovation and technology transfer to enhance productivity and competitiveness. Therefore, not only can governments play a direct role in supporting innovation and technology transfer, they can also play a role in structuring the markets in which innovation and technology transfer take place, for example through regulation and the oversight of technology transfer agreements.

60. Other policies that African governments may consider include:

(a) Effective leadership on innovation and technology transfer. A problem in many African countries is the use of yesterday's men and women (and institutions) to tackle tomorrow's problems and challenges. Effective leadership requires countries to use today's men and women to tackle tomorrow's known and unknown problems and challenges. Anchor institutions for technology and innovation, such as national innovation councils, national offices of technology assessment and national offices of innovation assessment should be staffed with today's men and women looking at tomorrow's problems, challenges and opportunities.

(b) Strengthening data collection with regard to innovation and technology transfer. Innovation and technology transfer are poorly captured in official statistics. Furthermore, their contribution to growth, increased productivity and enhanced competitiveness is still poorly understood in many African countries. As a consequence, the evidence base for policy is weak. To address this problem, African governments should strengthen data collection on innovation and technology transfer. This will enable reliable

reporting and will contribute to policy.[35] But this reporting needs to be based on a strong set of metrics focused on both input and output parameters, including at the firm level.

(c) In countries where it does not yet exist, governments should develop a strategy to encourage technology transfer from publicly funded local R&D institutions to the domestic private sector.

(d) Implementing innovation and technology transfer incentives around identified and agreed national challenges – such as industrialization, food security, and defence.

(e) Introducing technology and innovation quality rankings for leading firms – both domestic firms and subsidiaries of foreign multinational corporations – and experimenting with the use of awards and prizes to recognize leaders in innovation and technology transfer.

(f) Reviewing patent law to discourage strategic patenting by foreign firms, and strengthening the IPR regime to encourage innovation and technology transfer. In any case, patent laws should be enacted so as not to create a barrier to entry or to stifle innovation. They should require considerable inventive steps. In addition, they should require patents to be well defined: not too broad, general or all-encompassing.

(g) Facilitating the free flow of information on innovation and technology transfer. To this end, governments should have an innovation and technology transfer information strategy to optimize the flow of and access to information. A web portal could be an element of such a strategy, along with regular briefings and workshops carried out by the relevant agencies.

[35] NEPAD's African Innovation Outlook, although focused on science, technology and innovation and not specifically on technology transfer, is a step in the right direction.

VI. Additional sources

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