

SCIENCE, TECHNOLOGY AND GLOBALIZATION
Challenges and Opportunities for International Cooperation

Conference Summary

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INTRODUCTION

A major concern with the current trends in the global distribution of R&D activities is the apparent divide between the industrialized and developing countries. This divide helps to underscore the differences between countries, but it does not in itself clarify what could be done to facilitate technological innovation in developing countries. The divide does, however, point to opportunities for international cooperation in technology development. Although the developing countries hold 80% of the world's population, they produce 10% of publications. Their contributions to scientific literature, Internet activity and patents are equally limited. Furthermore, their human resource base is vulnerable to brain drain, as scientists move to countries with adequate infrastructure and incentives for scientific effort.

Despite a shortage of funds in developing countries to support R&D, there are areas that offer opportunities to developing countries to participate in scientific activity. For example, the bulk of the world's biological resources are located in developing countries. This fact enhances the potential for domestic research activities based on advances in the biological sciences. A focus on the use of biological resources, however, also entails the formulation of development strategies that take into account environmental management goals. The framework for doing this has already been provided under general commitments to pursue "sustainable development" strategies.

1. SCIENCE, TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

Science and technology can assume two major roles in furthering sustainability. First, S&T can help to decrease vulnerability by furthering development and increasing adaptive capacity (e.g. to climate change, and, on the economic front, to the persistent devaluation of their currencies and their consequent inability to repay debts). Second, S&T is an option helping to respond to the numerous contingencies (demographic, economic, social, environmental, etc.) that an unknown future holds. The impact of S&T is long-term. Hence, policies need to consider explicitly long-term uncertainties. Generation, testing, and adapting technological options to a variety of local conditions are processes requiring many decades and considerable investments in both embodied and disembodied aspects of technological change. The former aspects are global and easily transferable between markets, while the latter depend on local institutions, networks and communities, niche market applications, and investments. Both aspects are, in addition, interconnected and interrelated in a circular (as opposed to a traditional linear) model of the innovation-diffusion process. Hence, R&D strategies and policies are inadequate without explicit consideration of market structure and incentives that ultimately determine diffusion.

Redirecting S&T toward sustainability requires clear national fiscal policy signals. For instance, quantifying industrial effects on the environment (through levies, fees, taxes) and earmarking resulting revenues for S&T development provides market signals, as well as much needed resources for S&T development. New methodologies for optimal portfolio analysis under conditions of persistent uncertainties are also becoming available. These approaches should be used increasingly for developing priority areas for S&T development and international cooperation that can help in the transition towards sustainability.

2. SCIENCE, TECHNOLOGY AND GLOBALIZATION

Technologies are playing a crucial role in allowing globalization of economic and social activities. The rapid spread of the Internet is a welcome innovation, particularly to developing countries where sources of information are hard to come by. Penetration of new technologies in individual nations

heavily affects these nations' actual and potential economic development. Yet the impact of new technologies on developing, as well as developed countries is of decidedly mixed benefit. While new scientific and technological opportunities are rapidly growing, using them to solve human problems can be a problematic process in all countries. R&D investment is heavily concentrated in North America, Europe and Japan, and the outcomes are often not intended to be beneficial to developing countries. Nevertheless, high-tech products that may be described as luxuries in the developed countries may solve problems peculiar to the developing countries and, often, can be seen to be appropriate technology for the Third World. The adoption of cellular phones to circumvent the long waiting list for land lines, or the installation of photovoltaic systems in rural homes, are prime examples of the appropriateness of these high technologies. Yet international trade of high-tech products does not ensure the economic and technological upgrading and development of emerging countries, as endogenous learning must increase.

Developing economies should implement policies that will allow them not only to import high technology products and processes, but also to absorb, imitate and develop the technologies. This is a strategy that was adopted by many Asian countries in the 1950s, and led ultimately to the now well-established Tiger economies. Foreign direct investment is also relevant to transmission of know-how. Investments by trans-national corporations can be beneficial or can present obstacles to the formation of endogenous innovation systems, especially if they are not coupled with a strategy to improve absorptive capacity. Academic institutions and business companies may also engage in trans-border collaborations of potentially great benefit for development of endogenous S&T capabilities in developing countries. Governments in both developed and developing countries should increase the resources devoted to joint R&D programs.

3. EMERGING INNOVATION SYSTEMS

S&T policy is the result of interaction among government at various levels (national, regional, and supranational), firms (multi-national and high tech start-ups), universities and other knowledge-producing institutions. Universities are undergoing a bi-evolution in mission and focus, taking on roles in economic development and in growing new firms, in addition to their traditional roles. The incubator movement in Brazil provides a potential model for other countries, both developing and developed, in creating new firms, and raising the technological level of existing firms. Networked incubators can develop technology cooperatively. Incubators in Brazil have been the focus of municipalities, industrial associations, and government at various levels, providing a means of endogenous economic development in an era when local resources cannot afford large-scale development projects.

4. INTERNATIONAL COOPERATION IN RESEARCH AND DEVELOPMENT

In recent years there has been a major thrust to globalize R&D. The establishment of R&D centers by global corporations in developing countries is a recent phenomenon. Analysis of globalization of R&D in India shows a number of things. R&D centers act as strong signals for foreign investors and for entrepreneurs. Also, the perception that the Internet would act as a force to disperse firms is being proven wrong. Knowledge-creating clusters are more important than knowledge-utilizing clusters.

Developing countries need to strengthen their capability to enhance management of research through formulation of forward-looking research projects, by including elements of S&T research and of capacity building in their five-year or ten-year development plans. Availability of skilled

manpower is a major determinant for catalyzing cluster growth. With their strong external economies, clusters have an important role in developing capability. We are moving to a knowledge-based economy, and the role of entrepreneurs is likely to increase. Public policy has to consider venture funding as a viable option for technology development.

Analysis of the relationship between collaboration, innovation, and location in the US biotechnology industry helps to elucidate the R&D policy of these firms with respect to university collaborations. Firms with higher levels of R&D activity are more intent on engaging in R&D alliances. Many alliances occur with partners located outside of the local area, including other countries. More firms located in defined clusters of the biotechnology industry engage in collaborative R&D than do firms located elsewhere. University scientists are the main research partners (though not necessarily locally based), and the main purpose of collaboration by a cluster firm is access to basic research.

One of the main purposes of university-industry collaboration for a non-cluster firm is also product development. Firms engaged in collaborative R&D exhibit better innovation performance. Location continues to be important for start-up companies. Location inertia is important for established firms, who acknowledge the importance of location reputation, support networks, and traditional factors like nearness to universities and to venture capital, and supply of skilled labor, in the process of innovation. International collaboration is limited to formal R&D agreements (e.g., contracts), and most firms collaborate internationally for marketing purposes, rather than knowledge sourcing. US firms seek cluster-to-cluster R&D collaborations within the US. R&D policy is mostly driven by the identification of unmet market needs. However, these needs are mostly based in developed, rather than developing countries.

Case studies on regional technology suggest that developing countries might be able to begin to bridge the gulf between rapidly innovating biotechnologies and their economic and agricultural needs. The canola study offers a few options for public action, including: identification of niche market opportunities to advance through applied R&D; policies and programs to facilitate access to and import of basic proprietary technologies; creation of open-access, platform research centers (public and collective) to facilitate development of scientific interactions, community building, and joint problem solving; identification and attraction of competitive companies to a region; and rigorous, pro-supply policies and collaborations to ensure products of biotechnology are rigorously expedited and evaluated for safety and rapidly commercialized.

The question of why S&T has lagged in the South has several answers. Most important is the lack of budgeted commitment to S&T education, whose promotion can be done through the use of a wide range of conventional and non-conventional approaches. This commitment also entails increasing the level of national expenditure on science and technology in general and science education in particular.

Universities in the developing countries for a long time have been required by governments to be involved in developmental research, particularly in areas related to economic development. New higher degree programs need to be relevant to local needs and should be developed in close cooperation with government, industry and other sectors of the economy.

5. EMERGING RESEARCH POLICY ISSUES

5.1 Wider technological considerations

Current public policy debates on technology have tended to focus on short-term considerations in key sectors such as agriculture, which have a long record of activities in developing countries. A new research agenda would need to take into account long-term sustainability consideration, as well as other technological systems in fields such as human health, energy, water resources, information and communication, and environmental management.

There exists an urgent need to make explicit the link between science and sustainable development. S&T policy decisions should be niche-oriented and specific to the location and market, as well as to the problems at hand. In most mega-cities scientists grapple with the problem of air pollution, but political, social and economic factors prevent effective implementation of their findings. This kind of capability must be sought within any given socio-political context. In one country, the need might be for viable drinking water; in another it might be for food distribution.

A second issue is that there is no single sustainable technology. No matter what technologies are developed, they have some measurable impact. It is essential that these large effects be discovered not through disastrous events, but through analysis and simulation ahead of time. We should not assume that all systems are benign until shown to be otherwise.

Scientific knowledge today has increasingly diverse applications. In the absence of evidence of risk, new technologies are usually allowed to develop, while satisfying existing regulatory requirements. Once a technology is approved, uncertainty about threats to human health or the environment must be handled in some way. S&T has a role to play in reducing uncertainty, by placing the burden of proof on new technologies. Yet, the perception that only new technologies carry risks is not correct. Increasing the knowledge base is the only way to understand risks, even in existing technologies. The issue of uncertainty even in the knowledge base requires resource expenditure and concerted policy effort to manage, using accepted facts or even broad correlations regarding sustainability and environmental degradation.

5.2 Endogenous technological development

The emerging patterns of global research and development activities tend toward “clustering” of innovative activities in a few centers of technological origin. The policy challenge facing developing countries is how to establish their own foundations for research and development to address local and national needs. It is through such initiatives that these countries will be able to become viable partners in international research and development efforts. Building the foundation involves a better understanding of the dynamics associated with human capital development, institutional innovation, scientific infrastructure, and the overall relationships between knowledge creation and economic activity.

National innovation systems

A paradox may be summarized as follows: why should industrialized countries invest in technologies not essential to them, but essential to developing countries? One answer might include intellectual property rights, but in the long run, international collaboration is the best hope. Also lessons should be sought in various technology sectors and applied, where possible, to other sectors.

Successful international networks may be relevant across disciplines, as well as over geographical distances. Industrialized countries invest in technologies that are relevant to them, even when not essential.

Developing countries need to reinforce their knowledge patrimony and protect valuable information in order to preserve their R&D independence and investments. Debates should be promoted to reinforce the major role of intellectual property to support sustainability. With the right policies and the appropriate access to world markets, developing countries, through the improvement of their own intellectual property capabilities, will be able to provide incentives to individuals and organizations, while discouraging excessive costs involved in commercializing resources that are not unique.

Discussion of the private sector should include more than just multinational corporations, but also indigenous industries, particularly in developing countries. The knowledge-based economy is fundamentally financed and driven by private capital, while development is largely a result, not an explicit goal, of private actions. We need to find out how to exploit private actions – large multinational firms, local entrepreneurial ventures, and collective institutions, for public development objectives. This requires further examination of the structure, activities, and potential for private action in support of development. As part of this effort, attention should be paid to building firms that create new knowledge.

An important message is that globalization of R&D is not occurring in sufficient ways everywhere. We still need to remember that this process must include the world; developing countries must develop strategies to incorporate endogenous industry and traditional knowledge into the global network. Developing countries need more human capital invested in S&T policy-making. While some developing countries assume that the way to become major players is to revise their S&T policies to reflect globalization, many others direct their S&T policies at national needs, only later focusing on globalization. But questions of budgets are also important, as well as improving the management of research.

Human resource development

Completion of higher education in a developed country can severely limit options for developing country citizens who return home. Sometimes returnees are pushed into managerial positions and, sometimes, even into politics, because their level of education and overseas experience promotes their acceptance into decision-making circles. Brain drain is a complex issue, and the movement of scientists is influenced by a variety of factors, most of which are economical. Yet benefits from this process are bilateral.

Center-periphery relationships exist all over the world, even in highly developed regions. The relative ebb and flow is significant but not always predetermined (South to North, for instance). Capacity building may take many forms, addressing problems of infrastructure development, as well as aiding in countries' quests for self-sufficiency, which may be broadly understood as social and economic sustainability.

Equally important is basic education for all people, not just for those engaged in advanced R&D training. Centers of higher education need to link up with the network of knowledge, especially regional institutions and community colleges. A number of centers of excellence in various technological areas have already been established in the Third World and are accessible by other developing countries through a policy of South-South cooperation.

Student training in basic science, particularly in physics and mathematics, is acquiring greater recognition in developed countries. In developing countries, even when technologies are imported, research in basic sciences is necessary to make them work. Rather than insisting on developing indigenous technologies, when abundant and well-proven technologies exist, scientists can help choose the right ones and learn how to use them. Development requires a well-trained work force; therefore, efforts to eliminate illiteracy, and to provide high-quality education must be put in place as early as possible. The teaching of modern science has to be done by active scientists who read the current literature and are capable of conveying the latest advances to their students. As science and scientists play an important role in decisions made by governments, they must be involved in government

Stakeholder consultations

An essential part of the nurture of human capital in developing countries should be in-depth policy consultations with local, regional, national, and supranational stakeholders. These meetings would be opportunities for governments to communicate directly with local farm or industry cooperatives, primary, secondary, and higher education planners, and corporate representatives already located or considering location in the region.

Institutional development

If the North wants to solve the problems of developing countries, then consistent support should be given to the establishment of well-equipped and well-staffed institutions to carry out such research in the South. Without appropriate capacity to deal with problems of poverty, tropical diseases and other issues of developing countries, international collaboration cannot occur. Major items for this agenda include inducing policy makers to increase R&D expenditure in developing countries; stimulating research on S&T policy frameworks in developing countries, to be carried out in industrialized countries; strengthening research networks by involving developing countries; preparing case studies on successful R&D models; understanding factors that can stimulate entrepreneurial spirit and high-tech innovations in developing countries; identifying a public policy agenda that can support high technology clusters; inducing enterprises to work with labs, universities, and research institutes to form technological alliances; and understanding factors that make technological alliances successful and make firms learn rapidly.

Efforts at collaboration should not be domains exclusively of trained experts, but also gender balance and other efforts to include stakeholders should be made. Institutionalization of R&D entails various knowledge-based activities – from discovery to adaptation, adoption, and use – especially in agriculture.

Financing research and development

One major goal should be that developing countries contribute at least modest amounts of funding to R&D. It is important to highlight successes where political leadership exists to put this issue at the top of the national agenda.

Numerous real-world examples have been clarified of successful generation of greater public and private funding for science and technology. If a country is serious about S&T, it must rationalize distribution of funds in this direction. Certain developing countries have committed themselves to

high levels of S&T spending. Others have not. Other capacity-building strategies are already underway, with clear implications for further financial benefit in the countries of such activity. Efforts like these can provide important channels for collaborative funding by agencies in developed countries involved in parallel initiatives there.

5.3 International partnerships

There are, however, areas where industrialized countries could adjust their R&D patterns of funding and of technology transfer to reflect developing country concerns. The choice of these areas will be influenced by the existence of mutual interest. A wide range of international obligations involving technology cooperation provides a starting point in exploring such opportunities. Bilateral arrangements between nations also offer additional opportunities to both partners. Partnerships with industrialized countries should be complemented by cooperative measures among developing countries, possibly starting with regional arrangements.