NORTH/SOUTH TECHNOLOGY TRANSFER

THE ADJUSTMENTS AHEAD

ANALYTICAL STUDIES

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development;
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ÉTUDES ANALYTIQUES

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INTRODUCTION

The import and use of foreign technology continue to be of great importance for the industrialisation of developing countries. North-South economic relations cannot be understood without a clear appreciation of the way in which the technology of industrialised countries is created, diffused, and used in the industrialising countries. Without such knowledge and understanding, progress in North-South relations will be limited.

As a contribution to understanding the evolution of North-South technological relations the OECD Committee for Scientific and Technological Policy decided in October 1977 to examine the effects of North-South technology transfer on OECD economies and the implications for science and technology policies. One result was the Secretariat synthesis report published under the title North/South Technology Transfer: The Adjustments Ahead.(1)

The analytical and sector studies on which the synthesis report was partly based are now being circulated more widely following the recommendations of the Committee for Scientific and Technological Policy.

The analytical studies were commissioned in 1978 and most of the work was revised and finalised by the end of 1979. Studies of the Changing Legal Framework and the Identification of Sensitive Industries and Technological Trends were completed in mid-1980.

The analytical work presented here addresses four general problems. These are:

i) definition of the characteristics of technology diffusion and some criteria for measuring this diffusion;
ii) the role of imported technology in industrial development;
iii) changes that are associated with the use of imported technology; particularly
iv) the nature and magnitude of changes in established world patterns of output, employment and income.

Related to these general problems are more detailed ones. We must find out what is being transferred: is it machinery, licences, technical services, educational resources, R&D facilities? How is the composition of transfer changing, to whom is the technology transferred (to affiliates or to independent agents), and what are the terms of transfer? How well is the technology being absorbed and used? What are the effects and how are they distributed within and between countries?

Although each of the analytical studies touches on all four general problem areas, each concentrates on particular problems or on sensitive areas for government policy. While the note by Dunning sets out to define some of the characteristics of technology transfer, the study prepared by Rosenberg looks at the international diffusion of

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1) OECD, Paris, 1981.

technology and draws the lesson from economic history that continued flexibility and change is one imperative for long-term economic success. The studies by Graham and by Delorme look at national and international attempts to alter the terms of transfer and influence the price and economic effects of using imported technology. They also discuss the very different viewpoint that many developing countries have adopted. Finally, work from the IFO-Institut sets out to look at some implications of prospective changes in world patterns of output.

Although we concentrate on the effects on OECD countries in the synthesis report, it is essential that other aspects of technology transfer, including the economic evolution of industrialising countries and an historical appraisal of technology transfer, be considered if the effects are to be fully appreciated. Despite the aim of manageable comprehensiveness, all aspects could not be analysed. The social effects of modern technology in developing countries were not considered in detail, neither were aid policies and programmes; these present specific problems which were outside our terms of reference.

The collection of analytical studies begins with a short note by Dunning, discussing some important features of technology transfer and effects associated with it. The note was prepared to raise some of the problem areas to be considered in subsequent analytical work. It should not be considered as a strict set of guidelines for the remaining studies. For example, in each of the analytical studies, authors explicitly or implicitly considered the concept of technology transfer which was most suitable for their particular study. This diversity reflects the wide range of opinions on the relative importance of different determinants and effects of transfers. Some of this diversity of opinion is reflected in the definitions discussed in the synthesis report.

The historical study undertaken by Rosenberg traces the inevitable diffusion of industrial technology and industrial methods of production from Britain to continental Europe and their subsequent spread to the United States, Japan, and Russia. The experience of Britain, the nature of her economic and structural changes and the impossibility of preventing the diffusion of new technology abroad (with a consequent boost to the productivity, output, and competitiveness of countries importing the technology) are all treated in some depth. From this analysis are drawn some general factors which shape contemporary transfers to developing countries and some elements that will influence the future.

The study prepared by Graham begins by discussing the terms of transfer of industrial technology and some of the determinants of technology pricing. Price dynamics and the possibilities of influencing price structure are examined next. Finally, the study discusses attempts by governments in developing countries to influence the terms of technology transfer.

The changing international legal framework for technology transfer is examined by Delorme. Currently there are a number of continuing negotiations to define new legal arrangements or guidelines, or to revise existing arrangements. These have mainly been initiated by developing countries wishing to modify the monopolies held by inventors and owners of industrial property rights. Traditionally it has been recognised that investments in the creation of new technology may be rewarded by granting monopoly rights or allowing the monopoly use of that technology. These rewards provide incentives for continued investment in invention and innovation. But it has been argued that another result of granting monopoly rights may be the sub-optimal use of new technology and inefficiencies in overall development. It is difficult to devise a mutually acceptable system that rewards the creators of knowledge and ensures that the knowledge diffuses

at an optimum rate. The study on the legal framework emphasises that this may be even more difficult internationally when developed countries seek to reward invention and innovation by acknowledging proprietary rights and by maintaining a system that allows enterprises some flexibility in their international agreements, while at the same time developing countries seek to maximise their access to technology to accelerate industrial development. The study goes on to examine the background and progress of international negotiations that are attempting to set up or revise international rules that have a bearing on the creation and diffusion of technology.

Finally, the study from the IFO-Institut attempts to identify industries in OECD countries that will be most affected by transfers of technology to developing countries and by their industrialisation. Following this analysis, the study suggests some possible lines of action for technology policy.

It is clear from the studies that North-South issues cannot be treated in isolation. They are one aspect of the general problems linked to technological leadership and the diffusion of technology, and the desirable extent and direction of government intervention in the development and spread of new technology. It is hoped that the studies will contribute positively to continuing discussions on North-South relations and that they will also provide useful general insights into the factors affecting the international diffusion of technology.

1

TOWARDS A TAXONOMY OF TECHNOLOGY TRANSFER AND POSSIBLE IMPACTS ON OECD COUNTRIES

by
J.H. Dunning*

Technology, as a particular form of resource endowment, has been variously defined. The simplest, yet all embracing definitions, include those of Root[1], "the body of knowledge that is applicable to the production of goods and the creation of new goods", and of Jones[2], "the way in which resources are converted into commodities".

Other writers have attempted to identify, more specifically, the "what" or "how" of technology, or to classify types of technology by one criteria or another. Thus, Baranson in a study on the transfer of industrial technology[3] defines such technology as "the knowledge set of processing and/or fabricating techniques required to produce industrial materials, components and end-products". Typically, it includes "data on equipment requirements, detailed processing sheets, standards and specifications for raw materials or industrial materials, quality control procedures and other related technical information". Teece[4] argues for a distinction between technology embodied in physical terms, e.g. capital goods, blueprints, technical specifications, and that which takes the form of information which is necessary for the efficient utilisation of this hardware. He identifies such unembodied knowledge as "methods of organisation and operation, quality control, and various other manufacturing procedures". References to this latter form of technology would appeal to writers like Gabriel[5,6] who emphasize the role of both managerial and organisational skills in the technology creation process.

The extent to which human capital as well as physical capital should be considered as a form of technology has never been completely resolved in the literature. The dividing line between the two forms is difficult to draw, if for no other reason than today's physical capital embodies the innovatory skills and application of yesterday's human capital. Some economists prefer to distinguish between various forms of real capital (rather than technology). Johnson[7], for example, distinguishes between the embodiment of knowledge contained in plant, tools, machinery, or other items of capital equipment (material capital); or in intangible assets, e.g. knowledge about production marketing or financial processes, or in rights to these, e.g. specifications, blueprints, patents, etc. (knowledge capital); or in specialised skills, e.g. management, marketing, finance and organisation, which help create new information and ideas, and make better use of the other forms of capital (human capital). A similar distinction was used by UNCTAD in guidelines for the study of the transfer of technology to developing countries. To quote:

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"Technology is an essential input to production, and as such it is bought and sold in the world market as a 'commodity' embodied in one of the following forms:

i) in capital goods and sometimes intermediary goods which are bought and sold in markets, particularly in connection with investment decisions;

ii) in human labour, usually qualified and sometimes highly qualified and specialised manpower, with capacity to make correct use of the equipments and techniques and to master the problem solving and information producing apparati;

iii) in information, whether of a technical or of a commercial nature, which is provided in markets, or kept secret as part of monopolistic practices."*

Another group of writers tend to emphasize the different organisational characteristics of technology. Quinn/8/ was one of the first economists to distinguish between proprietary technology, i.e. that owned (or controlled) specifically by particular institutions and non-proprietary technology, which includes not only the results of new knowledge contained in the technical literature but "direct purchases of hardware or services, technical service activities backing up these sales, demonstrations of modern management technologies, technical assistance to suppliers and customers, and observation and imitation of proprietary technologies". Along similar lines, Hall and Johnson/9/ and Hayden/10/ stress the distinction between general, system-specific and firm-specific technology.** In the 70s, the modality of marketing technology has also come under scrutiny; in particular, whether it is transmitted between two independent economic agents, at arms length prices, or internally within the same enterprise on a non-contractual basis.

A final area of debate has been to do with the distinction between technology and technological capacity; viz. technology as a flow of knowledge and technology as a stock of knowledge. It is possible, so it is argued, that technology may be transferred from one country to another, without there being a change in technological capacity of either country. This may be true if one thinks of technological capacity as the ability to generate new technology and of technology as an input fed into a particular type of production process. But the dividing line is rarely a hard and fast one, if for no other reason than that the learning process associated with acquiring the new technology may help advance the capacity of the recipient to create future technology. The Japanese case is a classic example here.

In some respects, this last area of debate reflects the different areas of activity to which technology is applied. A transfer of research and development (R & D) capabilities, for example, will tend to add to a country's stock of innovatory capacity, more than a transfer of production or marketing technology. To some countries, the ability to generate new technology is one of the most important criteria by which imported technology is evaluated.

To this bewildering array of conceptions, another dimension is added when one considers the word transfer. Again, interpretations differ; nor, indeed, is there any consensus on exactly what should be the focus of attention. Essentially, in the present context, one is concerned with the modality by which one country acquires technology or technological capacity from another. The word transfer in the literature seems to

* UNCTAD, TD/B/AC.11/9, December 1972.

** General technology refers to information common to one industry and possessed by all firms in the industry; system-specific technology is when a firm in manufacturing an item acquires information that is peculiar to that item; firm-specific technology is knowledge or skill which is unequal for any particular firm.

embrace any form of transmittal of technology between institutions, or within the same institution, over space. In everyday use, however, it suggests that the transferer loses what is being transferred to the transferee; certainly, dictionary definitions which use words such as "convey, hand over, make over possession of ..., etc." support this view. Clearly, in the case of so called "public goods" - i.e. goods or services, including some forms of knowledge, which once produced can be transferred from the transferer to transferee, without any cost on the transferer's part, this is not the case. In this case, dissemination or diffusion may be a more appropriate term/11/ - although not all forms of dissemination are costless./4/

There are several other words of similar meaning; each differs in nuance, but, as a generic expression, to cover all forms of acquisition of technology by one individual or institution, or part of an institution, from another, the word transmit seems to be particularly appropriate, as it covers both the actual exchange of knowledge and the dissemination of it. In defining transmittal, the dictionary focuses on the "communication" aspect of the acquisition process.

TOWARDS A TAXONOMY OF TECHNOLOGICAL TRANSMISSION

The particular attributes of technology transmission which command the interest of any research investigator will naturally depend on the purposes of the investigation i.e. what exactly one is trying to find out. In this present study, one is primarily interested in the effects which the acquisition of technology by developing countries from developed countries (which are Members of the OECD), in which the latter have been willing participants* and which involve some form of institutional arrangement, may have on the achievement of objectives of the technology exporting nations and on policies directed towards these goals. In particular, one is interested in the extent of and kinds of technology being transmitted, to whom they are transmitted and the terms on which they are transmitted. In turn, each of these variables will be influenced by the modality or vehicle of transmittal and the characteristics and goals of the parties involved in the transmittal. In particular, whether the technology is being transferred between countries internally within multinational enterprises (MNEs), or between institutions in host countries, or by arms length contractual agreements between private and/or public bodies, may be of considerable importance in influencing the repercussions of the transmission in the sending country.

a) Technology

We will begin our consideration of the main types of technology with the broadest possible conception of technology as "a resource which comprises knowledge applied to improving the efficiency of the production and marketing of existing goods and services and of the creation of new goods and services". A first important distinction is between the technology of innovation (i.e. the type of technology which adds to the recipient country's capacity to create new technology) and the technology of production, taking production to embrace all stages in the production process from the extraction of minerals and raw materials and agricultural pursuits, right through to the marketing of the final products, including the supporting service industries, e.g. insurance,

* We abstract from the consideration of acquisition by stealing of free or virtually free goods, e.g. knowledge disseminated through professional and scientific and technological journals, through universities and research institutions, through personal contact at conferences, etc.

banking, finance and consultancies. This initial distinction is an important one, although as we said earlier, it may be a difficult one to draw. In a sense, all imported knowledge adds to the technological capacity of a country, in that it may help to produce goods which otherwise would not be produced (or produced as cheaply). However, not all knowledge is capable of generating or even sustaining itself. The transmittal of a chemical formula may help a recipient country to produce the chemical in question; but it will not necessarily help it discover new formulae or even adapt it to its own needs. Clearly, the effects on an industrial country which helps a developing country to set up its own chemical R & D facilities might be very different from those which simply licensed its formulae to that same country.

This first delineation of technology may immediately be followed by two others; the first distinguishes between material, product and process technology, and the second between the operating areas in which innovation and production technology may be applied. It is worth noting that the relevance of the sub-areas will vary quite considerably between industries; for example, in some consumer goods industries, the technology of marketing is likely to be a more important ingredient in the total package of knowledge than in capital goods industries; in the more technologically intensive sectors, innovatory technology will tend to be valued more highly than in the less technologically intensive sectors.

The next distinction is between human, material and knowledge technology, i.e. the form in which the technology is transmitted. The technological capacity of a nation might be advanced by an immigration of managers, skilled scientists or laboratory technicians to the acquiring country; or by the import of knowledge contained in plant design, formulae preparation,etc.; or by the purchase of plant and equipment. Production, marketing and organisational technology might be similarly classified, although the balance between the forms may well differ between the sectors, e.g. human capital is obviously of vital importance in managerial and organisational technology; knowledge and physical capital may predominate in the highly technical manufacturing processes.

Moving further, we might next inject the Hall and Johnson distinction between what they call general, system specific and firm specific technology. General technology, in the form of information common to an industry or trade, e.g. as contained in professional publications, may well be easily available, and the home country may have difficulty in controlling its export. Firm specific technology, on the other hand, is that specifically attributable to an enterprise's experience and activities excepting that which may be associated with any specific items a firm produces. This latter type of knowledge may be called system specific, except that such information is usually available for other firms to acquire. It would also be possible to sub-divide these characteristics according to whether they were proprietary or not.

b) The terms of transfer

A second important area of interest concerns the terms on which technology is transmitted. These will, of course, vary not only between the different types of technology, they will also be strongly influenced by both country and organisation/modality factors. The first breakdown of the terms of transmittal is between the payment charged for the technology and the conditions attached to its provision. The payment may vary from zero or near free to a monopoly price, depending on the type of technology being marketed and the underlying supply and purchasing conditions. The price itself may take different forms, e.g. a contracted lump-sum payment, a royalty based on the value of sales of the product in which the technology is embodied, an administrative and

service fee, or a combination of the three. In the case of technology supplied within a MNE, part of the reward may take the form of profits and dividends, or of gains resulting from intra-company transfer pricing.

The conditions attached to the supply of technology (which may be imposed by the supplying or purchasing firms, or by Governments of supplying or purchasing countries) may range from none to a complex set of controls or restrictions on:

i) the use made of it,
ii) the markets to which the products it helps to produce may be sold, and
iii) the sourcing of inputs, both to produce the product in question and others manufactured by the transferee.

Conditions may also embrace the supply of cross-licensing agreements and other knowledge-sharing facilities. Both the price and the conditions of sale for any given amount of knowledge may vary considerably with the organisation/modality of transfer.

Clearly the terms and conditions of transfer may affect both the supplying enterprises and supplying country's attitude towards the transmission of technology. But often the real costs and benefits to a country extend beyond those which affect the individual firms involved in the transfer; often too, they are consequential upon a transfer rather than agreed as part of the initial contract. Here, the distinction between the private and the social costs and benefits of technology transmission becomes relevant. Moreover, it becomes inappropriate to talk about terms - in the sense that these imply a package of payments and conditions agreed in advance, or, at least, in the case of a MNE, a reasonable expectancy of a return on the investment necessary to generate the technology. Instead, attention is directed towards the impact of technology transmission on particular goals. To take an example: to a supplying country, the benefit of increased income from abroad earned from a technology transfer made by one of its own companies might be reduced by any additional domestic unemployment, which might be the direct result of that transfer. On the other hand, the export of technology might lead to an increase of exports of goods from the transferer or other companies in the sending country, to the benefit of both, beyond that of any direct receipts of royalties, fees, profits and dividends. Much of the evidence on the benefit of the effects of foreign direct investment (see Hufbauer and Adler[12], Reddaway et al. [13], Streeten and Lall[14] and Hawkins[15]) suggests that a lot of the benefits of technology transmission take this form.

Sometimes, of course, Governments may themselves influence the terms and conditions of technology transmission to ensure that, as far as possible, they are consistent with national interests. Of these, yesterday's effects will be reflected in today's terms. Here country specific factors enter the picture. Home governments may insist on their foreign affiliates not exporting certain kinds of products to certain countries, or forbid certain types of knowledge from being transmitted, or insist upon payments for the knowledge taking a certain form. By contrast, efforts of host Governments are usually directed to minimising the price paid for imported technology and/or of ensuring that the conditions attached to the transmission (e.g. with respect to export restrictions) do the least possible damage to the (perceived) national interest.

c) Country-specific factors

We will now turn to some of the country-specific factors likely to affect the impact of technology transmittal on the supplying countries. Here, we argue that the same technology, provided under similar conditions and terms, may differently affect the

supplying country and any consequential policies it may pursue, according to the variety of factors specific to that country. Is the recipient country a developing or developed country? Is it an industrialised economy or not? Is it a competitor to the country supplying the technology or do the resources and needs of the two economies complement each other? Is it a powerful or a weak nation in the international bargaining stakes? Is the technological relationship a symmetrical or an asymmetrical one? What sort of technological infrastructure does the recipient economy have? What of its political ideology, its market structure and its economic stability? These and other factors will influence the terms of transmission, both agreed and consequential.

d) The forms and modalities of transfer

A fourth set of factors is perhaps the most important of all because these factors influence the other three. They cover some of the main organisational forms and modalities of resource transmission. First, we must distinguish between commercial and non-commercial transferers and transferees. The former largely comprise firms, although individuals may also perform this role. Non-commercial institutions include governments, international agencies, e.g. the UNCTAD and the World Bank, and non-profit making private institutions, e.g. charities. Second, there are three main forms of transmission:

i) gifts,
ii) contracted technology,
iii) non-contracted technology,

the second being further classified as to whether the transmission is primarily undertaken within the normal operations of an MNE or between independent parties. We say primarily, because it is possible that a specific piece of technology may be transferred on a contractual basis within the general form of an equity involvement. Another way of looking at these forms is whether they are conducted within the same enterprise, i.e. internal transmissions, or whether they are conducted between different enterprises, i.e. external transfers./16/

The next important distinction is between the various kinds of each type of transfer. Gifts, for example, may take the form of inter-Government assistance or donations from private charities. There are a host of contractual arrangements. These range from turnkey projects - predominantly intended to export and start-up a manufacturing operation (e.g. the Togliatti plant set up by Fiat in Russia) - through management contracts, franchising, leasing arrangements, co-production and complementation agreements to straightforward licensing. There is some evidence to suggest that the contractual form of resource transmission is increasing in importance, relative to that of direct equity investment (see Dunning and Pearce)./17/ Developing countries tend to prefer this form because they believe it retains decision taking within indigenous firms; in addition, most contracts are time-limited and can be renegotiated. New varieties of contractual ventures - some involving consortia of both private and public institutions - are evolving all the time. Some examples of these are contained in papers by Baranson/3/ and Gabriel/6/.

The organisational strategy of the technology transfer is especially important in the case of MNEs and some of the larger companies which engage in contractual ventures in several countries. The key question concerns the strategy they adopt towards their overseas operations and the control they exert over them. This tends to be reflected in the conditions attached to particular contracts or in the general control exercised

over international resource allocation and markets in the case of fully owned or majority owned affiliates of MNEs. The more integrated the transferer is in its global operations, the more likely decisions over product and production strategy, investment expenditure, R & D, market allocations, purchasing outlets, managerial recruitment and so on, are to be centralised.

Such centralisation of decision taking by MNEs often provokes fierce reactions on the part of host Governments; indeed a great part of the disquiet and hostility of developing Governments about the effects of MNEs has rested on the claim that in pursuing global strategies, they have taken decisions which have affected resource allocation in their affiliates in a way which has not been consistent with national interests. This has led Governments both to limit the extent to which MNEs might participate in host countries, and to encourage or enforce the indigenous action of decision taking within affiliates of MNEs. Such policies have not always been successful, often the real power to control decision taking turns not on the ownership of equity capital but on the possession of a unique firm-specific asset - usually some form of technology. Studies of industries in which there is little or no equity participation suggest that foreign firms may exert a great deal of control over decision taking and that the right to exercise this control is built into contractual agreements. This right is particularly jealously guarded in the type of firm which produces a more or less internationally standardized product or service wherever it operates, and there is a need to ensure that the appropriate quality, in fact, is achieved. Airlines, hotels, catering establishments and car rental companies are examples of such activities.

We may further widen our considerations to include the functional areas in which control over decision taking (affecting the conditions of transfer and hence the return to the transferer and transferer's country) and the ways in which this control is exercised. These are self-evident and link with terms of transfer, country-specific factors and the modality of transfer. Hence, management contracts might be expected to contain more control over decision taking than straight licensing agreements; control over hotel management might be greater in a developing country entering, for the first time, into the hotel business, than a developed country with long experience of running hotels; control over labour recruitment might be less than over investment expenditure, R & D and so on. Again, industry and firm specific factors are likely to be important.

A SELECTION OF THE KEY VARIABLES FOR CONSIDERATION

From this jungle of interrelated factors, all of which, in some way or another, are likely to have some effect on the costs and benefits resulting from the export of technology, there is need to identify the most important, or potentially the most important, ones, so that they may be examined in some detail in the rest of the study. As we argued earlier, the first necessity is to specify the criteria by which effects are to be judged. What goals are developed countries seeking to achieve which might be advanced or thwarted by transmitting technology to developing countries?

Unfortunately, different technology producing countries have different goals, particularly in the non-economic field. But all, to some degree or another, are interested in the impact of technology exports on a number of key strategic and economic variables. It may not be unreasonable to assume that those identified for the United States by Nau [18] are the concern of most, if not all, OECD Member countries. Nau and his co-authors examined the impact of industrial technology transfer from the United States to

four groups of countries (viz. the Soviet Union, advanced Western countries, resource-rich developing countries and resource-poor developing countries) on five main policy objectives of the United States. These he initially identifies in terms of the motives for transfer, but one could equally view the table from the perspective of the effects of a technology transfer, whatever the reason for it in the first place. Nau's classification is reproduced in Table 1; it is self-evident and reasonably comprehensive. Clearly, these goals are not necessarily mutually consistent, in the sense that they are simultaneously obtainable; moreover, the value and priorities attached to them may vary over time. Nau himself suggests that postwar developments in the United States changed the main emphasis of evaluating technology transfers from a largely military and strategic perspective, which prevailed from the end of World War II up to the early 60s to an economic and industrial one in the later 60s. Although this emphasis remains in the 70s, it is increasingly being tempered by an awareness of social-environmental implications such as those currently illustrated in the controversies over the export of fast breeder nuclear reactors and supersonic aircraft.

Table 1

MOTIVATIONS OF TECHNOLOGY TRANSFER

Motivation	Definition
Military-strategic	Use or value of technology transfer for the development, manufacture or deployment of military capabilities, i.e. weaponry and forces: a. directly enhance military capabilities b. improve civilian capabilities and release resources to military outlays or to offset adverse civilian effects of existing military outlays.
Foreign policy-diplomatic	Use or value of technology transfer for influencing intentions (as compared with capabilities) in the international arena.
Economic-commercial	Use or value of technology transfer for profit or commercial gain.
Social-environmental	Use or value of technology transfer for improving the "quality of life," i.e. consequences for equity and ecology (as compared with commercial gain).
Administrative-institutional	Use or value of technology transfer to advance organisational or bureaucratic interests within US domestic system.

Source: Compiled by Nau. [18]

Nau discusses some of the implications for US Government policy and initiatives towards technology transfer, expressed through such modalities as foreign assistance, export control, NATO and so on. However, the general thrust of his argument is that the main actors and initiators in technology production and transmission have shifted from non-commercial to commercial institutions, although indirectly by a variety of Government controls and policies, not specifically to do with technology, the capacity and direction of technology creation and dissemination by private industry is affected.

Thus food and drug legislation has influenced the pattern of innovation in the pharmaceutical industry; Government procurement policy has fashioned the direction of R & D in the computer and micro-electronic industry; Government space programmes have had a wide range of spin-off effects on several industries, and so on. Though Governments may be less directly involved in the technology business, indirectly by their strategic economic and social policies,they continue to exercise considerable control over the direction of industry's technological capability and exports.

The Nau approach may be easily extended to cover the other industrial Member countries of OECD. Basically, one suspects, the trends identified in the United States have been experienced, to a greater or lesser degree, by all industrial nations. The economic and industrial consequences of technology creation and export are uppermost in framing Government policy, although in the longer term (as Gilpin[197] and others have pointed out) improving relative economic strength may be as important a political goal. Anything which causes a shift in the distribution of income and wealth between countries might then be considered as having some political implications. The initial economic strength of nations, i.e., their position in the international productivity and growth league, might then influence their attitudes towards anything, for good or bad, which might affect this position. They may also have different attitudes according to which countries acquire their technology, for example, from the viewpoint of their actual or potential industrial competitiveness.

Some papers at an OECD conference in 1975 on the impact of MNEs on scientific and technological capacity of Member countries identified some of the components of scientific and technological policy in these countries. Outside certain industries, regarded as key industries in terms of security or strategic goals, policy such as it was at that time seemed mainly to be directed to achieving certain economic and industrial objectives. Though again these varied in emphasis between countries (some countries may aim for more economic independence than others), it may be possible to pinpoint a set of common criteria which guide most countries in their scientific and technological strategy. However, despite some commonalities, the country studies also suggested that at that time there were considerable differences between countries in the extent to which they pursued an identifiable science and technology policy and the type of contents of such a policy.

A TAXONOMY OF IMPACTS

In this section, we suggest there are two main ways of looking at the impact of technology transmission on the sending country. The first is to look at any transmission - whatever type or form it takes - on particular sectors of the home country, in terms of their perceived goals. The second is to discriminate between the forms of technology transmission, by the different economic and other effects they have.

a) A general classification of impacts

Impacts might be considered at a highly aggregated (macro-) or highly disaggregated (micro-) level. The most usual classification is between:

i) country,
ii) industry or sector,
iii) region,
iv) particular interest groups (trade unions, businesses, consumers, etc.), and