TECHNOLOGY AND TECHNOLOGY TRANSFER: SOME BASIC ISSUES

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Abstract

This paper addresses various issues relating to technology and transfer of technology such as technology and society, technology and science, channels and models of technology transfer, the role of multinational companies in transfer of technology, etc.
The ultimate objective is to pose the question of relevance of some existing models and ideas like technological independence in an increasingly globalised world economy.

Key Words: Technology, technology transfer, FDI, technological independence

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INTRODUCTION

In this paper we address basic questions concerning technology and transfer of technology. In Section I we discuss the nature of technology, technology and science and intermediate technology. In Section II, channels and process of technology transfer will be examined through a discussion of some traditional transfer models. Finally in the concluding section we offer a critique of these models.

SECTION I: TECHNOLOGY, SCIENCE AND SOCIETY

WHAT IS TECHNOLOGY?

Technology has been defined in various ways. While older definitions emphasise "technique" of production, more recent definitions are much broader in that they include marketing and financial management, for instance, in defining technology. We believe the reason for the broadening of the concept over the years has to do with the evolution of the capitalist system. We will come back to this point at the end of this section.

According to the Encyclopaedia Britannica 'Technology may be defined as the systematic study of techniques for making and doing things. The term itself, a combination of the Greek <u>techné</u>, "art and craft", with <u>logos</u>, "word, speech", meant in Greece a discourse on the arts, both fine and applied. When it first appeared in English in the 17^{th} Century, it was used to mean a discussion of the applied art only, and gradually these "arts" themselves came to be the object of the designation'. (EB V28, P451).

The Britannica goes on to assert that in the early 20th Century, technology included a 'growing range of means, processes, and ideas in addition to tools and machines' (Ibid. P451). Britannica continues by claiming that in the second half of this century technology came to be defined by terms like "The means or activity by which man seeks to change or manipulate his environment" (Ibid. P451). The discussion alone raises a number of interesting points and questions. First of all, although the gap between the 17th Century definition and Greek definition of technology seems enormous as we move from fine and applied arts to a narrower field of only applied arts, the development of information technology in recent years, in effect, has brought us closer to the more organic definition of technology that avoids the fixed opposition between production, craft i.e. "applied" and arts proper, i.e. "fine". Recent decades have witnessed increasing use of technology in all branches of fine arts, e.g. TV, film, animation, etc. A second point concerns the reasons for the narrower definition of technology in the 17th Century and, in fact, an even more restricted definition in the 19th Century, when as evident in, for instance, Marx's discussion about technology, where the latter is assumed to refer only to technology of production (process technology). The nature of industrial revolution and the pattern of industrialisation in England must have influenced Marx's concept of technology as he modelled his views of capitalist development on the English experience. The latter was unique in that it relied on the one hand on self-finance, e.g. family business and cheap labour (enclosures leading to Poor Laws) and on the other hand the position of the first comer in combination with a vast empire. The security of self-finance and a captive market combined with cheap labour led to a one-sided emphasis on production and neglect of financial and marketing management and quality control. The latter aspects have become increasingly important since the end of World War II which saw the decline of the British Empire and the British monopoly of industrial production and the emergence of the

US and EU and finally Newly Industrialised Countries. The post-war developments have created a more competitive environment in the world economy (Auerbach 1988). The questions of finance, marketing and quality control have become very important. This process did not start after World War II. By the end of the 19th Century British industry was eclipsed by the rise of American and German industry. The patterns of industrialisation in these countries were in sharp contrast to British experience. By the end of the 19th Century the US had acquired a continental market within its border partly due to land-grant schemes that created a rich farming community with a penchant for industrial goods. In Germany the state and investment banks played a major role. Also education played an important part in German industrialisation (Kemp, 1985).

A third point in Britannica's very definition of technology is 'The systematic study of techniques for making and doing things'. (Emphasis added). Normally technology is perceived as a collection of techniques, rather than the study of them. Here we encounter the boundaries of science and technology. We find an interesting definition of technique in J D Bernal's **Science in History**. According to Bernal, 'A technique is an individually acquired and socially secured way of doing something; a science is a way of understanding how to do it in order to do it further.' (Bernal, 1969, P47).

Bernal clearly distinguishes between technique and science, which is useful but ultimately mechanistic as the development of science itself depends on technological development in general and technologies of science in particular (e.g. various instruments, equipment and methodologies used in scientific research). Thus science and technology, just like art and technology (mentioned above) have become increasingly organically connected. Bernal's definition raises a further point about the relation between technology and society, to which we return in the next section.

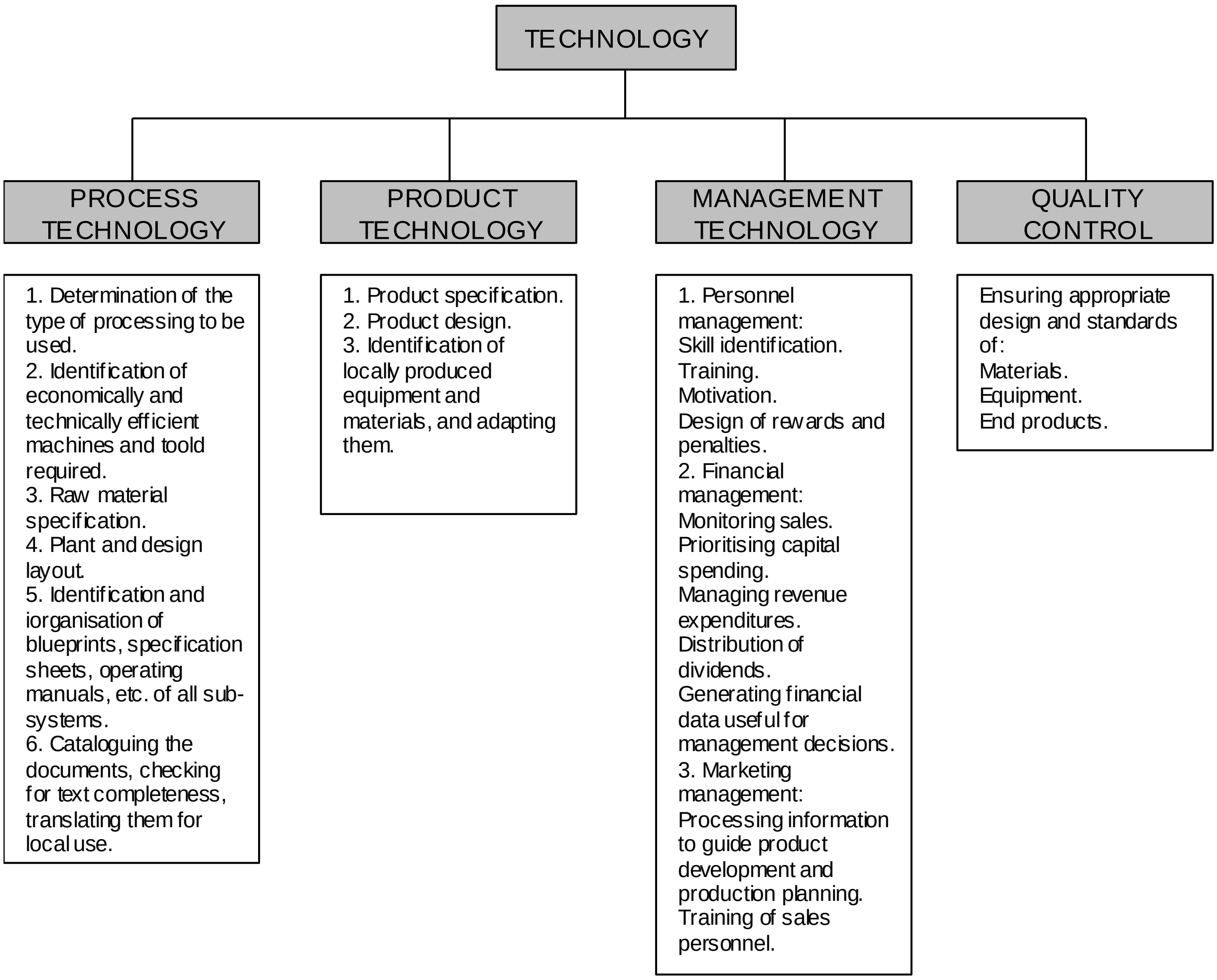
Today, a very broad definition of what constitutes technology has come into vogue as is evident in Chart 2.1 below.

In this chart technology includes not only process technology (the narrow and traditional view of technology) but product technology as well as financial, marketing technologies and quality control.

Now by way of conclusion we will briefly discuss the reasons for the rise of the broader definition of technology. The main reason seems to be the globalisation and the rise of the world economy (a world market as predicted by Marx and Engels in **The Communist Manifesto** [1848]).

We have already discussed the widely different patterns of industrialisation in England and elsewhere in the 19th and 20th Centuries. As opposed to the 19th Century when the world faced a virtual monopoly by Britain, the end of the century witnessed the rise of American and German industrialisation soon to be followed by a number of European countries and Japan. Although sporadic attempts at industrialisation appeared in the south in the 19th Century (e.g. Egypt under Mohamed Ali) and in the inter war period in the 20th Century (e.g. Brazil and Argentina) it was the end of World War II and the herald of decolonisation that led to massive industrialisation in Asia and Latin America as well as southern and eastern Europe. The only exceptions have been sub-Saharan Africa (except for Nigeria and South Africa) and the rest of the countries collectively known as the Least Developed Countries (LDC's).

Chart 1 (source: UNCTC, 1988)



> The rise of newly industrialising countries (NIC's) first in south east Asia and then in other parts of Asia, southern Europe, north Africa and Latin America, fundamentally changed the shape of the world economy.

Helped by the spread of multinational companies, GATT attempts at liberalisation of world trade as well as tremendous technological developments in the post-war era (to mention just a few) southern industrialisation as well as developments such as European integration has led to a much more competitive world economy. In order to compete in the world economy it is not enough to possess the latest state of the art process technology. Process technology is not an end in itself. It not only should lead to product development in line with the changing needs of the world population but also be combined with appropriate financial and marketing technique. Products should also exhibit high quality or 'value for money'.

We believe the above mentioned changes in the world economy have led to the broader concept of technology.

TECHNOLOGY AND SOCIETY

It is tempting to identify the history of technology with human history as the Britannica does:

> *By virtue of his nature as a toolmaker, man is therefore a technologist from the beginning, and the history of*

> *technology encompasses the whole evolution of man.*
> (Ibid. P452)

Of course we have also Marx's view of historical development, which has often been narrowly interpreted as technological determinism and broadly as economic determinism. We will come back to Marx at the end of this section. Before that we want to assert that even Britannica having identified human history with history of technology admits certain qualifications: Three points are mentioned in the context of the interaction of technology with other aspects of social life, i.e. "social need, social resources and a sympathetic social ethos" (P452). For instance, it is well known that Leonardo da Vinci's notebooks are "full of ideas for helicopters, submarines and airplanes," but obviously these ideas became inventions some centuries later. (P452) The point being that although technological ideas and concepts may exist they may not materialise due to the absence of any of the three conditions mentioned above.

Social resources, institution, services, ethos, etc. determine and in time are determined by the development of technology. For instance, although throughout many millennia, technology developed in ancient China and the Middle East, industrial revolution did not occur in these areas but in England, the most unlikely location in historical terms. The question as to why industrial revolution did not occur in China or the Middle East is still an open question. But what is clear is that the culture and social institutions in East and West may explain to a large degree why, in spite of the technological advances in the East, industrial revolution occurred in the West. Of course there is no question about the transfer of knowledge and technology from East to West, e.g. the influence of Muslim culture in Spain during the Muslim rule (see Watt, 1972 and Watt & Cachia, 1965).

Here we turn to Marx's views on technology and society. We will focus on two interpretations, i.e. Rosenberg and Shamsavari. Both interpretations dispute the narrow interpretation of Marx's view of history as technological determinism.

A) ROSENBERG

Although Rosenberg attaches a great deal of importance to the role of technology in Marx's view of historical development, he categorically refutes the interpretation of Marx as a technological determinist. First he quotes a number of passages from Marx, which may be interpreted as technological determinism (e.g. "The handmill gives you a society with the feudal lord and the steam engine a society with the industrial capitalist." From **Poverty of Philosophy** [Rosenberg, 1982, P36]). He then refers to the **Communist Manifesto**, where Marx and Engels clearly attribute the rise of the capitalist system to profit-making opportunities that came with the discovery of the New World, the rounding of the Cape of Good Hope, leading to the colonisation of the Americas and the East. Rosenberg refutes the view that it was the growth in technology of e.g. navigation that led to the rise of capitalist system, as 'Marx states <u>twice</u> that the improvements in navigation were caused by growth in markets and commercial opportunities' (Rosenberg, P37).

Rosenberg makes a further important contribution to the role of science in technological development. He contests Kuznets' assertion: "The epochal innovation that distinguishes the modern economic epoch is the extended application of science to problems of economic production" (Ibid. P41) by asserting that the extent of scientific involvement in technology depends on the nature of technology itself. He believes that Marx clearly addressed the question. "The manufacturing system, which was the dominant mode of production of early capitalism, produced a high degree of worker specialisation." (Ibid. P41). There then is not much room for the application of science as the latter depends primarily on exact and precise measures. It was the development of machinery that made possible the application of science to technology. With the advent of modern machinery, the skills of the workers were transformed into the operation of machinery. The tools that were operated by skilled workers were now part of a machine. It is only with this development that science could intervene. That is to say scientific achievements are possible when the human input with its dependence on physical and mental abilities, can be eliminated. Then the development of machine-based industry increased productivity immensely by eliminating the human factor.

Rosenberg's interpretation of Marx is truly breathtaking. Modern technology has become more and more science based. And this is because the technology has more and more moved away from production dependent on human skill, dexterity as well as mental and physical limits placed on workers.

In this century the development of IT testifies to the validity of Rosenberg's interpretation. The origin of IT goes back to the 19^{th} Century but it was only after World War II that IT made a breakthrough. Technological development, e.g. the invention of semi-conductors made the application of science to technology increasingly relevant and appropriate as it provided yet another phase in eliminating the human factor.

The picture that emerges is one of a complex interaction between society, science and technology. First of all technology develops in response to social conditions of production, e.g. market expansion, opportunities for profit-making. Secondly science becomes applicable to technology to the extent that technology itself develops in ways that eliminate the human factor. But as the latter is socially determined, we cannot identify Marx's theory of history with technological determinism.

B. SHAMSAVARI

Shamsavari's critique of technological and economic determinist interpretation of Marx is in some ways similar to Rosenberg's. But he makes a fresh contribution (Shamsavari, 1991).

Like Rosenberg, he believes that capitalism arose without any significant changes in technology. Furthermore capitalism put to use existing technologies in response to opportunities in the internal and international markets for profit making.

Thus the new social relations of production (of capitalism) arose without significant technological change. However the further development of capitalism necessitated immense technical changes first experienced in the industrial revolution in England. With this development, capitalism finds a technical basis suited to its requirements. Thus rather than technology determining social relations of production it is the other way around. Social relations determine the nature of technology.

Through a critique of Cohen (1979) he establishes a number of points in relation to the role of technology in history. The main difference between Rosenberg and Shamsavari is the fact that the latter bases his methodology on Hegel and Marx's dialectical approaches.

Shamsavari's position, as opposed to Rosenberg's, seems particularly suited to technological transfer to Less Developed Countries. According to Shamsavari, the capitalist system gave rise to technologies that particularly suited the systematic features of capitalism, e.g. the limitless urge to produce surplus-value (profit). The limitless urge encounters psychological and social/political limits, i.e. human physical and psychological ability to work beyond certain hours in a working day, the rise of a trade union movement that aimed at limitation of the working day and social and political outcry against the excesses in the exploitation of children and women's labour in 19^{th} Century England.

A continuation of the extraction of 'absolute' surplus value would not only lead to lower life expectancy in the working classes and out migration (thus a decline in the pool of available labour) but also have wide-ranging social and political repercussions.

The use of machinery provided the required technical basis for capitalism as it enabled the system to extract 'relative' surplus value, i.e. a mode of extraction of surplus value that did not rely on a prolongation of the working day (the 'absolute form'). Relative surplus value can be extracted in two ways without prolongation of the working day (or even consistent with a reduction).

1. By reducing the cost of wage goods, e.g. food, textiles, housing, etc.
2. By intensifying the labour process.

The first was achieved by use of machinery in agriculture, textile and building trades. The second was achieved first by the development of the assembly line by Henry Ford (Shamsavari, 1991, Chap.6).

Another development that came with Fordism was the production of low quality products, produced on mass scale for mass consumption. This suited capitalist development. While capitalism in the 1910's eventually found an adequate technical basis, the transfer of technology to the Soviet Union and later to Less Developed Countries proved to be problematic.

The capitalist technology imported into the Soviet Union was in contradiction with the form of ownership (social relations of production) and simply reproduced hierarchical division of labour, which characterises the capitalist system. The capitalist technology imported into less developed countries often proved to be inadequate for the developmental goals of these countries. This lead to the start of intermediate technology debate that we will turn to (see Shamsavari, 2000).

THE DEBATE ON INTERMEDIATE TECHNOLOGY

Schumacher was the first person to raise the question of appropriate or intermediate technology in his seminal work Small Is Beautiful (Schumacher, 1973). Although intended as a work targeted at Less Developed Countries it became an icon of the 1960's counter cultures, i.e. it was interpreted as alternative not just in Less Developed Countries but also in Developed countries. Big companies, large multinational corporations, even bureaucracies were identified with the 'ugly big' as opposed to 'beautiful small'.

The basic motif in Schumacher's book was the contrast between modern technology (used mostly in western industrialised countries) and ancient technologies still in use in Less Developed Countries, particularly in rural areas but also in small-scale urban industry.

The following chart contrasts the two technologies. As opposed to these two kinds of technologies, Schumacher suggests an intermediate technology that would raise productivity at lower costs (compared to advance technology), use local resources, skills, labour pools and that, further, would be easy to operate, maintain etc.

CHART 2

	ADVANCED TECHNOLOGY	**BACKWARD TECHNOLOGY**
THE NATURE	Complex	Simple
EQUIPMENT	Machinery	Tools
MAINTENANCE OPERATION	Complicated	Easy
SKILL LEVEL	Highly Skilled or Specialised	Skilled, not necessarily specialised
FACTOR-INTENSITY	Fairly Capital Intensive	Labour Intensive
RAW MATERIALS	Local, but largely imported	Mostly local
PRODUCTIVITY	High	Low
COST	Expensive	Cheap

Thus the idea of intermediate technology seemed suited to conditions in many Less Developed Countries, where there are abundant labour resources, low skill levels, low productivity, lower educational levels, low levels of capital formation etc. The idea was to raise productivity levels, thus income, with minimum cost in terms of imported capital, raw materials, skilled labour etc. Although Schumacher’s ideas were ignored by most development economists when they appeared first in the 1970's, they gradually became to be taken seriously.

Two circumstances helped:

1) The general disillusionment with state led large scale Import-Substitution-Industrialisation (ISI) strategy of economic development, which produced a fairly high growth rate (e.g. Brazil) but at the expense of high unemployment rates and worsening income distribution. This led to the rise of Basic Needs Approach.
2) The rise of Newly Industrialised Countries in South East Asia where high growth rates were accompanied by a more equitable income distribution and higher employment levels.
3) 'Urban Bias', a policy adopted by many LDC's, which systematically gives priority to the urban sector compared to the rural (Lipton, 1977).

As the ideas of IT were being more and more appreciated a major criticism from the Marxist camp came from Arghiri Emmanuel (1982). He basically dismissed the idea on the grounds that IT adoption is equivalent to denial of advanced technology to Less Developed Countries.

Both the total embracing of IT and its total rejection is false for the following reasons:

A) The idea of intermediate technology is both industry specific and stage of development specific. There are certain industries and sectors of Less Developed Countries that may benefit from IT, e.g. the rural sector or the small-scale industry in urban areas. However, other industries may require large scale as a matter of efficiency and productivity as many fields of manufacturing exhibit economies of scale. Also countries at a certain stage of development, e.g. low income, predominantly agricultural societies, can benefit tremendously from IT. When this stage is passed modern technology may become appropriate as higher growth rates in income per head make large scale production possible.

B) Schumacher's ideas represent a broad generalisation of the condition in Less Developed Countries in the 1950's and 1960's, which no longer holds true. The fact is that several countries in Less Developed Countries industrialised very rapidly with minimum of urban bias (India and China are prime examples).

C) Total rejection of IT is based on technological and economic determinism. This approach tries to idealise modern technology with total disregard to normal conditions in which technology is applied.

SECTION II: TECHNOLOGY TRANSFER CHANNELS AND MODELS

Technology can be transferred in a variety of ways. Today the market for technology is highly imperfect due to protection mechanisms for intellectual property rights in the form of patents and trade marks as well as often the high initial capital costs which create formidable obstacles to market entry. The only channel approaching free market is licensing, which was used extensively by former Soviet Union and to a lesser extent by Japan (Stewart, 1978). However, as we shall see below, this route often is not available for certain types of technology transfer.

THE CHOICE OF TRANSFER CHANNEL

The idea of choice presupposes the availability of alternatives. The choice of channel of transfer of technology is made basically between two alternatives either:

(a) To transfer technology by FDI or joint venture (the internalised method) or

(b) To transfer through contractual arrangements e.g. licensing (the externalised route) (UNCTC, 1988)

In most cases, the multinational company, when unrestrained, will prefer technology transfer through the foreign direct investment channel to any other form of transfer channel (UNCTAD 1991). But it has not got an unlimited freedom. Even when a multinational company has an indisputable “technological distinctiveness” which offers it a strong monopolist bargaining power, its choice of channel of technology transfer may be limited by various factors, most of which are outside its effective control. Examples of these are government legislation, industry structure and competition.

Underlying the issue of choice of transfer channel is the degree of control which the multinational company may have over the channel. The multinational company typically perceives its global operations as an integrated organisational activity to be directed and controlled ultimately from a central office in the home country. Given this, a multinational company would prefer a transfer channel which it would be under its effective control , such as a wholly-owned subsidiary, to any other form of channel under which effective control over the channel of transfer enables the company to adapt operational activities in the host country to changes in domestic and world market conditions unforeseen when the transfer arrangements were made.

In addition to the effective control factor, Baranson (1969) has mentioned five other factors that may influence the preference for the direct investment channel as against contractual arrangement. First, if a multinational company possesses enough financial and human resources to invest abroad, it may decisively choose the direct investment channel of transfer. Second, if the company fears that the adoption of any other channel of transfer but the direct investment channel will result in the divulgence of valuable know-how, it will refrain from adopting such other channels. This fear stems from the need to protect monopolist advantages which 'technological distinctiveness' may provide to the company in a given market. Third, the direct investment channel may be chosen if the technology transfer involves a broad line of intricately related products or is an integral part of marketing and financial management of the company. Four, where the technology to be transferred is highly complex and the foreign affiliate lacks the technical and industrial sophistication to exploit it commercially, the multinational company will choose the direct investment channel. Finally, multinational companies will want to invest directly in the recipient country if there arises the need to protect their product standards and internationally renowned trade mark and brand name. On the other hand, the multinational company may prefer licensing technology instead of direct investment for a variety of reasons. One of these is the nature (or age) of the technology concerned. If the technology is the mature or standardised type which can be classified as “old” or peripheral technology, licensing may be preferred to direct investment as that will not impinge upon the profitability of the company as a whole (Chatterji, 1990).

Another reason is the specific advantage which a particular technology gives the owner. A firm, especially a large one, possessing a specific asset (for example Coca Cola) may licence its technology widely for royalties instead of involving itself in capital investment. This may be possible simply because the company will maintain control over the vital secret of know-how in the technology package. Coca Cola achieves this by simply supplying an already compounded syrup which the licensee uses to produce Coca Cola soft drinks. Yet another reason is the regulation of foreign direct investment in some host countries. Some host government policies make it effectively impossible to profit from foreign direct investment, and leaves licensing as the main alternative option under such regulation (Caves l982).

Furthermore, the preference for licensing derives from the size of the host market and the risks involved in investing directly. If a host market is small, the risk of direct investment becomes higher which may induce the multinational company to license its technology. The preference for licensing may be increased if the host country shows signs of political instability that may put investment at risk. This is a particular problem among most of the developing countries.

Other reasons include the inexperience and national-orientation of the company, and the capability of the potential licensee. If the technology owner has no experience in foreign direct investment and is nationally oriented, licensing will be preferred over direct investment. Equally, if the technology is not very successful commercially, the multinational company may license the technology instead of undertaking direct investment (Buckley,1989).

Yet another consideration is branding and trademarks. A world-known brand name, e.g. Mercedes, will not be subject to a licensing agreement as the licensee is free to make modifications that will effect the reputation of the branded product.

Finally, in a situation where patent litigation or competitive technological development may be avoided, multinational companies may opt for licensing of their technologies. The decision on the channel for transferring technology is not as simple as we have presented it above. Between the two possible transfer options of wholly-owned subsidiary and licensing are many intermediates which are also possible alternatives. There are even some practical situations where most of the determinants discussed above play little role in the decisions. Such situations exist mostly in the developing countries where lack of competition and capable indigenous enterprises encourage the transfer of technology mainly through foreign direct investment.

THE TECHNOLOGY TRANSFER PROCESS

The technology transfer process involves two basic models: the direct and indirect transfer models (UNCTAD 1991). Others have referred to these as “unbundled” and “bundled” methods, respectively. A multinational company will use any of the two methods depending upon the issues discussed in the previous section.

THE DIRECT TRANSFER METHOD

In Figure 1 we present the basic structure of the direct method of technology transfer. As can be seen in the Figure, in the direct transfer mode the recipient enterprise engages a number of separate suppliers of technology to supply it directly with the various elements of technical knowledge it needs. The supply could be of individual technological elements or a combination of elements. An essential feature in the direct transfer method is the independence of the two parties in the transaction. The technology supplier and receiver are generally independent, non-affiliated enterprises. Another feature is the strictly legal contract of the transaction. The supply of technology takes place under contractual agreement stating clearly the rights and obligations of the contracting parties.

FIGURE 1. DIRECT METHOD OF TECHNOLOGY TRANSFER

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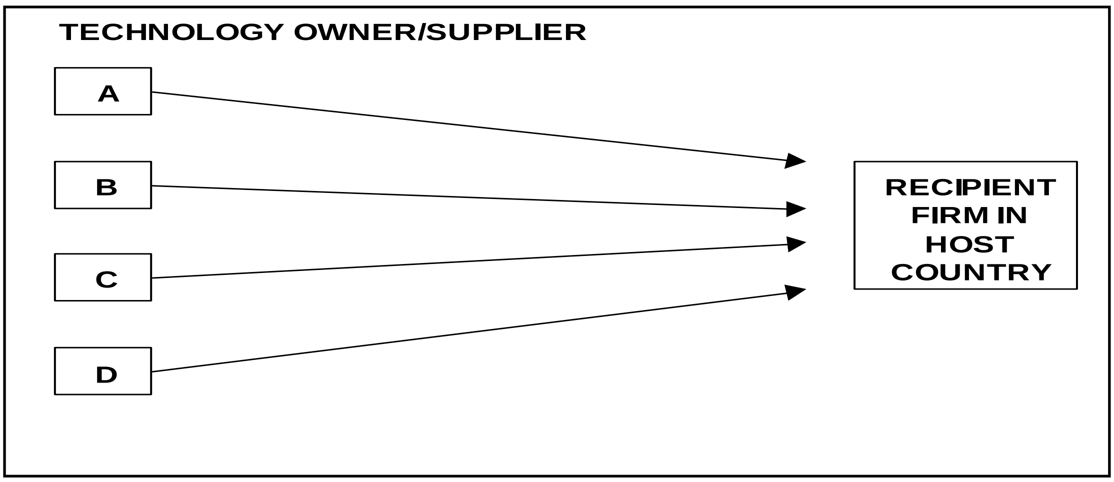


Under the direct transfer method, the multinational company can use a variety of forms contractual devices to transfer technology. These include, among their most common 1.

Licensing Agreements.

2. Technical Service Agreements

3. Machinery Supply Agreements

4. Engineering and Construction Agreement

5. Management Contracts

6. “Turnkey” Contracts

This classification is arbitrary since it is common in practice to find a single contractual agreement covering more than one of the categories. For instance, license agreements generally incorporate technical service contracts. A "turnkey" agreement, on the other hand, may include licence, technical service as well as engineering and construction contracts. The choice of any one device depends upon the requirement of the receiving enterprise. We shall discuss a few devices in some detail.

Licensing Agreement

This is a process in which one company (the licensor) which possesses intellectual property rights, e.g. technology, brand name, etc. allows another company (the licensee) to use or sell these rights in return for a financial reward (royalties). Licensing agreements are not new in the business world. As mentioned above both the former Soviet Union and (to a lesser extent) Japan used licensing to acquire technology from the West.

Licensing seems appropriate for small companies in high technology sectors. The reasons are that a small company does not have the financial resources to engage in either exporting or FDI. Also being in a high technology field, the chances are that the new technology can be upgraded leaving the company in a non-competitive position. Thus licensing can help a small company in a high technology field to recoup its initial high costs of research and development (R&D) at a low cost.

However, licensing has distinct disadvantages. The licensee, as mentioned above, can become a powerful competitor in future once the term of license has expired. Also during the time of licensing agreement the licensor has no control over the quality of the product. Thus a good brand name may be compromised through unscrupulous activities of the licensee. Thus in considering licensing agreement a firm should balance the initial cost-saving against the problems of control over the quality of the product.

Occasionally the agreement includes technical service contracts relating to either technical or managerial skills or both, the supply of intermediate inputs and even the supply of machinery. This is particularly so in licence agreements contracted with enterprises in developing countries. This situation may be explained by the imperfection of the technology market in the developing countries and the monopolist powers the suppliers of technology often possess.

Charges made for technology supplied under a licence agreement are referred to as royalties. Payment for technical services provided are generally referred to as fees. These are all rate charges upon either "gross" or “net” sales of the licensee. The rates charged in each case are set during negotiation for the transfer of technology. The rate set is generally a function of the relative bargaining powers of the contracting parties as determined by the technology supply-demand relationship in the market (Bhagwati 1983). Some of the contractual agreements, such as engineering and construction contracts, are paid for in lump sum.

As a method of technology transfer licensing has many advantages. First, licensing avoids trade barriers imposed on the sale of plant and equipment. Second, since equity participation is not necessary condition of licence agreement, the fear of foreign domination is exercised. Third, where foreign direct investment is prohibited licensing may constitute the major alternatives to other forms of technology transfer. Finally, where there are governmental restrictions on the remission of foreign exchange, payments for technology are often given favourable considerations. However, licence agreements have been criticised bitterly for the restrictive Clauses they generally embody. These range from tied purchase of inputs, machinery and spare parts, restriction on exports to limitation of local development of technological capabilities (Etel. 1985).

Machinery Supply Contract

The supply of goods, especially capital goods such as machinery and spare parts, has been a traditional way of transferring technology to developing countries. Many types of plant and equipment, hand-tools, transportation and communication devices and even consumer goods which the multinational company supplies in developing countries embody technologies which purchasers learn to use. Even simple equipment carries with it the design, composition of material used to produce it and, to a limited extent, the production method.

The multinational company finds this method of transfer convenient and simple. In the first place, the company's risks are low as the payment for machinery is guaranteed. Secondly, its involvement in transmitting the embodied technology is restricted to the manuals of instruction accompanying the machinery except where a separate or an all-embracing contract which includes the provision of technical assistance is generally the prevalent one (Sirgurdson 1990). In some cases, the multinational company provides technicians to install the machinery and test-run it for the purchasers.

Technology import through the purchase of machinery has been an important source to many developing countries. Latin America, for instance, acquired a great deal of technical knowledge through the purchase of instruments for measurement and control. However, this "direct transfer" channel is often subject to restrictions imposed by patent right over the embodied technology and by governments of purchasing countries. In the former case, a patented machine will be available for purchase only if the machine manufacturer holds the patent. In the case of the latter restrictions, government of purchasing countries often impose restrictions on the import of some machinery to conserve foreign exchange, discourage the import of "inappropriate" machinery and, perhaps, encourage domestic manufacturing efforts. Furthermore, technology embodied in machinery is just one aspect of technology required for productive activity. It follows, therefore, that the success of this method of transfer depends upon the availability of other complementary know-how.

Franchising

Franchising is a variation on licensing, which in certain ways is an improvement on the latter as it involves an ongoing relationship between the franchiser and the franchisee. Whereas the pure form of licensing involves a one off-sale of intellectual property rights by the licensor to the licensee and subsequent loss of control by the former on the quality of the goods produced by the latter under license, franchising may involve many activities ranging from training of the staff of the franchisee to control over operations engaged in by the latter under the franchise agreement. Franchising like licensing involves payment of royalties over time including an initial payment.

Typically franchising may include any of the following:

i) Use of technology, design, packaging, brand name, etc.

ii) Training of the staff and help with management.

iii) Control of operations of the franchisee by the franchiser and control of the quality of the product or service.

The growth of franchising has been spectacular since the 1970s. In both the US and UK the number of franchises, the level of employment and the volume of sales have grown considerably and continue to grow. Apart from examples given above, many fast food retailers such as Macdonalds and Burger King operate under franchise. All these examples testify to the fact that franchising is most widely used where consumers are directly involved, i.e. at the retail level. No matter what the originator of the franchise contract is, e.g. manufacturer or wholesaler, its benefits are apparent at the retail level. In a way it is easy to see why franchising has become such a popular form of a company's engagement in foreign markets. Take the cases of petrol, soft drinks and fast foods for instance. Here we are dealing with branded products, Esso, Coca-Cola and Burger King. The goods are not sophisticated and complex, such as cars or computers. They do not require after-sales service or consumer education. The technology is not complex and difficult to transfer or copy. The goods are not easily tradable across national boundaries (e.g. hamburgers that need to be cooked on spot at the point of consumption). There is a need for continuous quality control to assure consumer loyalty. Thus exporting may not be a viable option. Licensing would be inappropriate in view of the importance of continuous quality assurance. As incomes have continually grown in developed countries as well as some developing countries in the past five decades and as the pattern of food, drinks and petrol consumption has changed due to a faster pace of life and work, demand for fast food, bottled drinks etc. has increased tremendously.

Franchising, thus, has emerged as a very popular form of international business in response to these trends.

In practice, like in the case of licensing, problems arise. Some of these problems include government regulations, problems of finding suitable franchisees, lack of host country investment, control of franchisees, adapting a franchise to local needs and trade mark obstacles.

Management Contracts

These include management, marketing and technical service contracts. These contracts involve transfer of skills and technology in return for a fee. If a product, technology or brand name has been sold under a licensing agreement, the licensee may need further assistance in maintenance of plant and equipment, marketing etc. One problem with this form of international business is the maintenance of a working relationship which is suitable to both parties to management contract.

Turnkey Contract

Turnkey projects involve the design and construction of a facility by an MNC in return for a fee in a host country The other party may be a domestic company in the host country or a national government. Car assembly plants, suspension bridges, telecommunication systems and power stations are some examples of turnkey projects. Thus a turnkey project is a one-off transaction. But it often involves a package that may include management contracts, e.g. a technical service contract and/or training and marketing etc.. Thus it may entail a long-term relationship between the supplier and the client and thus may prove very lucrative for the supplier company. The turnkey project may also involve financing arrangement by the supplier company. Finally it should be noted that it is usually large companies that originate a turnkey project as the technology and the scale of financing, technical support and training may be beyond the resources of a small or medium-sized firm.

Under turnkey contracts the technology supplying company agrees to undertake the full range of technical and managerial operations required to establish an enterprise in full operating condition to the local owner. Typically, the turn-key arrangement expects the supplier of technology to transfer a "package" of all elements of technological know-how required to set up and operate for a limited period a new production facility.

The multinational company may undertake a turnkey contract because of its “embracing arrangement”. Some turnkey agreements include additional items such as training of local personnel and the provision of technical assistance. Some may include process technology, though this is not a typical form while others may require the technology supplier to manage the plant for a period before handing it over. Such package deals provide ample opportunities for transfer pricing practices.

Advantages of turnkey contract include the following: 1) when technology is complex, the ability to assemble and operate it gives the proprietor a considerable advantage. Thus turnkey contract is a way of maximising profit from the ownership of technology. This is specially the case when FDI may not be a viable route for international entry of the firm due to host country restrictions on FDI or the risks associated with the latter (Hill, 2001, p. 368). Hill uses the example of oil producing countries where the host governments own oilfields and do not permit FDI. 2) Turnkey contract is less risky than FDI as it involves a sales contract rather than investment in productive facilities in host countries with uncertain return due to a number of factors such as unstable governments and hostile attitude toward foreign presence.

Hill mentions three disadvantages of turnkey contract: first, the company entering the contract has no long term prospect in the host country; second, a company involved in such a contract may potentially help to create a competitor. Hill’s third point is almost identical with his second point. We may add another disadvantage from the host country point of view:

Though turnkey arrangements have the advantage, to the host country, of reducing the risks of acquiring various elements of technology through a variety of contractual agreements and acquiring the transferred know-how through learning-by-doing, there are suspicions about its efficiency in transmitting technology. A United Nations study argues that unless turnkey arrangements are supplemented by management and/or technical assistance contracts, the recipient may not have a meaningful guarantee of plant performance. But Kopelmanns (1970) argues that the advantage of having a number of separate .contractual agreements is that they encourage the development of 'national technological capabilities.' Despite these arguments, it seems that much reliance upon 'turnkey' contracts may cause delays in indigenous development of those skills required to organise and set up production facilities in developing countries.

International Subcontracting (Outsourcing)

This occurs when a manufacturing firm in a developed country subcontracts the manufacture of parts, components, sub-assemblies or even final goods to a firm in an LDC to take advantage of lower labour costs or special incentives provided by the host government, e.g. tax breaks. This form of contract has its origins in the US companies that operated in Mexico in the 1950s and 1960s. These companies would export parts and components, e.g. of electric or electronic goods to Mexico to be assembled into final goods, thus taking advantage of lower labour costs. The final products would be re-exported back to the US or exported to other countries (Shamsavari, 1973, Chap. 5). This form of international business was encouraged tremendously by changes in the US Tariff Code in late 1960s. These changes involved exemption of American parts exported to Mexico from US tariff when final products were exported to the US. Thus only value-added in Mexico, primarily labour costs which were low, was subject to tariff. Similar changes in EU enabled European firms to shift parts of their manufacturing operations to North African countries. Today a number of countries, particularly in Asia (a good example being People's Republic of China), operate Export Processing Zones (EPZs) which include developed infrastructure, skilled but low-cost labour and tax incentives, to attract foreign investment. Textiles, electronic goods and air-frame production are some of the examples of the sectors involved in international subcontracting (UNCTACD, 1993, Chap. 5). The advantages for LDCs are immense as they acquire modern technology, have access to rich country export markets and enjoy a high rate of economic growth. Originating companies benefit from low wages, skilled and disciplined workforce and tax breaks.

INDIRECT TRANSFER OF TECHNOLOGY

The direct transfer method, with its various contractual arrangements, is thus an attractive option despite its major limitations which includes the lack of equity share control of the technology receiving firm by the supplier firm. This truncates the unified control structure most desired by the multinational company in its operations abroad and often puts the company in a difficult position with respect to policy-decision making. The second option of "Indirect Transfer" provides the condition for achieving this desire. Joint ventures and foreign direct investment (FDI) are major routs of indirect (internalised) transfer routes.

Joint Ventures

Joint ventures have grown considerably since the 1960s. In fact while the former Soviet Union and Japan, as indicated above, transferred technology through licensing agreements and South American countries welcomed wholly-owned FDI from The USA and Europe (e.g. Ford Company investments in Brazil in 1950s and 1960s), the success of the Asian economies have largely been due to joint ventures between Japanese and American companies with domestic firms (e.g. South Korean firms producing Hyundai, Daewoo and Kia cars) or the former and the domestic government (Malaysia's car manufacturers) (Gwynne, 1990, Chap 10).

Joint ventures take two basic forms, the equity and the contractual. The former involves the creation of an entirely new company through partnership between two or more companies. Thus a separate legal entity is created in which the participating firms exercise control in proportion to their share in the equity of the new company. On the other hand the contractual form does not lead to the creation of a new and distinct company. The participating firms in the joint venture cooperate with each other and share risks and benefits. The rights and duties of each participating firm are stipulated in the joint venture contract which stipulates, for instance, the extent of cooperation in technology transfer or sharing, research and development, use of channels of distribution and product, price and promotional policies.

A major contributing factor in the rise of joint ventures has been the apprehension of many developing countries in the 1960s and 1970s about wholly-owned FDI by multinational companies (MNCs). This apprehension was based on a number of factors such as the power of an MNC to influence the politics of a country, its ability (through transfer pricing) to avoid taxation, its tendency to export expensive and inappropriate technology (eg. capital-intensive) to a labour-abundant country, etc. The emergence of joint ventures put to rest some of these reservations by developing countries, as domestic government and companies involved in joint ventures with MNCs, could now exercise some degree of influence and control over the decisions of MNCs. As a result the change in the attitudes of developing countries was so immense that as of late 1960s and early 1970s we witnessed a gradual shift from negative attitudes to foreign investment by MNCs to highly positive ones. Thus joint ventures played an important part in opening many Less-Developed Countries (LDCs) to foreign investment.

Joint ventures offer many advantages to participating MNCs and host countries. Some of these advantages include the removal of former objections and obstacles to foreign investment, sharing costs in face of rapid technological change, the pooling of technological capabilities, access to distribution and marketing channels of partners in joint venture.

However, there are also disadvantages in joint venture agreements. These involve mostly possible disagreements among partners in a joint venture over a number of strategic issues. Joint ventures may be terminated in favour of wholly-owned FDI if a strong partner finds it attractive. There may arise disagreements over the strategic aims of the joint venture, operational and managerial procedures, the use of retained profits, product or pricing policies, etc.

Foreign Direct Investment (FDI)

FDI is distinguished from another form of foreign investment known as Foreign Portfolio Investment (FPI). The latter involves investments in financial assets in foreign countries, e.g. stocks and bonds. The objective is normally to obtain a high rate of return on investment. FDI on the other hand usually involves investment in physical capital, e.g. technology, plant and equipment. The main differences can be summarised as follows:

While FPI is normally oriented towards a good rate of return on investment and thus not concerned with the way funds are invested, FDI seeks to control the way funds are invested. FPI is usually a one-way road, i.e. funds flow from low return to high return (interest) countries. By contrast, FDI is a two-way avenue. As it does not occur in response to higher interest rates, it can flow in many directions: from rich countries to poor countries, from one rich country to another rich country, from a poor country to another poor country and even from a poor country to a rich country. An example of the latter is the South Korean investments in car manufacturing in Canada and the United Kingdom. Finally while PI can conceivably flows to any sector of the host economy, FDI shows a more specialized, more focused flow of investment to particular sectors. The latter are usually identified as technology-intensive and R&D-intensive(Hymer, 1976).

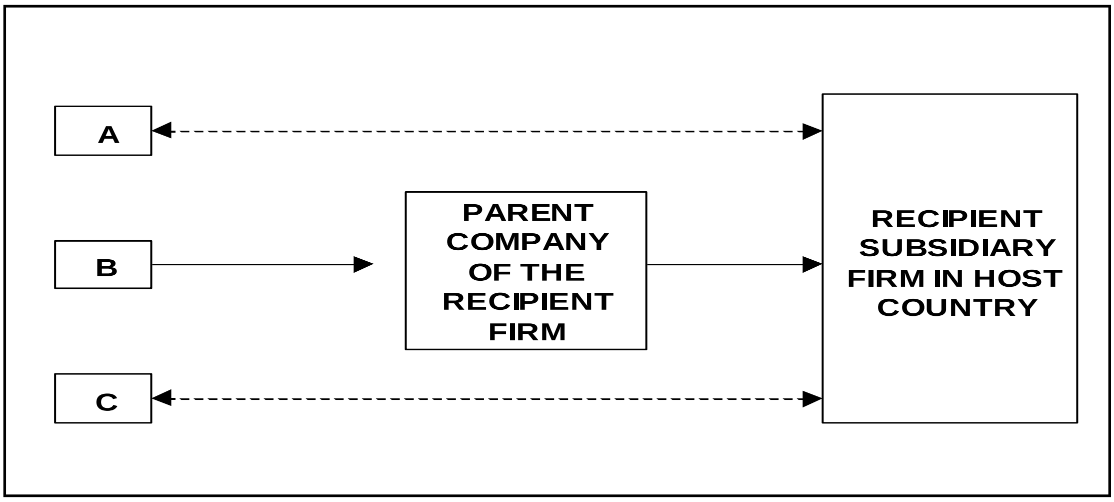
Until the 1940s FPI was the dominant form of international investment. In 1950s FDI began to acquire a more dominant position. The post-war period witnessed a massive influx of American FDI to Europe and later to LDCs. Since the 1970s we have seen the rise of European and Japanese MNCs investing in the US and LDCs . Finally in the 1980s and 1990s we witness the rise of the so called New Multinationals, i.e. companies from LDCs, which primarily invest in other LDCs, but occasionally also in DCs.

Since the 1960 contribution by Hymer (1960/1976) who highlighted the above-mentioned differences between PI and FDI, there has been numerous contributions which have attempted to explain the reasons behind FDI. The central question these theories have attempted to address is why a firm would engage in international production which involves many economic and political risks rather than either export its products or license its technology, product, brand name, etc. A dominant position is occupied by the so- called OLI theories, i.e. Ownership, Location and Internalization. Briefly the ownership theories emphasise ownership-specific advantages that a firm may possess, e.g. technology, brand name, etc., which due to imperfect markets can be best utilized by FDI. Thus the investing firm would occupy a dominant position in the market because of its superior technology, management and marketing skills. Exports or licensing would not fully return the cost of investing in new process and product technology. The location theories emphasis the fact that as opposed to exporting that involve tariffs and other trade restrictions, FDI manages to avoid these restrictions as well as benefiting from other location-specific factors such as lower labour and raw material costs. Internalization theories rest on the theory of the firm and in particular Coase Theorem. Firms exist because of high transaction costs in using markets. Thus market may offer raw materials at high prices or may exhibit considerable delays in supplying raw materials and parts. Or there may not exist a market for the needed raw material or part. For instance the first generation car-makers had to produce engines and other parts as these had no use in any other manufacturing process and had to be engineered by the producing firm itself. Or consider the first generation of modern computers. Memory chips would not have a market as there were no other sector that used microprocessors. Thus certain activities such as engine making or the production of microchips had to be internalised. According to this theory FDI takes place for the same reasons as a national firm emerges, i.e. in response to high transactions of using the market.

The problem with OLI theories is that many of the factors used to explain FDI have been present in the world economy for a long time. For instance, cheap labour in LDCs is not a post-war phenomenon. Coase theorem is applicable universally regardless of post-war conditions. The point we wish to make is that the rise of the MNCs and FDI has more to do with fundamental changes in world economy after the war. These include the Bretton-Woods Agreements which through the establishment of the International Monetary Fund (IMF) contributed to exchange rate stability among member countries thus encouraging both foreign trade and investment, the General Agreements on Tariffs and Trade (GATT) which successively through a number of rounds of negotiations, e.g. Kennedy and Tokyo Rounds managed to reduce trade barriers, particularly tariffs, the rapid technological change, decolonisation and rapid population growth in LDCs, new life-styles, the rise of consumerism, cultural revolution and other changes.

As noted above, FDI as opposed to FPI does not occur in all sectors of the economy. Its sectoral distribution is biased towards technology and R&D-intensive industries. For instance, FDI is still the preferred mode in I) the branded food and beverage processing industries, where the use of registered trademarks and brand names are important; ii) pharmaceutical, fashion-wear and electric goods, sectors in which technology is not difficult to obtain, e.g. through a licensing agreement, but the operation of patent system and intellectual property rights plus the rapid rate of new product development create significant barriers to entry by other firms; iii) industries in which, the effect of product differentiation in creating barriers to entry are strengthened by the existence of complex technology, economies of scale and high capital requirements (eg. computers, cars except for the assembly stage which can be supplied as a turnkey project and electrical power equipment).

FIGURE 2. THE INDIRECT FOREIGN INVESTMENT TRANSFER MODEL



This model is different from the one in Figures 1 in a number of ways. First the intermediary and recipient firms are parent and subsidiary companies respectively which means that they are affiliated and not independent. The subsidiary company may be wholly or majority owned by the parent company implying that both have common interests, policies and objectives. Second, almost all the technological elements required by the subsidiary firm are owned and supplied by the parent company, the few elements that may be obtained from other suppliers are generally not the core production technology required by the subsidiary. In most cases these comprise machinery and equipment not produced by the parent company. These are generally allowed to be shipped directly from the manufacturer (broken arrows) to the subsidiary who sends feedback (reverse broken arrows) to the manufacturer in respect of the performance of the machinery. These are the only areas of direct contact between the "other technology owners" and the parent company. Third, the parent company may also have equity interest in the "other owner" or vice versa. This means that the three sets of enterprises involved in the transaction are in fact affiliated.

Finally, and most importantly, the decision on what technology to transfer to the recipient firm is generally made by the intermediary firm. This is unlike the situation in the other models where the recipient firm gives the intermediary firm a shopping list of technological elements it requires to be supplied.

These differences make the direct investment mode theoretically complex. Practically, however, it is simple to operate. This derives from the fact that control in the model is unified and concentrated in the parent company. Decision making and implementation therefore become fairly straightforward and easy. Furthermore, the fact that both enterprises have an identity of interests, policies and objectives, makes co-operation, evaluation and control less of a problem compared to independent non-affiliated companies relationship. Moreover, technology transfer under the direct investment method takes the form of a "package transfer" which simplifies the process and reduces areas of conflict.

The “package” provides, among others, plant and equipment, engineering and technical know-how, technical service and assistance, process technology, patents, trademarks and, most importantly, management skills and know-how (Daussage, 1992).

However, indirect foreign investment is not totally void of contractual agreements. In fact contractual agreements co-exist with it. But, the contract is generally a "package-deal" instead of separate agreements for each technological element as is the case in "pure" direct transfer model (Figure 1). For this and other reasons stated earlier, most multinational companies would choose the direct investment method to transfer technology to developing countries. Clearly, it is the most common method of technology transfer to those countries and, arguably, the most important.

TECHNOLOGY TRANSFER MODELS

Several models of framework were developed by economists and specialists in the area of technology transfer. We intend to emphasise two, which we consider more relevant to our case. The first model is called "Technology Transfer Process Stage" developed by E Souder (1990). Although this model was not specially developed to analyse the process of technology transfer to developing countries, it can be used as a fairly good guide in selecting strategies or policies when adopting technology.

The model consists of four stages:

1) Prospecting Stage
2) Developing Stage
3) Trial Stage
4) Adoption Stage

Following is the description of each stage briefly.

Prospecting Stage

Consists of analytical research and decision-making activities aimed at screening alternative technologies and selecting the ones that fit the user's requirement.

Developing Stage

Consists of physical and laboratory R&D activities focussed on enhancing, elaborating, embodying, and tailoring the selected technology from stage 1 to meet the user's requirement.

Trial Stage

In trial stage the developed technologies are field tested.

Adoption Stage

Consists of final development, technology modification, and user's implementation activities. In fact, Souder adds that the activities of four stages may overlap, some technologies may be so desirable that the user adopts them during their prospecting or developing stage thus bypassing certain stages.

Furthermore, there are certain roles in the model, which must be explained here. Souder describes them as follows: The disseminator role, sponsor role, developer role, implementer role. Those roles, he claims, influence the flow of activities through the stages of transfer.

We shall describe each role very briefly.

1. **The disseminator role:** involves making potential users aware of appropriate technologies and generally serves as a marriage broker between supplier of technology and its users. Examples of disseminator as Souder indicates, are libraries, librarians, and information specialists.

2. **The Sponsor Role:** covers political and financial support for various activities as well as for disseminators, developers and implementers. Government-funding agencies are examples of sponsor's role players.

3. **The Developer Role:** involves the conduct of laboratory and field trial R&D.

4. **The Implementer role:** deals with selling, customer development and trouble shooting.

Disseminators, as Sounder explains, operate within the prospecting and developing stage; and implementers within the trial and adoption stages.

Souder claims that the model can be used to help select the contingent set of best practices within each stage of technology transfer process. He illustrates the process of selecting as follow: First, consult the model to determine the stage of transfer process at which activities are to occur. Then implement all the essential practices for that stage.

It is clear now, that the model does not take into account the technological gap that exists between the seller of know-how operating in developed market and the buyer of know- how operating in developing countries. In conclusion, the model can not be used as an analytical framework to assess the acquisition of foreign technology in the developing countries. But we do not deny its suitability as a guiding model for firms, whether it is a buyer or seller with similar level of competitive advantages, who wish to formulate transfer policies by using those best practices in the way that was suggested. It could fit very well the buyer and seller of technology within intra-firm trade.

The second model was developed specially for developing countries in order to assess the level of acquisition of imported technology.

This model is called "Technology Acquisition Model" developed by Adikibi (1984). The model is known to be a very simple, practical and realistic one, and could be adopted and applied to any country searching for a systematic explanation and analysis of the process of foreign technology acquisition.

“TAM” is based upon four stages:

1) Physical Transfer Stage.
2) Anchorage Stage.
3) Diffusion Stage.
4) Assimilation Stage.

Physical Transfer Stage

The first stage comprises the actual movement of' technology elements such as plants, machinery, equipment, patents, personnel from the home to the host country. This stage is completed when the structure of production is set up to commence operations. It is suggested that a duration of 3 - 8 years are required for the completion of this stage. Certainly, as pointed out by Adikibi, the duration depends largely upon the level of development of both countries, home and host.

The Anchorage Stage

As is described by Adikibi, this stage is critical in the acquisition of foreign technology, without which the know-how remains alien to the host country. In the first phase of this stage, low level of technology anchorage, and the dominance of foreign input is noticed, especially in the case of a 100% wholly owned subsidiary. The preparation of detailed training programmes and the provision of the training facilities take place in this phase of anchorage process.

Phase II, as described by Adikibi, is the transitory phase from I (foreign input dominance) to phase II, which is characterised by domestic factor dominance. The major characterisation of this stage is training of the local employees. It includes in-plant, out-plant and overseas programmes geared towards implanting the technology and developing indigenous personnel capabilities. Phase II as described, will be the longest in duration and the most difficult to accomplish. In phase III, all the expected evidence of complete anchorage of technology appears, such as effective control in the areas of management, production, technical and financial functions; substantial decrease in the import of factor-inputs; production under the management by local personnel. Phase III, as described by Adikibi, will be shorter in duration than phase I and II, and it represents the stage where the technology is ripe for diffusion in to the industry.

The Diffusion Stage

The diffusion stage, has two main features, the first of these is the emergence of "imitator" indigenous firms within the industry which copy the basic and standardised designs and techniques of production in the industry. The second phase of the Diffusion Stage manifests in three ways. "Imitative Production" involves production of goods similar to those of the technology transferee. The other comprises the development of indigenous enterprises in the industry which compete with the transferee enterprise, the third feature is the increased number of host country nationals knowledgeable in the technology compared with number in the Anchorage stage. At this stage licensing of advanced technology for production becomes a beneficial and efficient method of co-operation with foreign counter-parts, because the basic know-how of the industry has now been diffused in the system. Unlike the Anchorage Stage, explained Adikibi, the completion time of the Diffusion Stage is expected to be much shorter. He adds the factors that may affect the duration include, among others, the entrepreneurial drive of nationals, the profit potential in the industry, government support and the national business environment. Adikibi concludes, that the start and completion times of the Diffusion Stage depend more on factors in the host national than foreign environment.

The Assimilation Stage

The main features of this system as described by Adikibi are high degree of concentration on R&D and deeper understanding of the process technology in order to determine whether to adapt or modify the technology to suit local needs. This stage, as Adikibi argues, has no completion time, because, as he states, the adoption and modification of any know-how is a continuous process.

Like any other theories or models "TAM" faces criticism such as the overlapping between the stages in the model. Certainly, depending on the nature of technology and determinants of host country, some technology may be so desirable that the user or the transferee firm adopts them during the physical transfer stage of technology, thus by-passing the subsequent stages. In addition, some of the stages may be carried out in parallel, such as the Diffusion Stage and Assimilation Stage or the Anchorage Stage and the Diffusion Stage and Assimilation Stage or the Anchorage Stage and the Diffusion Stage. It means two stages could start together, depending on the governments policy, strong economic motivation of the host country as well as how effective is the network of information, level of co-operation and collaboration between the firms, universities, R&D departments in the host country. Adikibi's point of view to this criticism, is that the overlapping between the stages presents no problem to the course of objectives of the stages. Because the overlapping activities between the stages contribute principally to the objectives of the stage, to which they belong.

The second point is the determination of the time span of each stage, and thus the entire acquisition process. Various factors may effect the completion time of each stage. For example the time span required to complete the Anchorage Stage for say, the computer manufacturing in the ARE may differ from the time required for the completion of the same stage in textile manufacturing. Adikibi argues that if one identify and determine which of the factors or combination of them have or exerts the greatest influence, the time span or speeding up the acquisition or delaying it, of each stage will respond accordingly.

The purpose of this model, as was declared by its developer, is to analyse and assess the process of technology transfer to and within the industries in the developing country. This could justify the absence of feedback arrows, for the indication of flow of information from developing country industries to the parent firm in the developed country.

SECTIOIN III: A CRITICAL ANALYSIS OF TECHNOLOGY TRANSFER MODELS

We believe that most traditional technological transfer models are based on a closed-economy assumption. This may have been suitable in 19th century and early 20th century. However, the post-World War II period has experienced greater globalisation in world economy.

The traditional technology transfer models are thus outdated. These models are based on a narrow definition of technology (i.e. process technology) and, as mentioned above, closed economy assumption. If we relax these definitions and assumptions, the traditional models fail to explain technology transfer.

We shall relax these assumptions and assume open economies a broader definition of technology. The open economy assumption opens up new avenues. For instance, a country with a system of flexible exchange rates may find it difficult to attract FDI in all sectors of the economy as MNC's may prefer to change outsourcing of raw materials and sub-assemblies to countries with devalued exchange rates.

The broader definition of technology implies that in the new millennium, transfer of knowledge is the key issue. Thus an LDC country may not be able to transfer (process) technology completely, but may be able to excel in other aspects of technology/knowledge transfer.

The important point to emphasise is that in today's globalised economy, technological transfer in the traditional sense is no longer relevant. What is relevant today is to transfer technology in the broad sense which we call knowledge transfer that enables a country to succeed in an increasingly competitive world economy (see World Bank. 98/99: Knowledge for Development).

The technology transfer models we have viewed so far are based on closed economy assumption. They are fair descriptions of the technology transfer in the 19th century and early 20th century. For instance, USA, Germany, Russia and Japan began industrialisation in the second half of the 19th century. They all relied on import substitution strategy using tariffs as protective measures. The main argument was 'infant industry' (Alexander Hamilton in the USA and Frederick List in Germany).

In the 20th century the prime examples of ISI has been the former Soviet Union, Brazil, India, Iran and Nigeria. The former Soviet Union used the licensing method to transfer technology. It is clear from the ideological perspective of the Soviet Union that technology should be transferred with a view to economic independence from the imperialist west. For Japan a similar perspective existed as Japan since the Maiji Restoration in the 1870's was desperate to stay independent and avoid colonisation by the west. China's attempt at economic independence in the 1950's shadowed the Soviet experience.

However, when we consider countries that were allied to the West or were independent from the West and East, the motive for ISI was based on Prebisch-Singer Hypothesis. We should not forget, however, that this period (1950's-1960's) witnessed the Bretton-Woods system of fixed exchange rates.

The Bretton-Woods system encouraged both trade and FDI. Countries like Brazil had an open policy of welcoming FDI in their ISI strategy. Brazil experienced high growth rates in this period as it enjoyed a high level of FDI and a substantial growth in feeder industries (e.g. MVI). Technology transfer was almost complete in Brazil with Ford (Brazil) achieving almost 100% domestic content by the early 1970's when the Bretton-Woods system broke down.

The breakdown of the Bretton-Woods system was due to a number of factors that need not concern us at this point. Here we are rather concerned with the implications of this breakdown for the industrialisation in the South and technology transfer by MNC's to LDC's.

To a lesser extent Japan also used licensing (Stewart, 1978). This method of technology transfer is suitable in a number of sectors of the economy where brand names, trademarks and ultimately quality control are not essential. These sectors include engineering industries (and in general capital goods sector) and those consumer goods industries that at early stage of development of a country where the object is to meet 'basic needs', do not depend on brand loyalty, product differentiation etc. e.g. textiles, hygiene goods such as soaps. Thus technology could be transferred in the second half of the 19^{th} century and the first half of the 20^{th} century through licensing.

The post-war period presents a different picture altogether. In this period, both in the North and South we witnessed rising per-capita incomes, consumerism and rising expectations as well as changing lifestyles associated with the rise of sub-cultures as well as social movements (civil rights, Women's Liberation).

Consumer products, product differentiation, quality, etc. in the context of rising per-capita incomes and increasing competition (Auerbach, 1988) made licensing a less attractive route for technology transfer.

Thus licensing that essentially led to some kind of technological independence (through complete transfer of technologies) became less relevant as the emerging industries in the South had to cater to more sophisticated customers in an increasingly competitive world economy.

In the post-war period we witness an increased role in technology transfer for FDI, joint ventures, franchising, management contracts and turnkey projects.

Thus, compared with the late 19^{th} century and early 20^{th} century methods of technology transfer, we are faced today with a multitude of methods. These methods are based on factors ranging from consumer loyalty to brands to the complexity of technical know-how. A recent study of technology transfer in car industry in Egypt (Taha, 2002) shows how this industry from the end of World War II to the present has moved from a strategy of complete (process) technology transfer (ISI) to a more market and export oriented strategy that may not require complete process technology transfer.

THE TECHNOLOGICAL DEPENDENCE/INDEPENDENCE PARADIGM

This assumes that it is possible for each country to achieve technological independence (Stewart, 1978). While historically there are precedents of technological independence (e.g. Britain in the 19^{th} century and to a limited extent USA, Japan and the former Soviet Union) the paradigm is clearly based on closed economy models. If we look at any of the above cases it is clear that none of them achieved technological independence in the long run.

It is possible to conceive of successful technology transfer and the independence in particular sectors of the economy where the forward and backward linkages are weak, or in the service sector where domestic suppliers are easy to organise. But when we consider a complex product such as a car, that uses thousands of parts, it is almost impossible to conceive of complete technological independence, except in large countries in their early stage of development.

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