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Technology, Development, and the Role of the World Bank

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Technology, Development, and the Role of the World Bank

by
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Abstract

Knowledge and information are increasingly becoming the key factors of production and exchange, and this has major implications for developing countries and for such international development institutions as the World Bank. Technological innovations are so numerous and radical that they are deeply affecting competition, social organizations, institutions, materials, and even life itself. Driving this rapid change are dramatic improvements in information and telecommunication technology, aided by advances in the tools of scientific inquiry and in the codification of knowledge.

The most immediate consequence of these developments is to increase the speed of production and product development. This in turn is leading to a revolution in business practices. Time and speed are now more central to competitive success, providing an advantage to producers with the best links to the markets and the greatest flexibility. In addition, the continuing rapid decline in the costs of transporting information and goods due to advances in telecommunications and the use of information technology have led to the growing irrelevance of the boundaries of geography and even of time, unifying national economies in a fast-moving, highly interdependent world economy.

This paper explores whether the quickly-changing, highly technical global economy presents a threat or an opportunity to developing countries. It discusses how developing countries acquire technology and how they can make effective use of technological innovations. It concludes with an overview of what role the World Bank has in supporting its clients in their attempts to create and nurture a climate conducive to acquiring and developing technology.

Contents

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The innovations are so numerous and radical that they are deeply affecting competition, social organizations, institutions, materials, and even life itself. Driving today's rapid technological change are dramatic improvements in information and telecommunication technology, aided by advances in the tools of scientific inquiry and in the codification of knowledge.

In electronic information processing, performance per unit cost has doubled every two to three years since the start of the computer revolution. In the life sciences, the increased ability to measure, analyze, and model living processes allows much greater efficiency in diagnosing and attempting to respond to illness as well as opening new possibilities to agriculture. There has also been an accelerated development of new materials, and rapid gains in the efficiency of traditional materials use. Even more traditional technologies, such as steel-making and metal-working, are undergoing substantial change, with information technology used both in new product development and in manufacturing processes.

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of the boundaries of geography and even of time, unifying national economies in a fast-moving, highly interdependent world economy.

Threats to Developing Countries — or Opportunities

The acceleration of technical change can be a threat to developing countries or provide opportunities. First, the threat. The development of new materials — and continuing increases in materials efficiency — will constrain demand growth for significant less-developed country (LDC) export items, such as cotton, jute, copper, and sugar. The systematic application of bio-engineering could result in the development of attractive substitutes for coffee and cocoa within ten years. Automation is also reducing the share of direct labor in production cost: in textiles, for example, the share of direct labor has fallen from 30 percent of production costs to as low as 3 percent in the newer automated lines. At the same time, because production processes have higher fixed costs, the ability to make efficient use of capital — for example, by minimizing break-downs and ensuring efficient repair — becomes a more central element of competition than is the cost of unskilled labor. With shorter product life cycles, it is the differences in efficiency in the production cycle, rather than wages alone, that determine the costs of bringing products to markets.

Now, the opportunity. The capacity of the developing economies to absorb new technologies is greater now than it has ever been due to the continuing rise of educational levels and to the younger and more adaptable populations. Many developing countries are also better integrated than before into the advanced science and engineering education systems of the most technologically-dynamic countries. Added to this are ongoing improvements in production and

design knowhow obtained through prolonged experience of working with and for export markets and multinational enterprises.

Advances in telecommunications and informatics are globalizing labor markets and permitting workers from developing countries to export service inputs to production processes in developed country markets, as illustrated by teleporting from the Caribbean and the software industry in Bangalore, India. In the Sudan, the use of satellite remote sensing after the 1984 drought allowed the government to assess the acreage and conditions of crops. In Kenya, the establishment of horticultural research centers and extension services was instrumental in stimulating the growth of the horticultural sector. In Zimbabwe, the national university is beginning to tap into the global knowledge base through television courses from developed countries.

More than by just spurring economic growth, technology can do much to reduce poverty and environmental damage. It can increase the supply of food and reduce morbidity and mortality, particularly in Africa. It can also increase the supply of water and reduce the intensity of its use in production. And, it can lower the costs and increase the supply of energy to the poor.

Acquiring and Making Effective use of Technology

In the continuous process of catching up to best practice in technology, developing countries face three main tasks. The first is to reduce the gap between best local practice and best international practice. In so doing, developing countries have to develop efficient ways to acquire foreign technology. The second is to reduce the gaps between best local practice and

average practice in a country's use of technology. This means developing countries need to develop networks, institutions, and human capital to support the diffusion of technology. The third task involves not only knowing what technological advances are occurring, but also tailoring them to the particular needs and circumstances of the country. Besides plugging in to international networks of researchers and tapping foreign technology, this requires developing the local technical human capital to take advantage of the new potential.

Developing countries acquire technology in many ways:

- imports of capital goods and components;
- design specifications and technical assistance from foreign buyers;
- foreign technology licensing;
- direct foreign investment and strategic alliances;
- foreign education and training;
- local research and development (R&D) efforts.

The technology that developing countries acquire through the first five channels dwarfs what they obtain from their own R&D.

The first two trade-related modes — imports of manufactured products and design specifications and technical assistance from foreign buyers — are the most important. Developing countries' manufactured imports from the OECD countries account for 11 percent of their GDP, and roughly half of those imports are capital goods. Their manufactured exports to OECD countries account for 7 percent of their GDP. Many of such exports are made to foreign design specifications and involve technical assistance from the buyers.

Foreign technology licensing is a much smaller percentage of developing countries' GDP, though it has been increasing not just for LDCs, but for all countries. This is a reflection of the increasing importance of global knowledge flows.

Direct foreign investment has also been increasing, with the greater globalization of the world economy. Such investment transfers not only capital but also technology, management, access to global networks of information, and access to markets.

Foreign education and training are harder to quantify, but they have become exceedingly important ways to acquire knowledge and technology. In the technical areas of higher education in the U.S., for example, half the students are from developing countries. Many of them eventually return to their home country or become part of an overseas network that can be a very valuable source of information to their home country for markets and technology.

Local R&D, besides being relatively small, is most often not such a useful source of technology. It generally is too academic or poorly funded to have much impact on the needs of the productive sector, except perhaps in agriculture, where there is a longer tradition of applied R&D work and extension services, much of it linked to international programs.

In 1991, the OECD economies spent about US$400 billion on R&D (roughly 2.5 percent of their GDP). The rest of the world (excluding the former Soviet Union) spent about US$16 billion on R&D, roughly 0.4 percent of GDP. The OECD countries therefore outspend the developing countries by a factor of 25. Individual R&D spending by some of the large multinationals is greater than the total national R&D budget of the even the largest developing

countries. As a result, developing countries need to become very efficient at making good use of foreign technology.

The most important way the LDCs get access to technology is through global linkages — transactions occurring mainly between private parties, rather than governments. This means that developing countries that want to take advantage of the potential of the rapid technological development in the advanced countries need to strengthen their links to the global economy. Most of this will be with private firms. This has implications for the policy and regulatory environment, technological support infrastructure, and human resources that developing countries need to put in place in order to take advantage of technology potential.

Creating a Policy and Regulatory Environment Conducive to Technological Upgrading

Four policy areas are critical:

- *A policy and regulatory environment that promotes rapid diffusion, adoption, and efficient use of new technologies.* This includes the promotion of lively competition as affected by the exchange rate and the trade regime as well as through a country's policy on anti-trust and domestic competition. Without strong internal and external pressures to lower costs, improve quality, and keep up with new products because of strong competition, there is no strong incentive to adopt more efficient new technology and organization.

- *Removing restrictions on foreign technology imports.* A key element of a developing country's technology strategy is to acquire foreign technology cheaply and effectively

and then to adapt it to local conditions. Developing countries that want increased access to foreign technology thus need to remove restrictions on formal arms-length technology import transactions, such as foreign direct investment (FDI), technology licensing agreements, technical assistance, and imports of capital goods. Imports of foreign technology should be seen not as substitutes for local development, but as complements.

- *Encouraging greater participation in world trade.* There is compelling evidence that exporting is an extremely effective source of learning. This highlights the importance of removing barriers to exports, such as tariffs on inputs, overvalued exchange rates, or inefficient transport and communications. There is also a need for export support institutions to provide information on foreign markets, on international product design and process change, and on export finance.

- *Facilitating foreign contacts.* Much technology is transferred through informal means — copying, reverse engineering, reading technical journals, attending foreign conferences and trade fairs, or hiring foreigners with specific technological expertise. Therefore policies should not hinder foreign travel and other contacts with foreigners and foreign goods and services.

Developing Local Technology Support Infrastructure

To help in the effective use and diffusion of technological information, it is necessary to develop networks and institutions that can tap into information about technology and market

trends both worldwide and locally. Many of these institutions require government action to get them started or to help them develop ahead of the market. Some of the key institutions are:

- technological information centers;
- technological extension services;
- productivity centers;
- metrology, standards, testing, and quality control;
- research and development.

For most developing countries, it is more important to focus on supporting the acquisition, assimilation, adaptation, and improvement of technology obtained primarily from abroad, rather than to do basic research. Enterprises in developing countries also need to be encouraged to initiate more technological projects. The cumulative productivity impact of small incremental changes — usually undertaken on the shop floor and in the R&D labs of productive firms — can contribute much more to an economy's competitiveness than the work in public R&D labs and universities. But there is also a need to foster closer interaction between universities, research institutes, and firms to stimulate the development of new knowledge as well as to speed the application of that new knowledge in the productive sector.

Investing in Human Resources

Investing in human capital is critical for taking advantage of the potential of new technology. In economies with inadequate basic skills, the overwhelming need is to achieve universal literacy and numeracy. Even in these economies, however, the more dynamic firms — if they are to grow — must draw on high-level technical capacities in managerial and product-

process development positions as well, as on such intermediate occupations as foremen. The Asian economies highlight the contribution of university training in science and engineering to growth.

Besides increasing investments in education there is a need to take advantage of advances in education technology to improve the way knowledge is transmitted and schools are organized. In addition, educational systems have to be redesigned to support the permanent retraining of the labor force, which has become necessary to meet the needs of a changing economy.

What This Means for the World Bank

As its clients intensify their links with the world economy, the Bank will have to assist them in the three areas identified above. It will also have to act as a catalyst or connector to help developing countries plug into the information-rich global economy.

Strengthening What the World Bank Already Does

In all of its work, the Bank needs to strengthen its focus on technology to ensure that its client countries do not fall behind in taking advantage of technological opportunities and in meeting the demands of the fast-moving, highly interdependent global economy.

Sector work and policy advice. In its economic and sector work, the Bank needs to go beyond the macroeconomic and general incentive regime to develop a better understanding of each country's technology problems. Countries need to refine economic policies affecting the

choice, use, and diffusion of technology. They also need technology policies, including those for direct foreign investment, technology transfer, intellectual property protection, and the incentives for local R&D. They also need technological infrastructure — information services and technological extension, norms and standards setting and testing institutions, and research and development institutions. Above all, they have to develop technical human capital through formal education and in-service training.

Sectoral projects. At the most general level, Bank-financed projects involve the *choice of the technologies* and the mobilization of local technological capacity to undertake the project. The Bank is *de facto* one of the main technological institutions catering to the needs of the developing world. However, it has not explicitly planned or recognized that role. Performing that role well requires knowledge of technological alternatives and local needs to ensure that technology choices fit the local environment and are sustainable. For example, the World Bank needs to be up-to-date on new developments in biotechnology and integrated pest and soil management in designing an agricultural project for the specific soils and climatic conditions in any one of its borrowers. To do this well, the Bank needs to keep abreast of the main technological, marketing, and investment trends taking place in today's very dynamic world. This is important not only for the viability of the projects the Bank supports in different sectors, but also for its policy advice in agriculture, human resources, energy, industry, infrastructure, environment, and technology.

The Bank is not very well organized to monitor and assess most of these new trends systematically. To remedy this, it should tap into information networks and develop informal networks with people in organizations that monitor trends.

At a more specific level, the Bank supports technology more directly through *projects primarily focused on technology-related infrastructure.* Most of these have been in agriculture. For example, the Bank has financed many projects for the establishment or improvement of agricultural research and extension institutions, and for explicit technology dissemination, such as the "training and visit" system. In industry, its activities have been limited primarily to creating specialized institutions for loan financing of technological development (Israel, Spain, Korea, Mexico, Hungary), though more recently they have also included financing metrology norms and standards (Turkey), restructuring of R&D institutes (India and China), and venture capital for technology development (India). In education, its activities have consisted of financing public R&D facilities (Brazil, China, Korea, Portugal) and science education (Brazil, China, Indonesia, Philippines, and others).

There has been little coordination among the different institutional, human capital, and policy aspects of the Bank's work to promote development of technological capability, efficiency, and competitiveness. In addition, there has been relatively little "cross-fertilization" between projects. Since the information, incentives, and the ability to respond to these incentives are so closely intertwined, a more coordinated approach would be more effective. In addition, the Bank needs to do more in financing technology support infrastructure other than R&D — metrology, standards, quality control, technological information, and productivity centers — and go beyond financing formal education to financing firm-led training and skill upgrading.

Technical assistance. In 1991, the World Bank provided about US$1.9 billion in technical assistance, most through project lending and the rest through free-standing technical assistance projects. The Bank should be able to increase its technical assistance for institution-

building and training in technology, and a large part of that could probably be financed by tapping external funds. Total technical assistance, including technical assistance grants, loans and loan arrangements from other members of the Development Assistance Committee of OECD as well as from regional development Banks, IMF, and the U.N. agencies, was about US$20 billion.

Research. To be effective in helping countries take advantage of the potential of technology and technological change, the World Bank has to improve its understanding of the roles these have in economic development. Research shows that incentives must stimulate enterprises to pay attention to quality and efficiency and to respond more effectively to changing demand and supply for goods, services, and inputs. But there is little understanding of how to improve the capacity to respond to those pressures and incentives in different settings and overcome the key bottlenecks. In addition, many questions remain on the most effective mix between government-sponsored efforts and privately-sponsored efforts to speed the development of some of these capabilities, and on how long they take to develop in different socio-economic circumstances.

The World Bank also needs to contract and carry out economic research and policy work on selected new technology areas of particular relevance for the Bank and its clients. For example, this type of work should be undertaken for the area of teleporting (the remote provision of services), which is opening up employment opportunities for labor from developing countries in activities ranging from data input and monitoring to software development.

Tailoring Bank actions to the specific situations of countries. A critical element of the Bank's strategy to support the capacity of developing countries to make more effective use of

technology is to tailor its advice and operations to the specific needs of each country. The problems and needs of the upper-middle-income and larger economies — such as Brazil, Mexico, and Korea, which already have large industrial sectors and significant technological capability — are very different from those in small, low-income economies — such as Guinea-Bissau, Laos, Ethiopia, Haiti, and Nepal, which are still dominated by traditional agricultural technologies and have very underdeveloped technological capability and technical human resources. In addition, the problems of economies undergoing transition to market systems such as China, Russia and other former Soviet Republics, are different in that often they already have good scientific and technological capability. For these countries, some of the key needs are redeploying that capability toward the needs of the productive sector and helping develop market-type incentives and institutions.

The following preliminary agenda shows what some of the main priorities might be for three types of economies, tailored to the specific conditions of each country.

Least Developed Economy

- Building up basic technical human capital skills.
- Building up basic technological support institutions, such as testing and technical information and extension centers through twinning arrangements with foreign counterparts.
- Promoting foreign linkages through subcontracting arrangements.

Transition Economy

- Restructuring public R&D institutes toward the needs of the productive sector.

- Promoting foreign study tours along lines of historical experience of technical assistance component of the Marshall Plan.
- Promoting greater foreign linkages, such as foreign direct investment, joint ventures, and strategic alliances.

Middle-income Economy

- Promoting standards, metrology and quality control institutions and procedures.
- Supporting productivity centers to help diffusion of technology to small and medium enterprises.
- Developing equity-type financial instruments to support growth of technology-based firms.

Making the World Bank a Connector in Today's Information-rich Global Economy

Technology development is central to the three primary objectives of the Bank — economic growth, poverty alleviation, and environmental sustainability. The main advantage of the Bank over other institutions is that it can provide comprehensive packages to countries — packages of policy action, technical assistance, and finance for institutional and human resource development. The Bank can also draw on its rich cross-country experience in recommending comprehensive technology development programs going beyond the purview of a single country.

More fundamentally, the greatest potential of the Bank is as the connector between knowledge and technology agents — among and within developed and developing economies. Some examples of specific initiatives that can be started immediately are the following.

Working with others to revolutionize education technology for development. Advances in education technology hold much promise for educational attainment and poverty reduction in the poorest countries. Recent rapid advances in interactive computing and telecommunications could radically reduce unit costs and increase quality, particularly in the poorest and more isolated countries, and at all educational levels, including basic and technical education. With present unit costs and quality of teachers, many developing countries still cannot afford to offer primary education to all. At the higher levels, the prospect of a globally interconnected network of university teaching and research is already possible. This is already causing profound changes in the way universities/research institutions are designed and managed. Particularly in Africa, this could result in a quantum leap in both quality and quantity. Much remains to be done to improve the economic feasibility of these propositions, but the payoff could be enormous.

Catalyzing world efforts to address specific problems. The Bank is in a position to serve the world by catalyzing the money, know-how, and institutional capacity to help solve problems of growth, poverty, and the environment. In the past, the Bank has been very successful in activities to mobilize world financial and intellectual interest to make possible long-term research efforts. An example is the Consultative Group on International Agricultural Research (CGIAR), which helps to finance international agricultural research centers. In these cases, the Bank did not itself do the details but forged strategic alliances with the best institutions in the world which executed parts of the solution.

The Bank should consider expanding these types of initiatives into other areas where there are strong global externalities, like the environment, or some specific technology initiatives. Such initiatives could overcome the lack of awareness of the problem or market

inducements too weak to marshall the resources needed to address the problem. For example, the Bank is supporting a solar energy initiative. It aims to commercialize the use of various technologies that use this abundant and environmentally attractive resource with enormous economic potential for developing countries. In initiatives of this type the role of the Bank is to leverage its efforts as a catalyst, connector, and disseminator rather than as direct financier, since the direct financial resources that it can allocate are limited.

Developing partnerships with other technology-related institutions. The Bank does not have the resources or the skills to keep up to date with the rapid development of new technologies. As a result, it needs to do more to develop partnerships with other technology-related institutions that can help it keep abreast of new developments. An example of such a partnership being developed is with the National Research Council (NRC), the research arm of the National Academy of Sciences, the National Academy of Engineering, and the National Institute of Medicine. Through its network, the NRC can mobilize scientific and technological expertise to address the state of the art in almost any area of science and technology. Developing partnerships with such institutions can help the Bank keep abreast of rapidly-advancing developments and also increase awareness among the scientific, engineering, and medical communities of some of the specific problems facing developing countries.

Helping developing countries plug into the global technology and information market. The most remote countries can now be connected to knowledge and data banks — wherever they are and at rapidly falling costs — enhancing their competitiveness and helping them bridge the knowledge gap. The recent unexpected and rapid spread of the Internet worldwide, including in Africa, is an example of how quickly information is becoming accessible in poor countries. Given the tremendous information potential offered by such networks, the Bank is exploring

ways to reduce the costs and facilitate the access of poor countries to the knowledge and data banks around the world. Interconnection is not enough, however. The key to this is providing the right combination of telecommunications hardware and software along with the people who can use them effectively. The users have to know what to ask for and how to search efficiently in the myraid data bases.

Because much of the knowledge of the development process resides in the minds and files of experts, another possible initiative could be to begin capturing what people in the Bank and in other development institutions know about the many aspects of development and to make that knowledge available in digital form on line, on disk, and on CD-ROM through a digital economic development intelligence service. That service could support resource centers to make information on useful techniques and technologies accessible to developing countries, and distribute entry tools for access to the world's electronic databases.

There is a tremendous opportunity for the Bank to mobilize international efforts to make good use of technological advances for global development. But the task facing the Bank goes beyond programs specifically focused on developing and deploying new technologies. Instead, the Bank must ensure that in each area of its work, the scope for innovation in enhancing the development process is fully exploited.

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