Africa in the global flows of technology: An overview.

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Abstract

This overview seeks to highlight Africa's place in the global flows of technology. As the least producer of technologies, its ability to access, adapt, use and modify foreign technologies has to be one of the key element of development strategies. While many papers have focused on research and development (R&D) expenditures, this overview compares Africa's use of intellectual property, trade in industrial machinery, attracting R&D projects and stimulating spending by businesses in comparison to other developing regions. The aim is to help policy makers and analysts realize that the gap in technology is much wider than that in incomes and that Africa may not develop without deliberate efforts to help firms and institutions acquire technologies to enable them compete in the global market place.

Introduction

The transfer of technology assets from one country to the other has been a subject of great debate especially after the 1970s. Much of the debate focussed on conditions associated with transfer of technology and, the costs and the lack of a fair market for technology . Much of this debate was and is driven by the recognition that technology is required for development of all countries. Since a handful of countries own most of the technology used, most countries will need technology transfer under fair conditions to meet their development aspirations.

For example, most telephone calls between African countries are still routed through Europe, attracting transit fees estimated to cost Africa between $400 million and $1 billion annually. [1]This may make a call from Chad to neighbouring Cameroon more expensive than to France as Chad's 16 international circuits are all with France. If such sums of money were invested in telephone infrastructure, it could lower the cost of calls within the continents and make the service affordable and accessible to more people in Africa, and promote development.

The term technology seems synonymous with biotechnology, nanotechnology or other sophisticated knowledge fields. In this case, it may sound like fiction and possibly irrelevant to the poor or a preserve for the rich. Technology has to be seen as a tool that enables farmers, industrialists, governments and society get the most out of their investment and thus important to all countries irrespective of their level of development.

Transfer of technology has been defined as the "transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service and does not extend to the transactions involving the mere sale or mere lease of goods." [2] Transfer of technology transactions include:

1 The assignment, sale and licensing of all forms of intellectual property, except for trade marks, service marks and trade names when they are not part of the agreement;

2 The provision of know-how and technical expertise in the form of feasibility studies, plans, diagrams, models, instructions, guides, formulae, basic or detailed engineering designs, specifications and equipment for training, services involving technical advisory and managerial personnel, and personnel training;

3 The provision of technological knowledge necessary for the installation, operation and functioning of plant and equipment, and turnkey projects;

4 The provision of technological knowledge necessary to acquire, install and use machinery, equipment, intermediate goods and/or raw materials which have been acquired by purchase, lease or other means; and

5 The provision of technological contents of industrial and technical cooperation arrangements.

This definition attempts to differentiate transfer of technology from diffusion of technology. Technology diffusion is best seen as the non-commercial, often involuntary or deliberate, dissemination of technology and skills or the ability of the technology importing country to learn from the acquired technology to develop its domestic capabilities. Government policies that encourage strategic alliances, joint ventures, training of employees and demonstrations, as well as international cooperation in research and education, among others, are deliberately designed to promote diffusions of knowledge, skills and techniques. Technology diffusion is important in deriving maximum benefits from any technology that has been transferred or accessed.

Technologies may diffuse across national borders when industrial and research clusters defy or spread across national boundaries [3] or through increased trade and research contacts, exhibitions, fairs, conferences etc. Similarly, education and exchange of expertise, even when they are targeted, are largely tools for technology diffusion rather than transfer. More importantly, technology diffusion may pass on skills and knowledge as well as organizational arrangements that may be difficult to buy or transfer.

Although there is a thin line between technology transfer and technology diffusion, such differentiation is important as measures that promote technology transfer are not necessarily the same as those that facilitate technology diffusion, and in determining actions or measures that constitute technology transfer in negotiating or assessing the implementation of technology transfer agreements.

For instance, countries are failing to agree whether the measures developed countries have undertaken and reported to the Council for TRIPS of the World Trade Organization (WTO) constitute technology transfer. [4] For developed countries, enabling their firms to invest in developing countries, funding workshops and training, among others, is technology transfer while developing countries would like to see the transfer of core technologies needed to manufacture a vaccine or produce energy, etc. In this case, developed countries are referring to technology diffusion while developing countries are referring to technology transfer. However, for developed countries, this is proprietary knowledge owned by the private sector, sometimes not even published.

It would be wrong to assume that technology is only transferred across countries. Few firms produce and own most of the technologies used in their industries. Other firms have to acquire the technology they need from those that own it, at home or abroad. For instance, International Business Machines (IBM) holds about 26,000 active patents in the United States and over 40,000 world-wide. [5] Other firms in the IT sector may need to use the knowledge developed by IBM to develop software, storage systems and displays, be they American or not. Similarly, many universities and research centres have developed technology transfer offices charged with the management and licensing of technologies largely to domestic industries and institutions. [6]

1 International technology flows

Most technologies are transferred internationally through trade and foreign direct investment (FDI). In trade, technologies are transferred through import of capital goods and of intermediates products needed to assemble high-technology exports, purchase of or access to intellectual assets and by exporting into a developed country market.

In terms of FDI, technology may be transferred through greenfield investments, acquisition and mergers, joint ventures and investment in R&D projects abroad. In addition to many other reasons, acquisitions and mergers may partly be driven by the need to gain access to key technologies, especially in knowledge intensive industries such as pharmaceuticals, information technologies (IT), automobiles and biotechnology.

1.1 Internationalization of R&D projects and expenditure

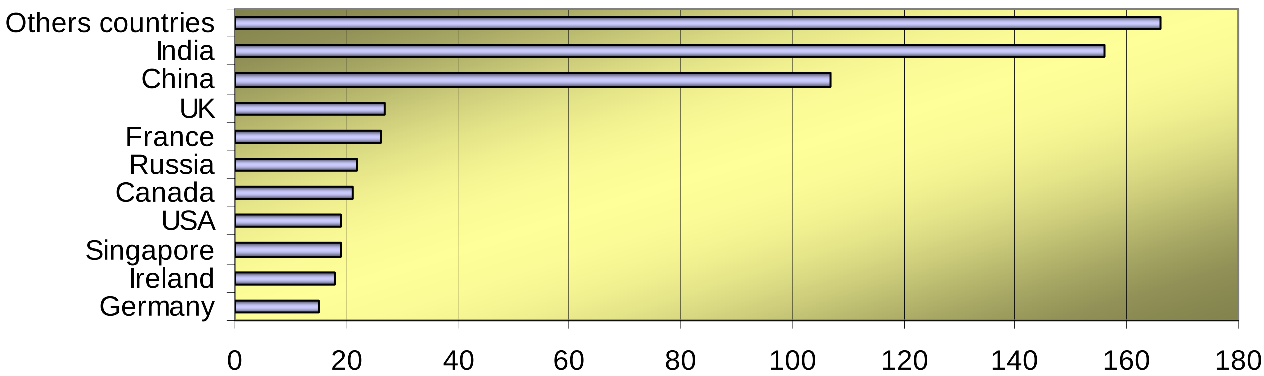
Firms or institutions may wish to locate a R&D unit in a country with a more advanced technological base than its home country in order to gain access to knowledge or skills of interest. Such investment is used to source technologies useful to the investing parent firm. A survey of United Kingdom firms with R&D units in the United States observed that they had higher productivity than comparable firms without such R&D units abroad. [7]

At national level, the Republic of Korea uses similar approach to source technology. For example, the Korean Institute of Science and Technology (KIST) has established international research centres. In addition to KIST-Europe (German) it has cooperative research centres with China and Russia. Specifically, the Korea-Russia Scientific and Technological Cooperation Centre seeks to evaluate and transfer Russian technologies that Korea cannot acquire from other advanced countries.

Another alternative is the location of R&D units of technologically advanced firms in emerging knowledge hubs. In this case, firms at the frontiers of knowledge generation may locate some of their R&D units in countries with the basic technological foundation to cut costs and develop or adapt their products to meet the needs of emerging markets. Such investment is likely to transfer skills and technologies to the host country, at least to perform R&D activities.

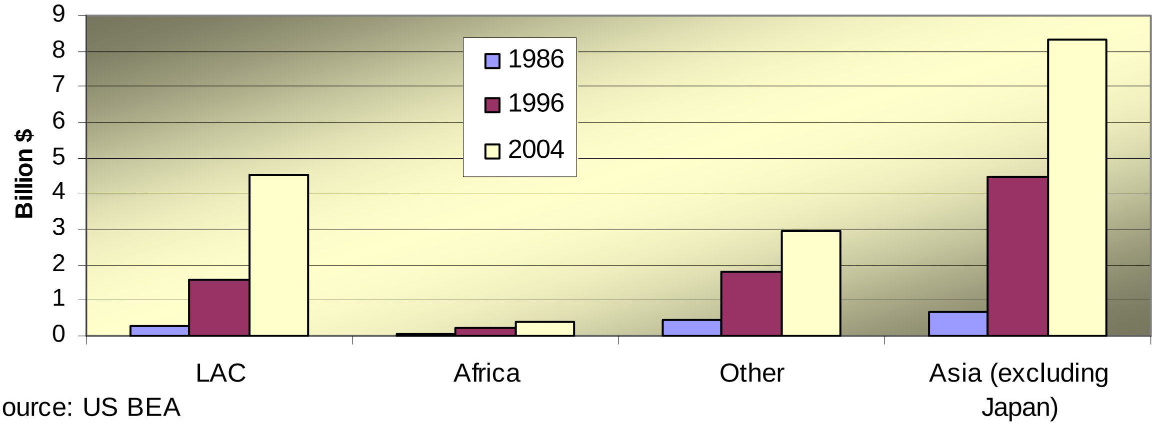
Figure 1. Top destinations for R&D projects

Number of projects (October 2004 to September 2005)



Source: LOCOmonitor

Figure 2. Royaty and licensing fees paid to US by developing regions



Source: US BEA

One of the most celebrated examples is the location of one of Intel's manufacturing and testing factory in Costa Rica, and its positive impact on exports, emergence of IT firms and growth of the economy. After years of decline, exports and gross domestic product (GDP) of the country grew rapidly after Intel's plant in Costa Rica commenced production in 1998. Although Intel has not transferred the technology to make microprocessors to Costa Rican firms, its presence has undoubted stimulated the growth of the IT sector - with over 100 firms.

Attracting such huge R&D-intensive investment is desirable but is not easy and does not seem to flow to all countries. For example, about 596 R&D projects were made abroad between September 2004 and October 2005. [8] About 75% of these projects were made by firms from United States, Germany, Japan, United Kingdom and France. As shown in figure 1, about 44% of these R&D projects were located in China and India. Among developing countries, China, India and Singapore were among the top 10 locations of foreign R&D centres. [9]

Therefore, technology flows through R&D projects is concentrated to a few countries and Africa's share is negligible. This is not surprising as most of the firms making such investment, such as IBM (19 projects), Microsoft (14 projects), Intel (12 projects) and Alcatel (10 projects), among others, are seeking to benefits from skills in countries such as India, China and Russia, to develop technologies at a lower cost than their home countries, in addition to adapting their products to meet the needs of markets. African countries with limited human capital and firms in IT sector is unlikely to be considered a destination for such investment.

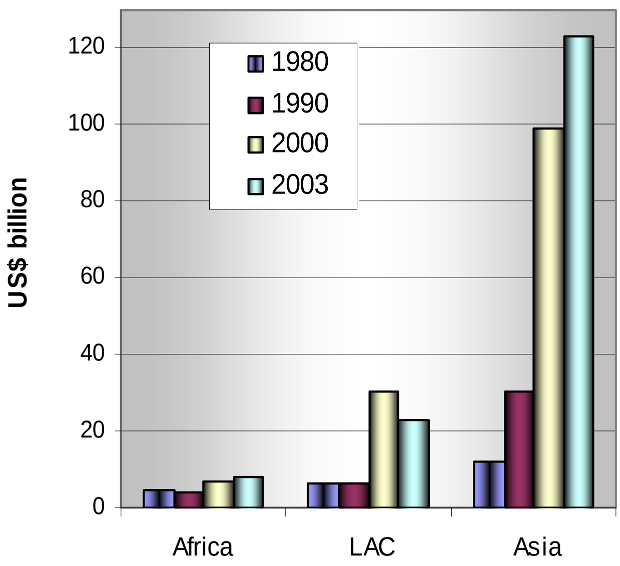
There is also an increase in R&D expenditure by foreign affiliates of technology-intensive firms. For example, R&D expenditure by majority owned foreign affiliates of United States parent firms in developing countries increased from $902 million in 1994 to $2.855 billion in 2001. [9] Affiliates of United States firms spent $29 million in Sub-Saharan Africa, $562 million in Latin America and the Caribbean and $2.39 billion in developing Asia on R&D activities in 2001. Out of the $29 million spent in Africa, $24 million was spent in South Africa. Globally, expenditure on R&D by foreign affiliates abroad increased from about $29 billion to $67 billion between 1993 and 2002. [9]

Increased expenditure on R&D by foreign affiliates may results in more technology being developed from which a country could earn fees, improve productivity and competitiveness through continuous innovation. This could play a role in modernization of production processes.

1.2 Trade in ideas: royalty and licensing fees payments.

The United States is the main exporter of technology to developed and developing countries. It is also a major importer of technologies but has a healthy trade balance in its favour as far as trade in intellectual property is con-

Figure 3. Imports of capital goods by developing regions



Source: UNCTAD

cerned. It is for this reason the United States will be used as a proxy of general trends in trade in intellectual property rights (IPR).

Royalty and licensing fees receipts by the United States increased from $8.1 billion in 1987 to about $52.6 billion in 2004. [10] Similarly, royalty and licensing fees paid by the United States to other countries increased from $1.4 billion to $23.4 billion over the same period. In general, developed countries account for a larger share of trade in intellectual assets.

Among developing regions, royalty and licensing fees paid to the United States increased 16-fold for Latin America and the Caribbean and 13-fold for Asia (excluding Japan) and 5-fold for Africa between 1986 and 2004 (see figure 2). South Africa accounted for over 50% of the payments made by Africa.

More importantly, Africa paid 58 times more in royalty and licensing fees than it received from the United States in 2004 – one of the worst trade balance deficit! All other regions paid between 1.9 and 2.7 times more than they received for trade in IP. In other words, Africa is developing very little knowledge of global interest.

1.3 Trade in capital goods

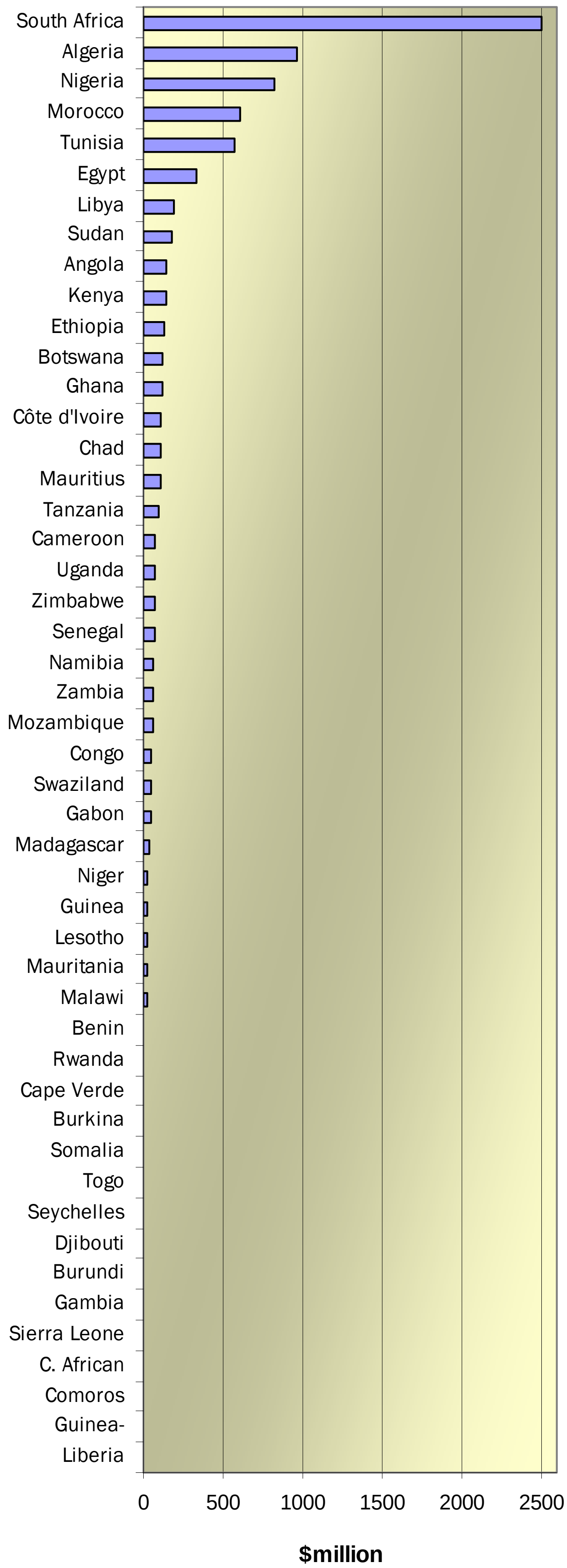
Technology may be embedded in machinery and equipment used in production of goods and delivery of services. Although the import of a piece of equipment does not constitute technology transfer by itself, such imports play a vital role in skills formation, development of innovative capabilities and establishment of a sound industrial base.

In this paper, the proxy of capital goods is the sum of handling, electrical and non-electrical machinery, telecommunication equipment and metal work machinery or tools (SITC [11] groups 736, 744, 745, 764 and 778) traded. Countries investing in manufacturing are likely to rely on this class of goods. Furthermore, workers learn and develop skills to operate, maintain, install and, in some case, modify imported sophisticated machinery. Such capabilities are the initial steps towards laying a sound technology and industrial foundation.

Among developing regions, the growth in the import of capital goods increased by 10-folds for Asia, 4-folds for Latin America and the Caribbean and 1.8-folds for Africa between 1980 and 2003. As shown in figure 3, the import value of capital goods by Africa has remained low- increasing from $4.5 billion in 1980 to $8.2 billion in 2003. [12]

About 21 African countries spent less than $50 million on imports of capital goods while another 11 countries spent between $50 million and $100 million in 2003. With $2.5 billion in imports of capital goods in 2003, South Africa accounted for about 30% of Africa's capital goods imports. The impact of capital goods import on technology transfer in a country may be difficult to assess as many factors are often at play, although research suggests it plays a key role. [13]

Figure 4. Imports of capital goods by African countries



Source: UNCTAD

Tunisia's imports of capital goods have increased from $106 million to $570 million between 1980 and 2003 while its exports of electrical and engineering machinery and transport equipment have increased from about $170 million to about $790 million between 1990 and 2001. [12]

One cannot conclude that such fast growth in Tunisia's manufacturing sector is due to the increase in imports of capital goods. However, it is equally difficult to assume that such growth in the manufacture of products requiring investment in sophisticated machinery could have been achieved within a decade by Tunisia without the import of capital goods. Similarly, it is difficult to imagine that such inflows of capital goods have not transferred or facilitated the transfer of technologies needed to produce the export goods and induced development of skills to maintain or adapt the imported machinery to local production environment.

2. Africa in the future technology market: A player or observer?

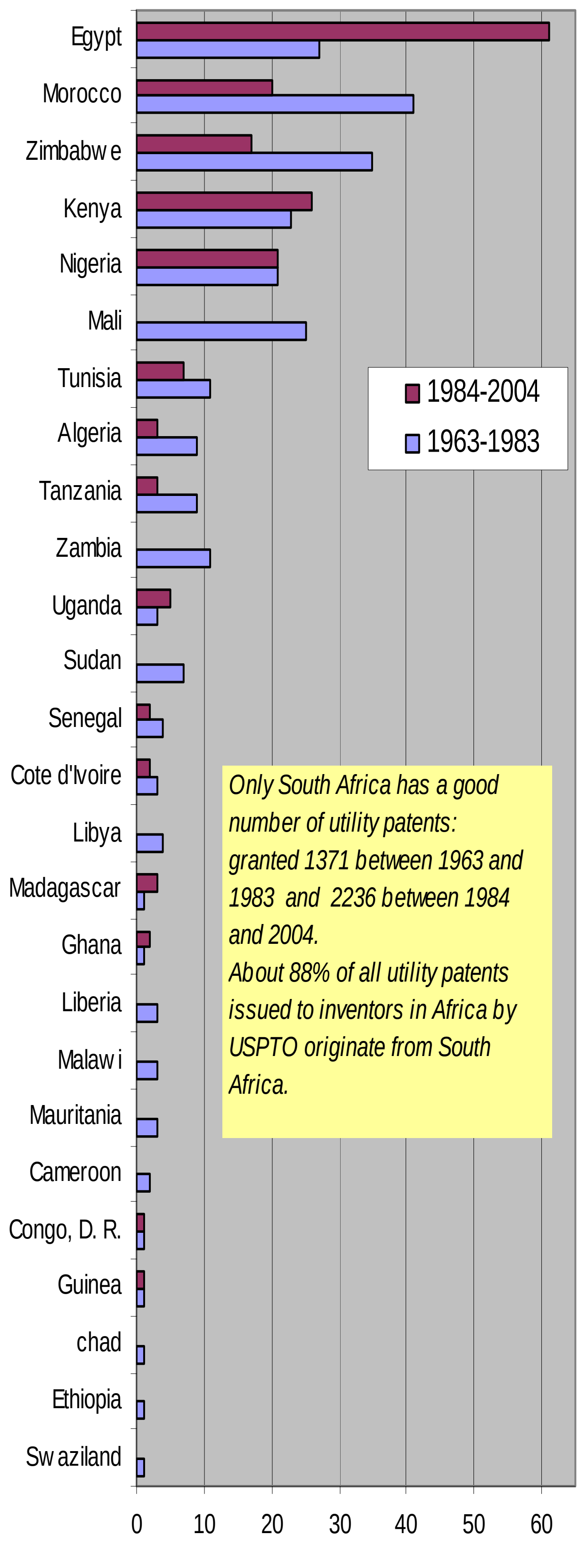
The increasing location of R&D projects and increased expenditure by foreign affiliates on R&D performed in developing countries is likely to fuel innovation. Similarly, the increase in outsourcing of assembly and manufacturing activities to developing country partners is also promoting the transfer of technologies and skills needed to develop new products and services. More contractors are passing on the cost of R&D to contract manufacturers in developing countries. Such changes in the global production may be shifting the traditional model of R&D and technology management as a preserve of headquarters to a more flexible and efficient technology development strategy that enables affiliates to compete in emerging and differentiating markets. Such shifts may help some developing countries become major owners and future players in the technology market.

For instance, the number of utility patents issued to inventors in China, India and Singapore has more than tripled in less than a decade. More than half of all the utility patents issued to inventors in China and India by the United States Patent Office (USPTO) between 1963 and 2004 were issued between 1999 and 2004 [14].

More importantly, Texas Instruments, IBM and General electric Company are the top three firms in India granted more utility patents by USPTO between 2000 and 2004 in India. In the case of IBM, they have risen from 8 patents granted in 2001 to 28 patents granted in 2004. It is important to also underscore that most USPTO utility patents issued to Indian inventors are from the Council of Scientific and Industrial Research (India)- over 100 patents a year. If this trend continues, India may see its knowledge base expand rapidly and the concentration of such top technology firms is likely to induce development and transfer of technology .

Africa is not benefiting from these trends and this is also reflected in the number of inventions seeking interna-

Figure 5. Utility patents granted to inventors in Africa over the last four decades by USPTO



Source: Based on USPTO

tional protection. For example, the total number of utility patents issued to inventors in Africa, excluding South Africa, by the USPTO has declined from 251 for the period 1963-1983 to 174 for the period 1984-2004. About 11 of the 27 African countries granted one or more utility patents by the USPTO did not get any in the last 20 years, as of 2004 (see figure 5). This is contrary to global trends.

The general decline in economic development, deterioration in terms of trade, political upheavals and limited investment in higher education and industries that affected parts of SSA in the 1980s and 1990s may explain why even the limited R&D activities by firms and institutions seized or was scaled down. Given patents reflect R&D activities of at least a few years ago, its not strange that Africa is behind in generation of knowledge of global interest.

Although South Africa has a good track of technology leadership in Africa and is issued about 100 to 123 utility patents per year by the USPTO over the last decade, the country seems to be registering a small decline in the number of patents issued to South African inventors.

It is also possible that African inventors think their inventions are of little interest to firms and inventors in developed countries or they simply do not know where or how to get a patent. It is also possible that they are not interested in patenting. But it may also be an indication of their lagging behind in technology use, development and trade. The latter seems the most plausible of the three reasons given the importance and time that has been devoted to developing and encouraging intellectual property protection, especially under the WTO.

Concluding remarks:

The need to stimulate technologies flows to Africa for development

Technology is not a panacea and should be pursued as part of the national industrial and development strategies. As East European countries soon found out, it may be easier to send a man to the moon than to use technology assets to promote industrial competitiveness.

Technology is not cheap to buy, use or produce. Therefore, before a call is made for more spending on technology assets, there must be clear goals such investment is meant to achieve, and all options to acquire, use and develop technologies have to be considered.

Different countries have used different strategies to acquire and develop technology. The Republic of Korea often formulates clear strategies on technologies, skills, numbers of professional and firms within the field of interest it wishes to develop in a given period of time and budget. It often focuses on acquisition of production and processing technologies to develop its products. For this reason, the country has a high technology import bill. In 2004, It paid $1.6 billion to the United States in royalties and licensing fees– almost twice that of China and four times that of Africa.

Chile uses a different strategy from that of Republic Korea. Chile employs its national R&D institutions to identify technologies that could be used to turn its vast natural resources into exports, to develop value-added products or improve production processes. Among others, Chile has acquired technologies that enabled it become a major exporter of salmons, wines and fruits. Since raw and processed agricultural and mining products account for a large share of its exports (~60%), technology payments are smaller than those of Korea.

Therefore, most African countries could promote technology transfer for development of industrial clusters or improving production processes. To achieve such targets, long-term plans to acquire, adapt and develop technologies, and mechanisms to deliver the technologies to market have to be put in place. Incentives, such as tax, soft loans etc may have to be provided to help emerging and existing firms access and use technologies.

African countries may have to revisit their higher education policies. Countries such as Chile, China, India and Tunisia, that invested in higher education are becoming part of the global production chains, and in the process accessing technologies. It is not surprising that these countries are attracting R&D projects or are using and producing more technologies.

With few exceptions, Africa has neglected higher education, a gamble that may be costing the continent dearly. The lack of skilled manpower is one of the most cited reasons why Africa is failing to close the digital, genetic and poverty divides. Many African countries now need technology to use technology. For example, some countries do not have the capacity to reproduce drugs already developed by others, and thus cannot take advantage of international agreements to do so, making some of the flexibilities in the WTO TRIPS Agreement meaningless.

Africa's low technology consumption and development is partly an indication of lack of a large number of firms and institutions with the capacity to exploit existing global knowledge base to upgrade or develop new production processes.

Developed countries too have a role to play (and should have interest) in facilitating technology transfer to Africa. The green revolution that helped Asia meet most of its food security concerns was driven by developed countries. In Africa, the European Union backed the eradication of rinderpest, an animal pest, with funding ($200 million over a decade) and technical support. Such investments saw some African centres develop capacity to produce and/or store the vaccine, and, for the majority of countries involved, national and cross-border surveillance and monitoring capacity. Above all, there is nothing wrong in including technology in official development assistance.

African countries could also develop innovative mechanism for funding R&D activities. For example, Mexico last year raised $44 million for science through fine for violation of campaign regulations by political parties [15]. Such measures advance science and democracy and Africa has major headaches with both. Indeed, similar measures already exist in some African countries on rural electrification taxes in electricity bill or road taxes in fuel pump pricing. However, these taxes tend to lack a technology development dimension—i.e. using part of it to fund alternative electrification or development of cheaper but effective road tarring materials.

Finally, encouraging the emergence of technology entrepreneurs and firms is part of prompting technology transfer and development. The birth of the biotechnology industry is often traced to Genentech, a firm founded by a University professor and a venture capitalist. Today, a vibrant biotechnology industry has emerged that is investing more in R&D than the public sector. Therefore, public investment is important in stimulating private sector growth if targeted, especially in emerging and new technologies or areas with limited industrial development.

For Africa, the question is not whether or not industry is investing in R&D or acquiring technologies but how we could acquire and/or use technologies to build industries. India and China are still relying on public sector investment for knowledge generation despite their economic and technological development.

Footnotes and references

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4. In 2003, the Council for TRIPS adopted a decision on implementation of Article 66.2 requiring developed country Members of the WTO to submit annual reports on actions taken or planned in pursuance of their commitments under Article 66.2. The reports are then reviewed for effectiveness of the incentives provided in promoting and encouraging technology transfer to least-developed country Members. Several reports have been submitted.
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