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Production and Dissemination of Knowledge: How global can it be?

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Introduction

The purpose of this paper is to identify ways in which the countries with resource constraints, mostly in the South, can become more significant players in the global production and development of knowledge, develop their scientific base and retain their skilled professionals in their countries. Although the topic cuts across all disciplinary fields, most examples used in this paper will be drawn from the social and biomedical sciences.

The world has become so integrated through globalization that few countries remain unaffected by changes occurring elsewhere. Countries are now integrated economically, financially, socially, educationally and technologically. Because of this integration, it has become even more critical that knowledge that is generated benefits people all over the world. The improvement in trans-continental transport by air and sea has made it easier for the world to become one. The economies of the leading countries in the North have evolved into knowledge-based economies (OECD, 1996). Knowledge economies have emerged from the increase in knowledge intensity concerning economic activities, as well as from the globalisation of economic affairs (Houghton & Sheenan, 2000). People can now carry diseases, ideas, technological know-how across borders. Knowledge intensity is driven by the information technology revolution and by other technological change (Houghton & Sheenan, 2000). Technological innovation has made it possible to transmit information globally to and from remote places, for example through satellite, internet and cell phones.

Techno-scientific innovation is considered to be a distinctive feature of knowledge-based economies. The Economist of January 9 2010 recently published an article celebrating the 350th anniversary of the Royal Society of London and its contribution to the development of science. This is indeed a very productive society, with 74 of its 1300 living members being Nobel Laureates. Developing countries participate only marginally in the generation and the diffusion of technology (Archibugi & Pietrobell, 2002). The capacity for innovation furthermore remains low in most African countries (Wolf, 2006).

But we cannot forget that Africa was far ahead of Europe in pre-colonial times. As early as the 12th century scholars were flocking to Timbuktu to study ancient manuscripts covering subjects such as astronomy, medicine, mathematics, chemistry, judicial law, government, and Islamic conflict resolution. "Islamic study during this period of human history, when the intellectual evolution had stalled in the rest of Europe was growing, evolving, and breaking new ground in the fields of science, mathematics, astronomy, law, and philosophy within the Muslim world." Chris Rainier (National Geographic News May 27, 2003)

Globalisation increases the need for strong national systems that are able to absorb new advances in global innovation from elsewhere in the world. The fostering of scientific and technological collaboration between developing and developed countries is required to ensure the global integration of knowledge, and the scientific community in developing countries, which is directly affected by these developments, is rapidly attempting to contribute to global integration of knowledge through increased investment in human resources and infrastructure. Ernst (2001:498) suggests that 'developing countries need to blend diverse international and domestic sources of knowledge to compensate for initially weak national production and innovation systems'.

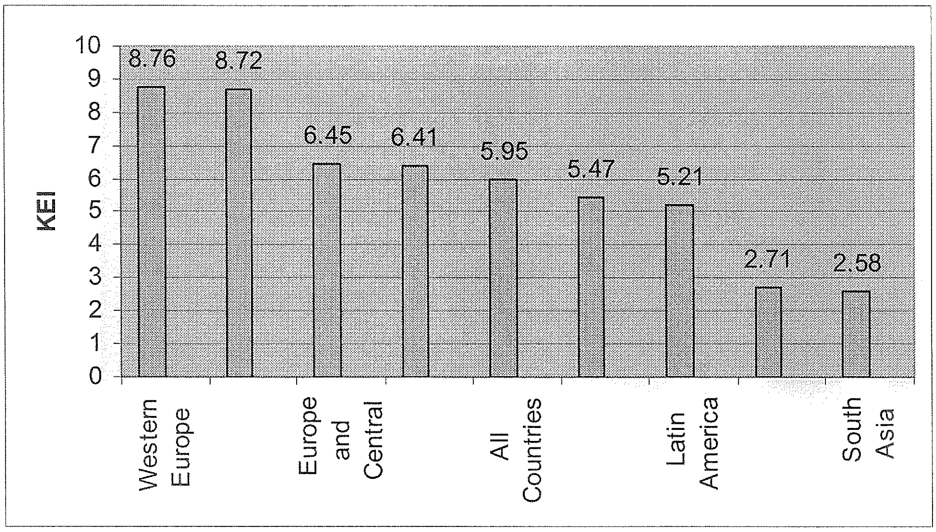
Progress in human development accelerated in the 20th century faster than any other epoch mainly as a result of knowledge generated through scientific advances and disseminated through new forms of information and communication technology. Some of the governments are beginning to rely on scientific evidence to determine how best to spend large their budgets, for example, to improve the quality of education or the health of the population, or even to design a national social security system. Activists will often express their displeasure when policy makers ignore scientific evidence, even if generated in other countries, to treat specific diseases or to reduce environmental hazards.

Who leads in knowledge generation?

Knowledge is most frequently generated in the North, albeit to a different extent in different countries depending on the capacity of human capital, since skilled labour and the presence of scientists is required in order to produce new knowledge. Based on data from the Science Citation Index, Social Science Citation Index and Humanities Citation Index, Ezra Ondari-Okemwa (2007) concluded that in 2006, the United States led the world in the output of scholarly publications, exceeding 100 000, followed by European countries such as the United Kingdom and Germany producing between 95 000 and 98 000 articles. India with a larger population than the US produced less than a third of the US output and the US neighbour, Mexico, produced only 10% of the US output. The 28 sub-Saharan countries in Africa reviewed in this study were only able to produce approximately 13 000 journal articles in the same year (of which more than 6 000 were produced by South Africa alone), with the most populous country, Nigeria, producing under 1300 per year. Segregating scientific output by discipline show even greater disparities

Using the 2009 World Bank knowledge economy index (KEI), which is the average score derived from the four key indicators of knowledge economy – *"economic incentive and institutional regime, education and human resources, the innovation system and ICT"* a different picture emerges. Western Europe leads in knowledge economy followed by G7 countries, which includes Canada, France, Italy, Japan, United Kingdom and USA. The East Asia and Pacific region though scores lower than industrialized countries, its performance is higher than that of Middle East and North Africa and Latin America. Africa and South Asia still have a long way to go to become knowledge economies.

Knowledge Economy Index 2009, cross region comparisons



Source: World Bank data, 2009.

The regional differences actually mask individual country differences. The 2009 World Bank KEI shows that Denmark (9.52) leads the world in KEI, followed closely by Sweden (9.51), Finland (9.37), Netherlands (9.35) and Norway (9.31). The emerging economies like Brazil (5.66), Turkey (5.55), South Africa (5.38), China (4.47) and India (3.09), still lag far behind.

What barriers prevent the South from penetrating the northern scientific arena?

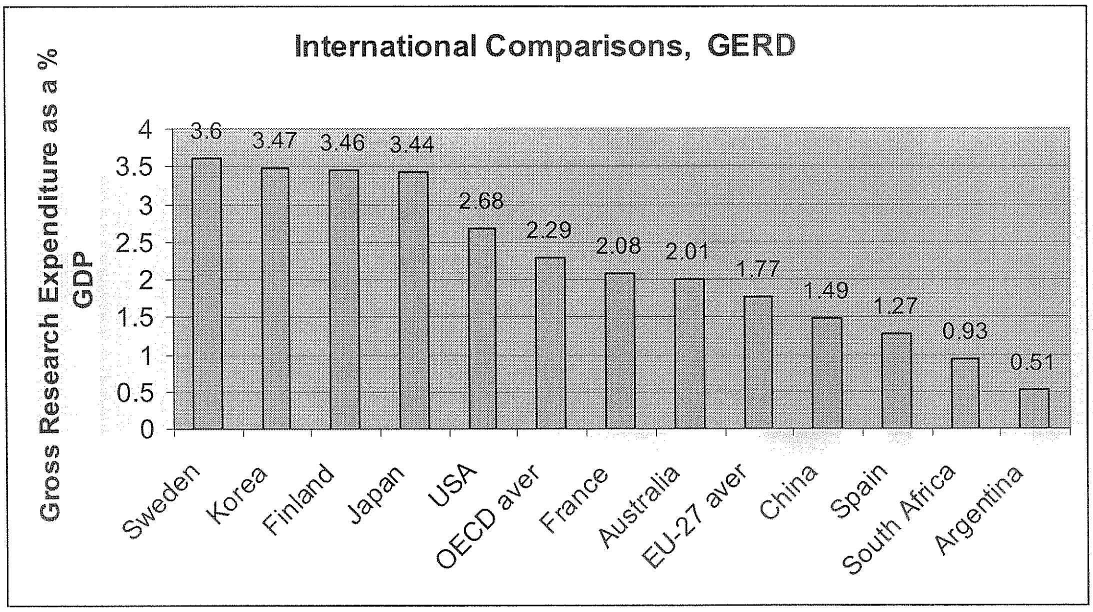
Scientific knowledge is meaningful if shared, discussed, replicated and interpreted beyond one's borders. Scientific advance would invariably take greater strides if North and South collaboration in information sharing were to happen at a quicker pace than at present. Solutions to intractable problems could be found quicker because the lens through which the problems are studied may very well be wider than at the present time. But for this to happen at a global level will require some fundamental changes in the composition and diversity of members of the research community. In some cases this is beginning to occur, but in others, barriers still remain.

Several studies were done to assess the barriers to knowledge penetration from the South to the North; I have selected two that are most pertinent; one on *North and South: Bridging the information gap* (Horton, 2000) and *Scholarly publishing in sub-Saharan Africa in the twenty first century: Challenges and opportunities* (Ondai-Okwema, 2007). Richard Horton carried out his survey with the help of medical scientists in Asia and Africa, , whereas Ezra Ondari-Okwema systematically reviewed publication indices in the hard sciences, the social sciences and the humanities to identify some of the barriers. Using these two sources and my personal observations in Africa, I see the barriers as falling into two categories: those internal to developing countries, and those generated externally.

Internal barriers

Economic wealth is a good predictor of scientific output. Poorer countries with low wealth intensity also have lower scientific citation intensity. Countries such as India, Brazil, China, Iran, South Africa and South Korea in 2004 were cited as having low intensity of wealth and scientific citation intensity. The exception is Luxembuorg, which has very high wealth intensity but very low citation intensity (King, 2004).

A consequence of poor economic development is low levels of investment in research infrastructure and domestic funding for research. Poor countries cannot prioritize research ahead of other pressing social needs, and are inclined to leave research funding to international donors. For the same reason, few libraries are built or "stocked" with latest books and journals and there is poor access to information technology, such as computers, the Internet and high speed bandwidth. The absence of funding for research also has an impact on the availability of skilled researchers. There are inadequate resources to train researchers in cutting edge fields; and there is a lack of a critical mass of scientists who can provide critical review, tutor and mentor emerging scientists. Inadequate research resources mean poor salaries for scientists, who then often join either the civil service or private sector for better pay. University staff in the medical field often have to deal with large classes, and demanding clinical work in under-staffed hospitals.. Coupled with a general lack of requirement for scientific publication for academic promotion; not many academics are motivated to find the additional time and resources to publish. Based on the latest OECD indicator of Gross Expenditure on Research and Development (GERD) it is clear that there is low level of investment in research and development in the South compared to the North.



Source: OECD Main Science and Technology Indicators, 2009 (adapted from South African Department of Science and Technology report: National Survey of Research and Experimental Development 2007/08)

It is therefore not a surprise that the number of full time equivalents of researcher per 1 000 people in employment is lowest in countries of the South; for example, South Africa (1.5), China (1.9) and Argentina (2.9) have low FTE rates compared to industrialized countries, such as Sweden (10.6) Japan (11.0), Australia (8.3) and Spain (6.0). The high rates of FTE of researchers leading to a country having a critical mass of scientists, can be achieved with high investment in science and technology. Countries from the South need to urgently address these infrastructural impediments if they are to succeed in penetrating these barriers and become a significant global player in global knowledge generation.

Domestic non-state funding, particularly from the private sector, might very well augment state funding. Apart from funding in-house research that is often proprietary in nature, the private sector is a useful source of research funding for universities, nongovernmental organizations and state-affiliated institutions. One way to encourage the private sector to contribute to research funding is to give them tax incentives, whereby those who invested in research and development, get a tax rebate. This is the case in South Africa, where a Research and Development (R&D) tax incentive to encourage private-sector investment in research and development activities (excluding research in social sciences and humanities) came into effect in November 2006. One can however not ignore the risks that can come with private sector funding. It is generally recognized that private support for research carries the risk of a perverse incentive to unfairly benefit the donor. Numerous cases have been documented in which pharmaceutical and medical devices companies unfairly influenced the outcome of research to favor their products (DeAngelis and Fontanarosa, 2008)

Other internal problems that can bar Southern scientists from significantly contributing to scientific knowledge are political, such as lack of freedom of speech in some countries, where scientists are expected to sing praises to the performance of political leaders and never to provide intellectual critique of government policies and programs in terms of their impact on human development. This is particularly true for social scientists in these settings. Scientists have been sidelined for speaking truth to power; they are often labeled anti-government. Emerging scientists have found this to be career limiting, and have consequently avoided science in favor of politically “safer” careers. Governments in the South who limit scientific space need to step back and allow scientists, particularly social scientists, to inform their policies through constructive critique that can help to redirect policy and program development in ways that will better benefit the people.

Poor education overall does affect the quality of scientists produced by countries in the South. Many students who have not studied mathematics and science find it difficult to follow careers that require analysis of quantitative data. It is no surprise that developing countries have shortages of statisticians, engineers, clinical and other scientists, etc. Consequently, one is more likely to encounter a qualitative than a quantitative researcher in developing countries. To address this barrier, it is critical that schooling be improved to increase access particularly to quality education in mathematics and science that will allow for an improved through-put from primary to tertiary level of suitably qualified students likely to choose research as their life careers.

Lack of incentives for scholarly publications may be a deterrent to scientists publishing their work. Unfortunately, because science is frequently undervalued, with a preference to allocate funds for services, there may be no resources for providing incentives for knowledge production. However, there are examples worth noting. The South African Department of Education awards monetary incentives for scholarly publications in at least 250 South African journals officially recognized by the Department, and some of which are indexed in Science Citation Index, Social Science Citation Index and Arts and Humanities Index. Unfortunately many black African intellectuals do not benefit from these incentives largely due to inadequate preparation for academic research. To correct this, South Africa has establish a program called "PhD as a driver of science and technology" that enrolls and trains PhD students as part of human capital development. Most of the participants are drawn from individuals previously disadvantaged under apartheid. More examples to give incentives for research and simultaneously build human capital are needed to create critical mass of knowledge generators.

External barriers

Some of the external factors (real of perceived) have to do with attitudes of practices or editors and scientists in the North. The dominance of English as the language of scientific communication has been shown to result in higher rejection rates in North-based journals for research papers submitted from China or Africa or in some cases India by scientists who are not fluent in English. Their papers are rejected for inelegant language, notwithstanding the quality of their research that could add value to current debates on specific matters. One way to remedy this situation would be for journals to create sub-editing sections dedicated to language, and for editors to have such articles subedited accordingly. This might encourage more researchers to write in English.

Northern reviewers often fail to appreciate the difficult context within which research is conducted in countries of the South. The insistence that conditions for research be tied to meeting the requirements of the northern institutional review boards, which may differ significantly from those of local review boards based on local conditions, delays many Southern researchers from conducting research. The approval process is so long that by the time the project is approved some of the researchers have changed jobs because funding was tied to approval.

Often research undertaken in the South is highly relevant to those residing in their region, but due to the relatively "local" nature of the research and research question, there is not an appropriate journal or publisher in the North where the study can be published. Consequently, findings are published in local publications with little or no international exposure.

One of the major barriers to publishing scholarly articles from the South is the high fees some journals charge for publishing electronically or in hard copy. If a researcher wants an article to appear within 12 months he/she may have to pay an exorbitant amount. One publisher announced that "Authors who would like their papers posted free online with immediate unrestricted open access may pay $US3 000 fee". For someone living in resource constrained settings working in universities or research institutions in a country where the majority of the population lives on two dollars per day, this simply means that the article will never be published, let alone in less than a year. Delayed access to information retards the speed of knowledge application. Northern publishers should adopt an open access policy to allow those living in resource constrained countries to participate in global information exchange. Work of SatelLife (www.healthnet.org), International Network for the Availability of Scientific Publications (www.inasp.info) and Electronic Publishing Trust for Development (www.epublishingtrust.org) are good examples of removing barriers to access to scholarly work for people in the South.

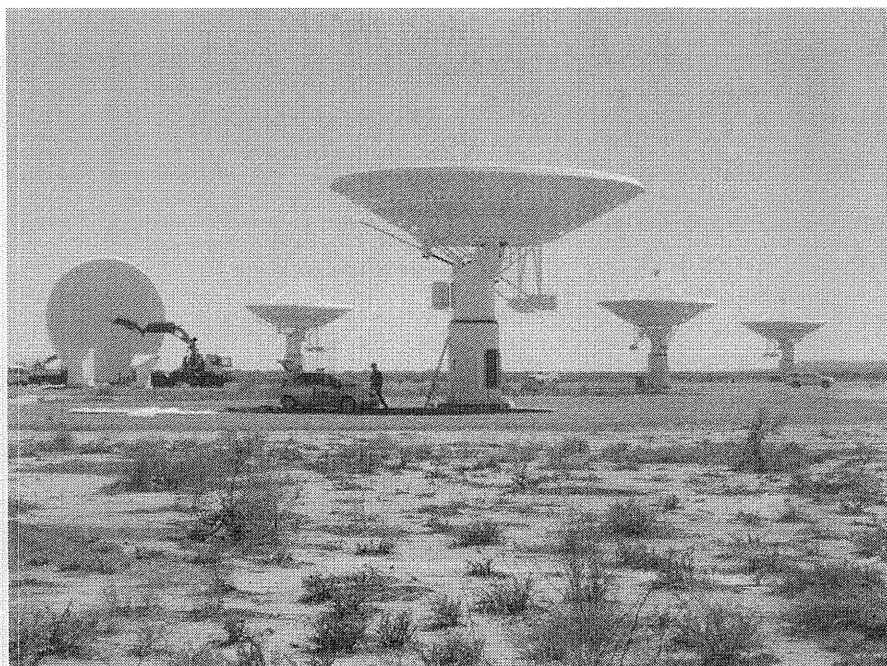
The poaching of best scientists to work for donor organizations or to work on projects where the principal investigator is in the North is yet another obstacle to getting scientists to contribute locally. The local scientist hardly has time to study immediate challenges, such as rare diseases. This might be mitigated by opening up of borders in the South to researchers in the North so that they can alleviate the human capital shortage. This might also give researchers from the North the opportunity to understand the context of where the research is being done. Increased movement of Northern scientists to the South may be beneficial both sides. This is presently limited to a large extent by the rigidity of immigration and work permit regulations in countries in the South.

Research agendas are often drawn in the North, either through funding agencies calling for proposals or by principal investigators living in the North who initiated the projects which require study participants from the South. Too often a research project is conceptualised in the North, executed in the South with excellent researchers in the South often reduced to serving as "fieldwork coordinators" and the findings published in the North. This is academic colonialism at its worst, with little or no opportunities for the real "Southern" issues to feed into the research agenda, and research findings being interpreted by people who are not always sufficiently aware of contextual issues. It is encouraging that the European Union's 7th Framework Programme for Research and Technological development invited scientists from the South to help shape their research agenda so that the calls for proposals include the relevant research questions from the South. Increasingly, researchers from Europe are beginning to acknowledge that the South may have a view that might inform Northern researchers, suggesting that a two way street in knowledge generation is the way to go.

Some of the public funding sources such as the EU are open to addressing the concerns of South-based scientists, but some of the private foundations are less amendable to deal with these concerns and this retards meaningful participation by the South. These foundations tend to develop their own research agenda and may tend to impose their views on the South; forcing them often to study what we consider their "pet" projects.

Despite these challenges, international funding for research and technology comes largely from the North and this has vastly contributed to development of scientific and technological infrastructure in the South. But it will take collaboration of scientists in the North and the South to have global impact. Here is one example worth sharing with the meeting.

South Africa, together with eight other African countries, is bidding to host the world's largest telescope, the Square Kilometer Array radio telescope. This is a global project which is being developed by a consortium of fifty-five institutions in nineteen countries. The governments of those countries also participate in the development of this $2 billion project. South Africa and Australia were short-listed as the potential sites for the SKA in 2006. A final decision is expected in 2012. South Africa's government has prioritized astronomy and wants to see Southern Africa become a major hub for astronomy in the Southern Hemisphere, including the HESS gamma ray telescope in Namibia, the SALT telescope in Sutherland in South Africa and the SKA, which will stretch across nine countries in Africa. The South African Department of Science and Technology has made available R2 billion for the design and construction of the MeerKAT radio telescope, which is a smaller version of the SKA – called a pre-cursor. This will develop and test the very cutting-edge technologies required for the SKA, as well as building the astronomy and engineering communities in South Africa and its partner countries. The first dishes of the MeerKAT are already in place in South Africa's Northern Cape Province and it is expected to start scientific observations in 2013. It has attracted great interest from astronomers and technologists around the world and many collaborations are already in place.



MeerKAT radio telescope

The team working on South Africa's SKA and MeerKAT project consists mainly of young scientists and engineers with no background in astronomy. They have, however, got world-class generic skills and have quickly been able to take a leading role in the global SKA technology development collaboration through working closely with such institutions as Oxford, Cambridge, Manchester, Berkeley, the National Radio Astronomy Observatory of the USA, ASTRON in the Netherlands, the National Radio Astronomy Observatory in India and others. They have developed world-class competency and expertise in the technologies which will be crucial in the global economy in the next 10-20 years.

It essential that Africa should be a host for major research infrastructure, without which it will not contribute significantly to global knowledge generation. The spin-off from such projects is immense, in strengthening the universities, in strengthening our innovation capacity and in changing the way people in Africa see science and engineering and contribute to global efforts to generate and disseminate knowledge.

Migration of scientists from the South to the North

One of the major barriers to developing countries to contribute to global scholarship is migration of professionals from the South to the North. In an on-line article, Tebeje (2005) made reference to statistics from the International Organization for Migration (IOM) who estimated that since 1990 the African continent lost approximately 20 000 professionals each year; and that about 300 000 African professionals were living outside of their mother continent by 2005. This problem is confounded if one takes into account that Africa had to employ – at a premium – some 150 000 skilled professionals from other parts of the world, to help address some of its most critical knowledge gaps.

Scientists from the South find the North attractive because of good research infrastructure. Laboratories are well equipped, libraries are available and accessible; salaries of scientists are competitive; universities have broad bandwidth and offer easy access to scholarly work on the internet. They also have critical mass of scientists for mutual collegial consultation when necessary. There is a good culture of questioning, investigation and undertaking research to settle debates or generate new ideas. Frankly speaking, the North has many pull factors for Southern scientists. It is no wonder that the Southern researchers gravitate to the north. Migration is not necessarily bad when scientists travel to gain experience and also share views. The problem arises when migration becomes a brain drain, when Southern scientists migrate to the North and never return to give back to their country what they have learned.

Sometimes even when they want to return, they find the environment at home not conducive to conducting research as articulated above. But even worse, there may be few positions for researchers, nor a career ladder and a career path over the life time employment. They may also lack support systems which they can use to mentor emerging scholars. These are push factors. They become more pronounced if they are coupled with high crime rates, high unemployment rates, poor living conditions, poor education opportunities for their children, political uprisings and conflicts that threaten lives.

What the South needs to do is to create conditions that pull researchers to their countries. They need to improve the living conditions of their people, improve education and produce a critical mass of scientists, create good research infrastructure such as libraries, laboratories, electronic communication with broad band, and above all cherish scientists and make research a career of choice at universities.

Finally, Northern editorial boards as well as Southern ones should be comprised of diverse multi-region member teams that will understand the context within which scientists are doing research. In this way they will be sensitive to the needs of the researchers from diverse contexts.

Conclusion

The world has much to gain if the production and dissemination of knowledge can be truly global. New forms of technology and a greater awareness of diversity have the potential of reducing some of the barriers of access and dissemination. However, for knowledge production to become truly global, it will be important to

- Jointly set the research agenda
- Share funding for research
- Remove conditions attached to funding research
- Ensure scientists have good research infrastructure no matter what country they live in
- Provide incentives to do research

The world can benefit if we can all work together in producing knowledge.

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