

TECHNOLOGY TRANSFER: VEHICLES, CONDITIONS, SPILLOVERS, AND POLICY CHALLENGES

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Summary

This paper reviews recent theoretical and empirical literature to underscore the main vehicles of technology transfer from developed to developing countries, as well as the conditions for, and results of, successful transfer. Based on this literature, the paper conducts a cross-country examination of the conditions for successful transfer and relates these to welfare and technology output indicators in the context of these vehicles. The main finding is that host countries with high absorptive capacity, such as those in East Asia, tend to attract more technology inflow, which, in turn, lead to high technology output and welfare performance. Past success, however, is no guarantee for the future. East Asian countries will need to pay greater attention to tertiary education if they wish to transit towards high-technology growth and become knowledge-based economies in the twenty-first century.

1. Introduction

With their vast reservoir of scientific knowledge and advanced technologies, it is not surprising that most of the new technology in the world is generated in the developed countries. The bulk of Research and Development (R&D) activities take place in the industrialized world, in developed countries. Most of the modern technologies are produced by multinational companies (MNC'S) in their home countries located in the developed world.

What are the vehicles through which these technologies are diffused across national borders from the developed (source) countries to the developing world? This is not an easy question to answer, as technology is often intangible, sometimes unobservable, and hence its transfer may not be easily amenable to evaluation. Furthermore, the means through which technology is diffused across borders are tremendously diverse and pose difficulties for effective capture. Be that as it may, there is a common agreement in the literature and among practitioners on some of the more common vehicles through which technology is diffused across borders. These include vehicles such as:

- a. foreign direct investment (FDI)
- b. licensing agreements
- c. joint ventures
- d. imports of machinery and equipment [capturing ‘machine-embodied’ technology]
- e. local contracts

The mere existence of a vast variety and diversity of diffusion channels in and of itself does not guarantee successful transfer of the necessary technology. Host country characteristics play an important role in determining the probability, nature, and scope of successful transfer, as well as in influencing its outcome. This raises important policy issues and challenges, which need to be carefully addressed by recipient countries keen on tapping into imported technology as a strategic weapon to leapfrog to a higher plane of development.

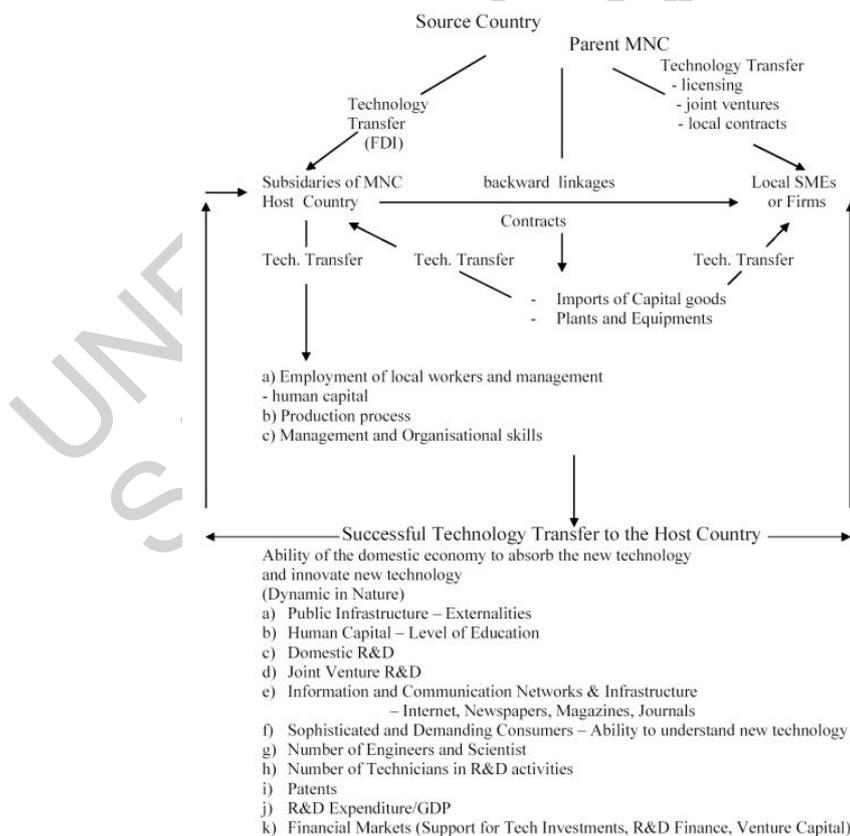


Figure 1. Sources of Technology Transfer from Multinational Corporations

This paper is organized as follows. Section 2 discusses the modes of technology transfer as well as the conditions for and results of successful transfer through a review of theories and studies. Based on this theoretical framework, an empirical investigation is carried out in Section 3 to determine the relationship between home country characteristics, especially absorptive capacity indicators, and the way these influence the outcome of transfer in the context of the various technology transfer vehicles. The discussion in Section 4 highlights certain policy issues and challenges which developing countries need to address in order to transit towards a high technology growth and become knowledge-based economies in the twenty-first century. Section 5 concludes the paper.

2. Modes of Technology Transfer and Outcomes of Successful Transfer

2.1. Modes of technology transfer

Figure 1 highlights the central role played by MNC'S in technology transfer through their operations in, or transactions with, foreign markets.

These operations/transactions can occur through the various avenues depicted in the figure, and may take the following forms:

a) Setting up of foreign affiliates

MNC'S may prefer to set up its affiliates in foreign countries as opposed to exporting their products and services to these countries in light of factors such as:

- i *the proprietary nature of the technology*: MNC'S would particularly wish to internalize the technology and prevent its appropriation by host country firms and competitors if the technology is new and has a long life span. This will enable the MNC'S to maintain control and ownership of the technology over a longer period of time. As has been pointed out, the incentive to set up affiliates is even stronger if the superiority of the new technology is also matched by superior knowledge and experience of the foreign market.
- ii *high cost of transactions for licensing*: This may be manifested through high costs of enforcement of agreements due to relative ease in leakage of technology to competitors and weak property rights in the developing recipient countries.

From the standpoint of the host country, foreign direct investment (FDI) also confers considerable benefits. Spillovers or technology transfer effects can flow from the MNC affiliates to the domestic economy through various channels, such as the training of local workers and managers by these affiliates. The domestic firms that subsequently employ these MNC-trained workers and managers become recipients of knowledge transferred from these entities. It has been pointed out that the managers of successful local firms in Latin America were previously employed by MNC'S.

The end result is that foreign direct investment (FDI) by MNC'S has contributed to technological capability building of many developing countries, such as Singapore, and

more recently Malaysia. Governments in these countries have set up joint technical training institutes with German, French and Japanese multinationals to train local staff. The Penang Skills Development Centre (PSDC) in Malaysia is a case in point. The PSDC was established in 1989 following consultations between the Penang Development Corporation (PDC) and the managing directors of several MNC'S operating in the state. Its primary mission is to provide specialized skills training to help firms upgrade personnel from production workers to technical specialists and technicians, though higher-level engineering courses are also offered.

It conducts short courses in a range of production operation and control skills, including the use of automated assembly equipment, and consults with firms on the design of in-house training programs. The Centre operates on land donated by the PDC and utilizes up-to-date equipment donated by or on loan from industry, as well as equipment purchased with government support.

It carries out bi-annual training needs assessments in order to guide the work of the curriculum development committees, which comprise its corporate members. The PSDC's rapid growth and favorable evaluation by its business members attracted the attention of the federal government, which in 1994 called for the replication of *industry-managed* skills development centers in each state. In 1995, a similar center was established with MNC participation in Selangor, and subsequently in other states such as Johor, Kedah, and Pahang.

b) Licensing

MNC'S would prefer licensing to overseas production if the barriers to entry into developing countries are very high. For example, entry barriers can operate if the foreign market is too small to warrant overseas production to achieve efficient scale in the integrated global operations of the MNC'S. It has been suggested that they would also prefer licensing of their technologies if they have little knowledge and experience of the foreign market. In some instances, MNC'S needing to incur high capital costs of investing in foreign markets will find the risks of such investments to be compounded even more if they have little knowledge of foreign markets. A third reason for choosing licensing would be if the technology has a short economic life span which yields little proprietary incentive to its owners, and licensing the short-lived technologies appear to be the best course of action.

c) Joint Ventures

As opposed to licensing, MNC'S can engage in joint ventures (minority or majority shareholders) for various reasons. One scenario for this to occur would be if the foreign partners are already fairly matured and have established some form of domestically-owned technology. In this case, the MNC'S may prefer to share its new technology with the local firms and spillovers can occur in both directions. A second reason is based on a risk-sharing motive. The risks of setting up foreign affiliates might be too high, and therefore the MNC'S may prefer to share this risk with local firms, especially if these local firms are already present in the domestic market. Furthermore,

the transactions cost of servicing the large domestic market could be substantially mitigated through cost-sharing with local partners in a joint venture.

There are a number of advantages underlying the formation of strategic alliances with domestic firms. Such benefits cover a wide range of areas including those arising from sharing of risk in R&D activities, sharing in the development cost of new products or technologies, better utilization of scarce qualified personnel in the domestic economy, sharing of marketing networks and channels within the domestic and global economy.

d) Imports of plants and machines

Another source through which technology is diffused from MNC'S to developing countries is through the latter's imports of plants and equipment from MNC'S in the source country. MNC'S from the source country can produce capital goods and export these capital goods to their affiliates or partners in foreign countries. However, the new technologies embodied in these capital goods will only produce significant positive spillover effects if the local firms have an adequate knowledge base to unbundle and learn from them.

e) Backward linkages

Other means or avenues for technology transfer are through backward linkages developed with the local firms. Effective technology transfer can occur when such backward linkages are sufficiently strong, thus allowing local firms to provide effective support for the operations of the MNC affiliates through local contracts.

To enhance the capability of local suppliers to provide effective support, the affiliates would teach the local firms new techniques in production, introduce new products, new management and organizational innovations.

A study of the electronics industry within East Asia, documented latecomer firms' dynamic progress along the learning ladder through subcontracting channels such as OEM (Original Equipment Manufacture), which later advanced to ODM (Own Design Manufacture), and then to OBM (Own Brand Manufacture). Such backward linkages allowed East Asian electronics firms to concentrate their learning firstly, in acquiring manufacturing skills, and then progress along the learning ladder to acquire design and new product development skills, and finally to developing R&D capabilities.

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