

# GLOBALIZATION OF TECHNOLOGY: ISSUES IN TECHNOLOGY TRANSFER AND TECHNOLOGICAL CAPABILITY BUILDING

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## Summary

Since the 1980s, a number of changes have taken place in the economic, political, and social spheres worldwide, creating a relatively more interdependent world. This process, which is labeled “globalization,” is mainly driven by two factors: the liberalization of economies worldwide and the emergence of new technologies, where the latter act both as a driving force and an enabling factor. Globalization is opening up new windows of opportunity for countries and firms to catch up with the leaders, but at the same time it also poses several challenges in terms of entry barriers. While some developing countries have been able to integrate themselves with the global economy and catch up with the more advanced countries, many others have failed to overcome the challenges and feel marginalized.

Today, the global economy is mainly characterized by “competition.” The liberalization of economies has opened up previously protected domestic markets, making competition a global issue. The emerging new technologies, such as information and communication technologies and biotechnology, have not only created new products, but through their diffusion have also changed the characteristic features of traditional products. The new technologies have a close proximity to basic sciences and the development of some of these technologies does not require much previous industrial

experience or huge capital investments. This has given an opportunity to countries with adequate pools of scientifically and technically trained people to increase the pace of their industrialization. At the same time, many innovations in technologies are occurring through inputs from different disciplines of science, compelling companies to form alliances with other firms and/or universities in their research and development activities. As a result, technology has become a key factor of competitive advantage both for nations and firms. This importance of technology has also changed the patterns of technology transfer and has implications for technological capability building, particularly in developing countries.

The main objective of this essay is to guide the reader through the global trends in different aspects of the economy and society in an integrated manner for a better understanding of the impacts of globalization. The essay is expected to help the reader in understanding how the technological changes are leading to restructuring of economies and societies world-wide and what implications such changes hold for less advanced economies and societies. The text illustrates the issues with appropriate examples where necessary.

This theme paper, which addresses the issues covered under it at a broader level, is organized as follows: Section 1 introduces the theme and identifies the issues for exploration. Section 2 describes the dynamics of the global business environment, setting the background for the specific issues to be addressed by the individual papers under the theme. Section 3 examines the characteristics of the new technologies, i.e. the new techno-economic paradigm, and analyzes the opportunities and challenges they provide for developing countries to catch up with the industrialized world. Section 4 presents the salient features of the knowledge networks that are formed by the enterprises in order to develop new technologies and meet the global competition. Section 5 discusses the successful condition for technology transfer and absorption. Section 6 examines the societal implications of globalization of technology. Section 7 concludes.

## **1. Introduction**

Since the 1980s, a number of crucial changes have been taking place in the economic, political, and social spheres, creating a relatively more interdependent world. This process, which is labeled “globalization,” is seen as offering unprecedented benefits, leading to enhancement of welfare to people worldwide. This process has opened up windows of opportunity for several countries to integrate themselves with the more advanced economies. Simultaneously, some countries feel that the globalization has marginalized them by creating several new barriers to entry into the world markets, the most important of such barriers being technological capabilities.

The characteristic features of international economic transactions have changed considerably, during the last two decades, mainly because of two factors: first, the liberalization and opening up of economies worldwide; and second, the emergence of new technologies which enabled as well as compelled the shift towards globalization.

The liberalization of economies has brought about several changes in trade, investments and technologies. Traditionally, international trade involved several different agents and consumers located in various countries creating economic relationships between them. But now much of the international trade takes place between the affiliates of the same firm (intra-firm) and between firms (inter-firm). This pattern of trade is creating internationally integrated production networks by facilitating new ways of organizing industries. The flows of foreign direct investment (FDI) and portfolio investments are facilitating the geographical spread of location and ownership of enterprises among countries. This has significant implications for technology diffusion and transfer to developing countries and the process of technological capability building in those countries.

The emergence of new technologies is acting both as a driving force and an enabling factor to globalization. The pattern of innovation shows that the development of new technologies requires input from several different disciplines. At the same time, these technologies are changing rapidly, shortening the product life-cycles. In combination, these factors are increasing the research and development (R&D) costs for companies, compelling them to recoup their investments as quickly as possible by diffusing their products and/or technologies in geographically wider markets. Rising technology development costs also call for cost reduction in other areas of operations. Consequently, companies are seeking to locate specific activities in the locations best suited for such activities, leading to a global division of labor. The new technologies are also facilitating such reorganization of operations by companies. For instance, the new information and communication technologies (ICT) allow companies to deploy resources and operations on a global scale and at the same time maintain central control. It is now technically feasible to build up reliable information and communication networks linking the headquarters of a company with its affiliates, suppliers, customers and even competitors worldwide. As a result of these forces, the new technologies have opened up opportunities for some developing countries or latecomers to industrialization to integrate themselves with the global economy.

At the same time, the new technologies have significantly changed the way the industrial activities are organized and the skill requirements for participation in the production. In other words, the new technologies have also brought about changes at the societal level in general. In combination with the liberalization, they have also changed the context, the conditions, and the channels under which technologies are diffused or transferred. These pose challenges for technological capability building in developing countries or latecomers to industrialization. They have to face up to issues such as which types of technologies to focus on, how to go about acquiring advanced technologies, which type of policy and business environment leads to successful industrialization and economic growth, and so on.

The main aim of this theme is to examine the driving forces behind the globalization of technology and its implications for technology transfer to, and technological capability building in, developing countries. The theme examines several specific issues, such as the new techno-economic paradigm and latecomer industrialization, global knowledge networks, foreign direct investment and technology transfer, and the social effects of globalization of technology.

## 2. Dynamics of Global Business Environment

The global business environment is changing continuously and rapidly, making it challenging for firms to operate in such an environment. The key driving force behind such a fluid environment is “competition.” With the liberalization of economies, competition has now become global and rapid technological changes are increasing this competition.

Technological change has had an effect on the pattern of international trade. The new production technologies, such as the resource-saving innovations, material substitution, and improved process technologies, have led to declining raw material-intensity of the final products. This has resulted in a slower growth or even a decline in international trade of raw materials, including several ores and metals, and also decreasing prices. For instance, as Sanjaya Lall (1998) estimated, the proportion of primary product exports in total world exports declined from 23 percent in 1980 to 11 percent in 1995. Several developing countries depend on export of these products. New technologies have also affected trade in manufactured goods, with the technology-intensive products becoming the most dynamic among them. For instance, the proportion of the resource-based manufactures in the total world exports of manufactured goods declined from about 24 percent in 1980 to 18 percent in 1995. At the same time, high technology products, such as electronics and electrical goods, have increased their share from about 14 percent in 1980 to about 23 percent in 1995.

During the period 1980–95 developing countries registered faster rates of growth in exports than industrialized countries in all product categories. Much of this can be attributed to the relocation of labor-intensive activities in high technology production to developing countries by transnational corporations (TNCs). But a significant part of it was also due to the expansion of indigenous technological capabilities in a few developing countries. Some developing countries, especially those in the east and south-east Asian region have successfully transformed themselves to exporters of high technology products, so much so that some of their firms have now become competitors to firms in the industrialized countries.

Today there is a group of countries that is successfully integrated into the globalization process and has derived the full benefits of it. At the same time, there is another larger group of countries that is marginalized from global economic developments and is facing uncertain prospects for the future. What are the characteristic features of this globalization that opens up opportunities for some and creates barriers for others? To what extent are the new technologies responsible for integration and/or marginalization of countries?

Technological developments and liberalization of economies during the recent decades have resulted in the creation of more unified markets in which companies are compelled to derive global-scale economies to remain competitive. As Levitt (1983) pointed out, the needs and preferences of consumers worldwide have become more homogenized, leading to the standardization of products, manufacturing and trade. Technological developments in the fields of communication and transport have opened up even remote and poor areas to witness the socio-economic changes that are taking place in the world.

Consequently, people in even those remote areas aspire to possess the same modern amenities and high quality goods that advanced economies have access to, which in turn is leading to the emergence of global markets for standardized consumer products. This has far-reaching effects not only on the economic conditions of these countries, but also on the social and political aspects.

As Bartlett and Ghoshal (1991) suggested, radical innovations also brought changes in industry economics and allowed companies in several industries to develop and manufacture products on a global basis. Quartz technology, for example, has transformed watch making into a scale-intensive global industry. In some industries that were not affected by external forces of change, companies started attempting to achieve global economies, by rationalizing their product lines, standardizing parts, and specializing their manufacturing operations. Such internal rationalization of operations led to a second wave of globalization in a range of industries such as automobiles, office equipment, industrial bearings, construction equipment, and machine tools. Even in culturally sensitive products, such as food and beverages, the success of companies such as Nestlé, Coca-Cola, and McDonald's shows that global markets do exist.

However, global competition became much more complex in the 1980s. A growing segment of consumers started favoring differentiated products and services, thereby creating opportunities for enterprises willing to meet such demand patterns in "niche" areas. To cater for such groups of consumers, some companies began to develop differentiated products across markets, while protecting their global scale economies. The new production technologies in the form of "flexible manufacturing systems" have enabled companies to cater to such complex demand patterns without losing the scale economies.

The globalized basis of competition has created a need for the development of new products and improvement of existing product lines on the basis of the distinctive characteristics of national markets and production environments that may require local adaptive work. This calls for greater worldwide learning and innovation. In a period of rapidly changing technology and shortening product life-cycles, a company's ability to develop and successfully commercialize innovations has become a key competitive strength.

The convergence of consumer preferences and the diffusion of technologies worldwide have led to changes in the pace and the location of innovation. According to Bartlett and Ghoshal (1991), companies based in industrialized countries can no longer assume that their domestic environment provides them with the most sophisticated consumers and the most advanced technological capabilities, and thus the most innovative environment in the world. Today, the newest consumer trend or market need may emerge anywhere in the world and the technologies to meet such demand may be located in some other country, including those in the developing world. Companies see that they can gain competitive advantage by sensing needs in one country, responding with capabilities located in a second, and diffusing the resulting innovation to markets around the globe.

The emergence of new pervasive technologies, in particular microelectronics, information and communication technologies (ICT), biotechnology and advanced

materials, have added another dimension to the business environment. They are diffusing rapidly through the creation of new products, processes and services leading to productivity improvements and new work practices. Further, incorporation of these technologies is also changing the characteristics and performance of many conventional products and processes. For example, today microelectronics have become key components in many traditional products such as automobiles, washing machines and ovens, improving their performance.

Such pervasive influence of new technologies, in turn, has a number of implications. First, the development of these technologies requires inputs from a diverse range of disciplines, crossing the traditional boundaries between scientific and technological disciplines and categorization such as basic research and applied and development research. For instance, in the field of high-temperature superconductors, basic research is being done with a view to commercial applications in the future. Similarly, in some areas of biotechnology, significant progress in applications will not be possible without breakthroughs in the understanding of basic biology and biochemistry. This means that there is a need to improve the interface between basic research on the one hand and development work on the other, basically arising from the increasing complexity, cost and time taken to generate innovations. As a result, the R&D activities, which were traditionally performed in-house within a company in a secure environment, may now need to be performed in collaboration with other organizations, either universities or other firms. Second, such organizations with specialized knowledge may be located outside the home country of a firm, leading to globalization of not only marketing and production functions, but also R&D activities.

Third, the increasing R&D costs, coupled with shortening product life-cycles, have compelled firms to recoup their costs as rapidly as possible, while still retaining their monopolistic positions. Therefore, firms have started launching their new products in as wide a geographical market area as possible, including the developing world, leading to rapid international diffusion of technologies.

Fourth, the increased R&D activities are also increasing the demand for R&D personnel and there has been a shortage in supply of such personnel in some industrialized countries. Consequently, as Prasada Reddy (2000) showed, R&D activities, although still largely concentrated within the industrialized world, are also being located in some developing countries. Such relocation also helps in reducing R&D costs in view of the lower salary levels in developing countries. Technologically this has become possible because of the proximity of new technologies to the basic science, which permits even those who lack industrial experience to participate in technology development activities. This leads to further diffusion of technologies to developing countries and opens up opportunities to them to upgrade their skill levels.

Fifth, these developments have placed the protection of intellectual property at the forefront of the discussions on trade and investments. Concerned about losing their competitiveness, if the technologies of their firms are allowed to be imitated, countries have even negotiated an international framework for the protection of intellectual property rights in the form of the Agreement on Trade-Related Intellectual Property Rights (TRIPS) under the World Trade Organization (WTO).

Last, the transformation of industrial production into technology-intensive activities and the need to achieve global scale economies have provided greater advantages for large transnational corporations to compete. As a result, in several crucial industries, today the competition takes place between a relatively small number of large firms which are oligopolistic in a geographical area that includes the markets in the industrialized as well as developing worlds. However, the picture for small firms, especially those located in developing countries is not discouraging. The new technologies also open up several areas of application and product development that have lower resource requirements. The experience of newly industrialized countries suggests that it is not necessary to generate technologies, but just that the application and effective utilization of new technologies can help firms to compete successfully in the global markets.

Due to such a dynamic business environment, competitiveness is continuously and quickly shifting among firms and countries, challenging and threatening those that are well entrenched with advanced capabilities in conventional technologies, while at the same time propelling some others, including some developing countries, into the forefront of the competition.

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