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The future of Africa now depends largely on the nature and outlook of its economic vision and the realignment of national institutions to reflect major trends in global and regional economic affairs. Ongoing political reforms in Africa have coincided with the growing realisation that economic growth is mainly a result of the transformation of knowledge (expressed in the form of education, science and technology and the associated institutions) into goods and services. This paper provides elements of a strategic policy outlook for Africa's economic renewal and growth, emphasising the role of science, technology and innovation.

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Most African economies have historically been associated with natural resources and raw materials. There is growing recognition, however, that a transition into modern economies will involve considerable investment and use of new knowledge.

A new economic vision for African countries – articulated at the highest level of government – should focus on the role of knowledge as a basis for economic transformation. Doing so will entail placing policy emphasis on emerging opportunities such as renewing infrastructure, building human capabilities, stimulating business development, and increasing participation in the global economy. These areas should provide a firm foundation upon which to base international partnerships.

Contemporary history informs us that the main explanation for the success of the industrialised countries lies in their ability to learn how to improve performance in a variety of fields – including institutional development, technological adaptation, trade, organisation and the use of natural resources (Rosenberg and Birdzell, 1986; Mokyr, 2002). In other words, the key to their success was their focus on improving their skills as a way to solve problems. They put a premium on learning.

One of the most elegant aspects of a learner's strategy is that every generation receives a legacy of knowledge that it can harness for its own advantage. Every generation blends the new and the old and thereby charts its own development path, making debates about innovation and tradition irrelevant.

At least three key factors have contributed to the rapid economic transformation of emerging economies. First, these countries invested heavily in basic infrastructure, including roads, schools, water, sanitation, irrigation, health centres, telecommunications and energy. They invested in the services that served as a foundation for technological learning. They focused on human capital development, and, in the process, they

ones where they do not exist. The challenge is building the international partnerships needed to align economic development policy with the long-term technological needs of Africa (Juma, 2005).

The promotion of science and technology as a way to meet human welfare needs must, however, take into account the additional need to protect Africa's environment for present and future generations. The concept of 'sustainable development' has been advanced specifically to ensure the integration of social, economic and environmental factors in development strategies and associated knowledge systems. Mapping out strategic options for Africa's economic renewal will therefore need to be undertaken in the context of sustainable development.

3.1 Higher education and research

Higher technical education is increasingly recognised as a critical aspect of the development process, especially with the growing awareness of the role of science, technology and innovation in economic renewal. While primary and secondary education have been at the focus of donor community attention for decades, higher education and research have been viewed as essential to development only in recent years.

The urgency of investing in higher technical education is compounded by the impact of HIV/AIDS and other infectious diseases on Africa's labour force. The challenges include building human capacity and transmitting technical skills to succeeding generations, which underscores the urgency to expand women's access to higher technical education.

Other than providing education, a new view is emerging that places universities and research institutions at the centre of the development process. The application of this concept also extends to other levels of learning, such as colleges, research and technical institutes and polytechnic schools. Higher education and research institutions have become a valuable resource for business, industry and society (Zaglul and Sherrard, 2005). In facilitating the development of business and industrial firms, universities can contribute to economic revival and growth in their regions. They integrate into the production sector and society in many ways: they conduct research and development for industry; create their own spin-off firms; are involved in capital formation projects, such as technology parks and for b3(aks and fo6(suchaun1parks a02rojo4vatnt)005). un;rojt Tw and uch1377TJ18.42)2()

Second, the new species of higher learning institutions places particular emphasis on building entrepreneurial skills among students. This additional focus ensures that students develop the capacity to transform ideas into business proposals as well as actual products and services for local and international markets. Students in these institutions will be expected to develop practical skills in enterprise creation as a prerequisite for graduation. This approach requires a reorientation of local banking and financial institutions, including the development of new instruments such as venture capital.

Third, most of the universities that exist in Africa were originally designed to support nation building. The challenge today is community development. As a result, the new species of university should integrate into the communities in which they are located and seek specifically to promote economic transformation in their locales. This means not only that their curricula will need to be adapted to local needs, but also that students should be expected to spend part of the time working with local communities.

The focus of the new species of university will be to produce graduates who are trained to create enterprises and therefore generate jobs while adding to the growth of the economy. This would be a departure from the present system, which focuses on providing technical skills to people who would not go on to create employment.

In addition to training, universities would need to function as incubators for businesses and social enterprises. This function would be in addition to the traditional practices of linking enterprises and Civil Society Organisations (CSOs) to universities. The educational institutions would help to nurture new enterprises through providing critical services in the early stages of enterprise development.

Efforts towards creating a strong technical foundation through polytechnics, which could convert into community colleges to serve local populations, are necessary. This would require proactive and flexible higher education regulators capable of linking curriculum development to local needs, promoting experiential learning, strengthening management and expanding opportunities for women.

3.1.2 Reorganising research institutions around technology missions

A knowledge-based development strategy will entail a redirection of the goals of national research institutions. It will require the framing of research in the context of its contributions to economic development. Thus, activities of research institutions should conform to the requirements of 'mission orientation' and 'scale of operation'. The missions should focus on solving specific problems. These strategies should focus on the major national and regional challenges that require scientific and technological response. However, a mission-oriented approach will only work if incorporated into national strategies.

The creation of 'research missions' could help integrate the activities of existing institutions around specific challenges. In the early 1970s, Taiwan (China) consolidated its national research institutes under the Industrial Technical Research Institute and charged it to focus on delivering the country into the semiconductor era. Through additional institutional innovations that included close cooperation with the private sector, it emerged as one of the world's leader in electronics research and spawned leading semiconductor companies. The country also created a science park in its proximity that has become a case study on economic transformation through science and technology.

Africa's research landscape has numerous institutions already, which could be reorganised into specific missions. At least three categories are readily identifiable:

- biomedical research (on human and animal health)
- agricultural research (on crops and livestock)
- ecological research (on forest, range, marine and other ecosystems).

These areas form sub-clusters around which to organise specific research missions designed to produce goods and services. While the relevance of health and agriculture to the economy are well understood, more attention to the role of ecological research for activities such as tourism and the overall maintenance of ecosystem services (fisheries including water supply) is necessary. The future of tourism, for example, will depend on the sustainability of existing wildlife habitats, some of which will require better management as well as rehabilitation.

The Republic of Kenya, for example, has a strong tradition in life sciences research. Its capital city, Nairobi has international and regional organisations, national research institutions, university departments, hospitals, non-governmental organisations and the private sector, which constitute the critical elements for developing a life science cluster. More specifically, the Republic of Kenya is already pioneering fields such as diagnostics for tropical human, crop, livestock and wildlife diseases. This effort should expand to include diagnostics for ecological change. Another area where the Republic of Kenya could provide leadership is in the development of bio-pesticides, building on its capabilities in the production of pyrethrum and its derivatives. This is particularly important given the opportunities provided by the global ban or restriction on the use persistent organic pollutants, such as DDT.

The emergence of such research clusters will entail a strong commitment from governments, the creation of complementary organisations such as venture capital firms, and considerable effort in institutional coordination and networking. The strategies should target the opportunities presented by advances in areas such as genomics and traditional strengths in the sciences. Moreover, the approach would also facilitate regional and international cooperation.

Life sciences are not the only areas where research could contribute to development. Two additional areas warrant attention. The continent's economic future crucially depends on the fate and state of its infrastructure whose development will depend on the contributions of the engineering, materials and related sciences. It is notable that these fields are particularly underdeveloped in Africa and hence could benefit from specific missions that seek to use local material in activities such as road construction and maintenance.

Other critical pieces involve expanding the energy base through alternative energy development programs, such as geothermal, biofuels, solar and wind energy. This sector is particularly important because of Africa's past investments, availability of human resources and its potential to stimulate complementary industries that provide parts and services to the expansion of the sector. Exploiting these opportunities requires supporting policies embedded in a national programme.

3.1.3 Financing technological innovation

One of the key aspects of technological development is funding. Currently, Africa does not have adequate and effective mechanisms for providing support to research. Many countries have used a variety of models, including independent funds such as the National Science Foundation in the USA and the National Research Fund of South Africa. Others have focused on ensuring that development needs guide research funding and, as such, have created specific funding mechanisms under development planning ministries (UN Millennium Project, 2005).

While this approach is not a substitute for funding to other activities, it distinguishes between measures designed to link technology to the economy from those aimed at creating new knowledge for general learning. What is critical, however, is to design appropriate institutional arrangements and supporting funding mechanisms that bring knowledge to bear on development.

Creating incentives for domestic mobilisation of financial resources, as a basis for leveraging external support would be essential. Other innovations in taxation, already widespread around the world, involve industry-wide levies to fund research, in similar lines as the Malaysian cess mechanism to fund research. Malaysia imposed cesses on rubber, palm oil, and timber to fund the Rubber Research Institute, the Palm Oil Research Institute, and the Forestry Research Institute. A cess on tea helps fund research on and marketing of tea in Sri Lanka.¹ The Republic of Kenya levies cess on its tea, coffee, and sugar industries, for example, to support the Tea Research Foundation, the Coffee Research Foundation, and the Kenya Sugar Board. These initiatives could be restructured to create a funding pool to cover common areas.

Reforming tax laws is an essential element in the proposed strategy. Private individuals and corporations need targeted tax incentives to contribute to research funds and other technology-related charitable activities. This instrument for supporting public welfare activities is now widely used in developing countries. It arises partly because of the lack of experience in managing charitable organisations and partly because of the reluctance of finance ministries to grant tax exemptions, fearing erosion of their revenue base.

The enactment of a *foundation law* that provides tax and other incentives to contributions to public interest activities, such as research, education, health and cultural development, would promote social welfare in general and economic growth in particular. Other countries are looking into using *national lotteries* as a source of funding for technological development.

Cess on imports could also be levied to finance innovation activities, although the World Trade Organisation may object to them. Another possibility is to impose a cess of 0.05 or 0.1% of the turnover of African capital markets to establish a global research and development fund, as an incentive for them to contribute to sustainable development.

Other initiatives could simply involve restructuring and redefining public expenditure. By integrating research and development activities into infrastructure development, for example, African governments could relax their public expenditure constraints imposed by sectoral budgetary caps. (Scientists in Brazil proposed a similar approach to their government as a framework for negotiations with the International Monetary Fund.) Such a strategy, if pursued, has the potential to unlock substantial funds for research and development in priority areas. But this strategy requires a shift in the budgetary philosophy of the International Financial Institutions to recognise

public expenditures on research and development as key to building capabilities for economic growth.

3.2 Infrastructure as technological foundation for development

Infrastructure is broadly defined as the facilities, structures and associated equipment and services that facilitate the flows of goods and services between individuals, firms and governments. Conventional infrastructure includes:

- public utilities, such as energy, telecommunications, water supply, sanitation and sewerage, and waste disposal
- public works, such as irrigation systems, schools, housing and hospitals
- transport sectors, such as roads, railways, ports, waterways and airports
- research facilities such as laboratories and related equipment.

Infrastructure services include the provision, operation, and maintenance of the physical facilities of the infrastructure.

Poor infrastructure is a critical barrier to accelerating growth and reducing poverty in Africa. Inadequate infrastructure has curtailed Africa's agricultural trade and integration into world markets, human development, including the delivery of health and education services. It has also undermined the investment climate by keeping the costs of doing business too high and hindering access to markets. In Uganda, for example, transport costs add the equivalent of an 80% export tax on textile exports, making them internationally uncompetitive (Commission for Africa, 2005). At their current levels of infrastructure, most African countries will not benefit from increased access to developed countries' markets, currently under negotiation at the World Trade Organisation.

Infrastructure investments also represent an enormous untapped potential for the creation of productive employment in Africa. It is estimated that increasing the stock of infrastructure by 1% could increase the level of Gross Domestic Product (GDP) by one percentage point. In certain cases, the impact is far greater: the Mozal investment in Mozambique doubled the country's exports and added 7% to GDP, created new jobs and, through its Small- and Medium-size Enterprise Empowerment and Linkages Programme, contracted and trained numerous local companies (Commission for Africa, 2005).

Electricity, transport and communications networks are the underlying factors behind efforts to improve basic science and technological capabilities. Advancements in information technology and its rapid diffusion could not happen without basic telecommunications infrastructure (UN Millennium Project, 2005). In addition, electronic information systems, which rely on telecommunications, account for a substantial proportion of production and distribution activities in the secondary and tertiary sectors of the economy. Without adequate infrastructure, further application of technology to development will not be possible in Africa.

3.2.1 Designing the learning process

The potential for infrastructure development also presents a golden opportunity for African countries to design technological learning processes. Development and

infrastructure literature often overlook infrastructure's dynamic nature. Every stage of an infrastructure project, from planning and design to construction and operation, involves the application of a wide range of technologies and associated institutional and managerial arrangements. Because of its important role, the learning process in infrastructure development should be an important element in a country's technological learning process.

Because infrastructure facilities and services are complex physical, organisational and institutional systems, they require deep understanding and adequate capabilities among all the agents, like engineers, managers, and government officials (UN Millennium Project, 2005; Juma, 2005). Africa should therefore structure the design and construction of railways, airports, roads, telecommunications networks, water supply and sanitation systems, and research facilities in ways that promote technological, organisational and institutional learning.

The alignment of research and training activities with infrastructure development is a critical element in promoting the development of domestic technological capabilities and should therefore be a critical element in project design. Infrastructure development priorities signal the need to build long-term capacity for maintenance and technology development (Ridley and Yee-Cheong, 2005). Such projects should provide ideas for curriculum development in universities and other research institutions. This convergence of interest is achievable with continuous interaction and cooperation between government, industry and academia. Where research institutions do not exist, infrastructure projects should explicitly propose their creation.

3.3 Business development

Economic change is largely a process whereby knowledge is transformed into goods and services. In this respect, creating links between knowledge generation and business development is the most important challenge facing Africa. To promote the development of local technology, African countries need to review the existing incentive structures. A range of structures suitable for creating and sustaining enterprises exists, from taxation regimes and market-based instruments to consumption policies and sources of change in the national system of innovation.

Innovation systems are sustained by the demand for technology from businesses as a market competition tool. In a well-functioning innovation system, the pressure of competition drives firms to demand better skills and knowledge from employees, knowledge institutions, such as universities and research institutes, and intermediary organisations (Nankani, 2005). The resulting 'technology deepening' or development comes from the interplay of people, know-how and institutions that are constantly seeking cost-effective means of production.

Much of the discussion of business development in Africa continues to focus on the role of multinational corporations, with only limited policy interest in the importance of domestic businesses as sources of economic dynamism (Pragnell, 2005). However, small and medium-sized enterprises account for over 90% of the private sector worldwide (UN Millennium Project, 2005). The critical nature of technological progress offers a significant role for small-and medium scale technology entrepreneurship in employment generation, facilitating structural change and stimulating growth.

Small- and medium-sized enterprises should lead the development of new opportunities and the use of technology. Most developed and newly industrialising

economies around the world have relied on small and medium-size enterprises as the drivers of rapid industrialisation. In advanced industrial economies, small and medium size enterprises developed much of the innovative and cutting edge technology (Andreassi, 2003). Post-war industrial upgrading in Taiwan (China), for example, relied mostly on the small- and medium-size enterprises. Here, they supplied multinational corporations and foreign buyers, gradually acquiring both the process and product

3.5 *Regional integration (Murenzi, 2005)²*

While it is prudent for Africa to emphasise international trade, doing so requires greater investment in developing capabilities to trade, including technological innovation, the development of business and human resources, and institutional strengthening. The impact of bigger markets on technological innovation, and the economies of scale and the diffusion of technical skills arising from infrastructure development are some of the most important gains Africa could make from regional integration.

A common feature of African regional integration agreements is their recognition of the importance of science and technology in economic development. The integration of science and technology is based on the recognition that individual African economies are small and poorly endowed with human, physical, and financial resources necessary to develop and harness science and technology (Murenzi, 2005; Mugabe, 2004). The cost of building science and technology infrastructure often overwhelms national economies, especially the smaller and poorer states.

There is momentum in African regionalism characterised by deliberate efforts to design and implement plans for the application of science and technology to development. Cooperation in science and technology can take various forms, including joint science projects, sharing of information, conferences, building and sharing joint laboratories, setting common standards for research and development, and exchange of expertise. Furthermore, the sheer magnitude of the necessary infrastructure development would require regional cooperation in project design and implementation to not only reduce costs but also facilitate greater learning.

Some African countries are already endowed with vast science and technology infrastructure, which could easily be exploited by less equipped countries. New regional initiatives, such as the East African Community, will need to emphasise the use of science, technology and innovation in their development.

3.6 *International trade and technology development*

The process of technological innovation is intricately linked to the global economic system. The shift from largely domestic activities to complex international relationships demands a review of policies that integrate science, technology and innovation into economic development strategies.

The involvement of developing countries in producing new technologies and innovations is almost negligible. Africa, in particular, lags far behind the rest of the developing world. Much of the international debate over technology has focused on new technologies and ignored the global context in which such inventions are applied. The challenge facing the global community is to create conditions that will enable developing countries to make full use of the global fund of knowledge to address development challenges.

Globalisation of technology falls into three categories: the international exploitation of nationally produced technology, the global generation of innovation and global technological collaborations (UN Millennium Project, 2005). The first category, international exploitation, includes innovators' attempts to gain economic advantages by exploiting their technological assets in foreign markets. Multinational corporations, as the main agents of this type, often maintain their national identity even as they spread their technologies to other countries. They exploit their technological assets by selling

innovative products and technological knowledge (through licences and patents), and establishing local production facilities (through foreign direct investment).

The second category, global generation, refers to the production of technologies by single proprietors (largely multinational corporations) on a global scale. The third category, global technological collaborations, has grown in importance in recent years. Technological collaborations occur when two companies establish joint ventures or formally agree to develop technical knowledge and products, while maintaining their respective ownership. Many partnerships are between firms located in different countries, thus contributing to technological globalisation.

The global rules for foreign direct investment have changed, as have the modes in which they are most useful. Global production systems have changed the structure of investment flows and how funds can be made available in certain parts of the world for long-term growth instead of rapid flight to new, cheaper locales (UN Millennium Project, 2005). Foreign direct investment needs to be used as a vehicle for carrying tacit knowledge as well as assisting enterprises at the frontiers of world technological learning. Under appropriate conditions, foreign companies can contribute to local industrial development by providing capital, markets, and technological and business skills. They can also increase the local content of their products through subcontracts with local small and medium sized enterprises.

To enhance technological competence, local firms in African countries will have to first enter the chain and then gradually move up it to engage in higher value-added activities. An analysis of value chain linkages would provide insights into how they facilitate or impede technological and industrial upgrading. Policy makers in Africa need to understand the structure and function of the existing global value chains and their likely trend over time.

3.7 Harnessing global intellectual resources

One of the concerns raised about investing in technical training in developing countries is the migration of skilled manpower to industrialised countries. The World Bank has estimated that although skilled workers account for just 4% of the Sub-Saharan labour force, they represent some 40% of its migrants (Özden and Schiff, 2005). Such studies tend to focus on policies that seek to curb the so-called 'brain drain'. But they miss the point. The real policy challenge for African countries is figuring out how to tap the expertise of those who migrate and upgrade their skills while in the Diaspora, not engage in futile efforts to stall international migration.

Diaspora communities have played important roles in economic transformations of several countries. The economic growth acceleration of Mauritius courtesy of thriving sugar, textile and clothing industries, and the financial services is attributed largely to its Chinese and European Diaspora (Subramanian and Roy, 2003). A repository of Diasporas that had important linkages with the rest of the world created positive externalities for the country. The small Chinese population in Mauritius played an important role in attracting the first wave of foreign direct investment flows from Hong Kong (China), who sought to circumvent the quotas imposed on its exports of textiles and clothing (Subramanian and Roy, 2003). The Indian Diaspora was instrumental in developing the offshore financial sector after influencing the signing of a double tax treaty (TJ0.00107Tc 0.000

The most notable case is the Taiwan (China) Diaspora, which played a crucial role in developing the country's electronics industry (Saxenian, 2001). This was a genuine partnership involving the mobility of skills and capital. Countries such as India are now understudying this model. A number of countries have adopted policy measures aimed at attracting expatriates to participate in the economies of their countries of origin. They are relying on the forces of globalisation such as connectivity, mobility and interdependence to promote the use of the diaspora as a source of input into national technological and business programmes. These measures include investment conferences, the creation of rosters of experts and direct appeals by national leaders.

Significant experiments are under way around the world to make effective use of the Diaspora (UN Millennium Project, 2005). For instance, the Swiss government has converted part of its consulate in Cambridge (Massachusetts, USA) into a focal point for interactions between Swiss experts in the USA and their counterparts at home. The Swiss House was created in recognition of the importance of the area as the world's leading knowledge centre, especially in the life sciences. The Boston area is home to more than 50 colleges and universities and a cluster of science and technology activities.

In another innovative example, the National University of Singapore has established a college at the University of Pennsylvania to focus on biotechnology and entrepreneurship. The complementary Singapore-Philadelphia Innovators' Network serves as a channel and link for entrepreneurs, investors and advisers in the Greater Philadelphia region and Singapore. The organisation seeks to create opportunities for collaboration and partnerships in the area (UN Millennium Project, 2005). India is introducing a number of policy measures – including granting dual citizenship to Indians in countries of strategic interest – aimed at strengthening the role of the Diaspora in national development.

Such approaches can be adopted by other developing countries, where the need to forge international technology partnerships may be even higher. The old-fashioned metaphor of the 'brain drain' should to be replaced by a new view of 'global knowledge flows'. In the new global economic dispensation, science and technology diplomacy should become an important focus of international diplomacy for developing countries. International diplomacy, at least for Africa, must move beyond political relations with foreign governments to include their Diaspora communities. It is an area of considerable untapped potential that could unlock rich knowledge networks, trade and funding opportunities hitherto ignored.

3.8 Managing change

Promoting a growth-oriented agenda will entail adjustments in the structure and functions of government. More fundamentally, science, technology and innovation issues should be addressed at the highest level of government and the advice to reach policy makers. This would only happen with the creation of an institutional framework and the commitment to support it.

Advisory structures differ across countries. In many countries science advisers report to the president or prime minister, with national scientific and engineering academies acting as the sources of policy advice. Whatever structure is adopted, the advising function should have some statutory, legislative or jurisdictional mandate to advise the highest levels of government. It should have its own operating budget and a budget for funding policy research. The adviser should have access to good and credible scientific or

technical information from the government, national academies and international

- Mugabe, J. (2004) *Regionalism and Technology Development in Africa: Strategies for Collective Learning to Close the Knowledge Divide*, Paper prepared for *Providing Demand*.
- Murenzi (2005) 'Africa in the global knowledge economy', in Juma, C. (Ed.): *Going for Growth: Science, Technology and Innovation in Africa*, Smith Institute, London, pp.48–59.
- Nankani, G. (2005) 'Knowledge for productivity-led growth', in Juma, C. (Ed.): *Going for Growth: Science, Technology and Innovation in Africa*, Smith Institute, London, pp.24–32.
- Özden, Ç. and Schiff, M. (Eds.) (2005) *International Migration, Remittances and the Brain Drain*, World Bank, Washington DC.
- Pragnell, M. (2005) 'Agriculture, business and development', in Juma, C. (Ed.): *Going for Growth: Science, Technology and Innovation in Africa*, Smith Institute, London, pp.88–99.
- Ridley, T. and Yee-Cheong, L. (2005) 'Infrastructure, innovation and development', in Juma, C. (Ed.): *Going for Growth: Science, Technology and Innovation in Africa*, Smith Institute, London, pp.62–71.
- Rosenberg, N. and Birdzell, L.E. (1986) *How the West Grew Rich: The Economic Transformation of the Western World*, Basic Books, New York.
- Saxenian, A. (2001) 'The Silicon Valley-Hsinchu connection: technical communities and industrial upgrading', *Industrial and Corporate Change*, Vol. 10, No. 4, pp.893–920.
- Subramanian, A. and Roy, D. (2003) 'Who can explain the Mauritian miracle? Meade, Romer, Sachs, or Rodrik?', in Rodrik, D. (Ed.): *In Search of Prosperity: Analytic Narratives on Economic Growth*, Princeton University Press, Princeton and Oxford, pp.205–243.
- UN Millennium Project (2005) 'Innovation: applying knowledge in development', *Task Force on Science, Technology and Innovation*, Earthscan Publishing, London.
- Zaglul, J. and Sherrard, D. (2005) 'Higher education in economic transformation', in Juma, C. (Ed.): *Going for Growth: Science, Technology and Innovation in Africa*, Smith Institute, London, pp.34–45.

¹Hong Kong (China), Malaysia, and Singapore have all established construction industry development boards. Funding for the boards comes from a compulsory cess on all construction contracts. The revenue is used to build capacity and promote innovations in construction materials and techniques.

²Excerpted from Murenzi (2005).

³The arrangement resulted in Mauritian offshore centres mediating large financial flows to India, making Mauritius the largest investor in India. The minority French community controlled the sugar sector and was at the forefront in negotiating an innovative and highly lucrative sugar quota with the European Union. Their foresightedness in choosing higher quantities at lower prices, when other countries went for low quantities at high prices proved decisive in earning Mauritius a windfall in rents, which proved vital in financing private investment and generating growth (Subramanian and Roy, 2003).