Technological Dependence : Its Nature, Consequences and Policy Implications

Report by the UNCTAD Secretariat*

THE NATURE OF TECHNOLOGICAL DEPENDENCE

The concept of dependence can be given several interpretations varying from « reliance », which can be mutual, to « being subordinate », which is certainly asymmetric. It is important to distinguish between these different connotations in analysing « technological dependence ». Technological dependence of one country on another in the sense of mutual reliance is not in itself a cause for concern, and may indeed facilitate prosperity through division of labour. The United Kingdom may well rely on the ability of France to make wine, while France relies on the ability of the United Kingdom to produce whisky. The picture is quite different when the relation is one-sided, and the concept of « technological dependence » refers to such an *asymmetric* form of dependence. A typical developing country depends technologically on developed economies in a manner that is quite asymmetric, involving a relation of subordination, and it is this asymmetry that makes the notion of technological dependence a central concern in economic development.

The developmet of the asymmetric features of technological dependence is largely the result of the industrial revolution, and in particular of the form that modern capitalism has taken. The dominance relations of the colonial era have helped to foster and perpetuate this asymmetry. The growth of such asymmetry and its numerous implications have been extensively discussed in recent years by economists of varying schools of thought. The characteristics of dependence as it exists today cannot be dissociated from the historical process that has brought this asymmetry into being while the experiences of the developing countries in different parts of the world are by no means uniform, there are enough characteristics in common to make it fruitful to view technological dependence as a global problem, without of course losing sight of variations within the over-all pattern.

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This chapter seeks to identify the various manifestations of technological dependence. Technology involves not merely the systematic application of scientific and other organized knowledge to practical tasks, but also the social and economic atmosphere within which such application has to take place (1). Furthermore, technology refers not only to ways of *producing* goods, but also ways of *fulfilling* needs and deriving satisfaction. The technology of consumption has a profound impact on the structure of the economy, influencing the goods and services to be produced (2). Even the attitudes and values of people are, in a sense, a part of technology since they affect the capabilities of a nation (3). Broadly defined, « technological dependence » covers all these issues and it is in this broad sense that the expression will be used in this report.

There are several distinct though highly inter-related aspects of technological dependence of developing countries. Bearing in mind the relevance of asymmetry in the concept of technological dependence, the following aspects — some of which are obviously more important than others — seem to need careful scrutiny.

A. *WEAKNESSES OF PRODUCTION AND TRADE STRUCTURES*

1. *Asymmetry of commodity pattern*

A somewhat intractable but important aspect of technological dependence concerns the asymmetry of commodity pattern. The types of consumer goods consumed in developing countries reflect the influence of *mores* in the advanced industrialized nations, and this applies particularly to the consumption of the upper classes (4). The technological dependence of developing countries on the richer ones thus extends to taste formation also, leading to a significant restriction of the economic options open to developing countries (in the absence of radical political changes transforming the structure of economic classes on which this commodity pattern depends).

2. *Assymmetry of means of production*

Asymmetry of means of production reflects the typically sharp difference in the abilities of developing and developed countries to produce machinery and other capital goods needed for production. This is certainly one cause of the contrast between technological capabilities of different types of economies (5). There is little doubt that the sophistication needed in the manufacture of capital goods makes an important contribution to the utilization and adaptation of these goods, especially when modern designs are involved.

3. *Asymmetry of trade bondage.*

One consequence of the dependence of developing countries on the more industrialized nations for the supply of technical know-how, patents, management and finance is the power that rests in the latter countries to influence trade policy in the former. This can, for example, take the form of an agreement by the developing country not to export certain products utilizing specific know-how, or a requirement to import machinery and other goods from some specified enterprise. This asymmetry of trade bondage may put a developing country at a considerable disadvantage in the utilization of modern technology and in making use of the best available exchange opportunities (6).

B. *TECHNICAL AND FINANCIAL DEPENDENCE*

1. *Asymmetry of technical knowledge*

Asymmetry of technical knowledge largely reflects the fact that modern techniques of production were typically evolved in the developed countries and that there are barriers — both natural as well as artificial — to the transmission of this knowledge.

This technical asymmetry leads to two rather different consequences, namely (a) the absence in developing countries of some technical knowledge that is widely available in the developed countries ; and (b) the unavailability in *both* developed and developing countries of knowledge of possible technical processes of particular interest to developing countries but not to the developed ones (7). Thus the asymmetry of technical knowledge applies both to the unequal availability of existing knowledge as well as to the world shortage of innovations geared towards the requirements of the economies of the developing countries, e.g., making better use of surplus labour or of specific local resources, including environmental resources, in producing goods for domestic consumption (8).

2. *Skill asymmetry*

The exploitation of production opportunities depends not merely on the knowledge of technical processes but also on the skill to operate these processes efficiently. The shortage of skilled labour in developing countries is, therefore, another aspect of technological dependence. The type of shortage varies from country to country. While some developing countries have a large supply of degree-holding engineers, qualified doctors and scientists, there still tends to be an acute shortage of skills that come mostly from practice and learning by doing. In general the skill asymmetry tends to be sharpest at the down-to-earth level.

3. *Financial asymmetry.*

Financial asymmetry arises with respect to both direct private investment as well as loans and aid from developed countries to developing ones. The financial dependence of developing countries has been much discussed. Since finance is an important part of the control of business decisions, financial asymmetry also implies an asymmetry of decision making. This is most conspicuous in the case of direct private investment, for example for transnational corporations (9), but the influence of finance on decisions is more widespread, affecting public bodies as well. Financial carrots and sticks are frequently very effective, also in the hands of governments of developed countries.

C. *CAPABILITIES FOR CONTROL AND INITIATIVE*

1. *Asymmetry of control*

The last two asymmettries listed are somewhat more general and are related to some of the specific asymmetries already touched upon. The asymmetry of control refers to the fact that many choices facing developing economies are, in fact, made in developed countries, leading thereby to a dichotomy between those who take decisions and those who take the *consequences* of those decisions. This applies particularly to business decisions involving choice of techniques and products for developing countries, especially when made by transnational firms ; this is closely linked with the financial asymmetry discussed earlier. But the phenomenon is more general, and the control reflects the pervasive influence — political, economic and cultural — of developed countries on life in the developing world. It should be noted in addition that there are also asymmetries in terms of regulations that reinforce this asymmetry of control. The imperfect markets for technology and capital often permit industrialized countries to obtain special treatment in the developing countries in terms of governmental regulation. While this is essentially a part of the price that is extracted for supplying technology or capital, the consequences of such concessions are not always easy to understand (10).

2. *Asymmetry of initiative*

Finally, there is a basic difference between the typical developed country and the typical developing one in the ability to assume the initiative in the technological sphere, and indeed in the confidence necessary to do so even when the technical ability exists. In a state of imitative existence, the boldness needed to challenge the received technology is typically absent. This asymmetry of initiative may be hard to quantify, but it is certainly one of the more fundamental characteristics of under-development.

TECHNOLOGICAL DEPENDENCE AND RECENT DEVELOPMENT EXPERIENCE

Although the application of imported science and technology over the last quarter century has brought some progress in accelerating the growth of output, improving material standards of life and spreading modernization, the low-income countries still find themselves unable to meet the basic needs of the majority of their populations. The purpose of this chapter is briefly to consider the extent to which the prevailing approach to industrialization, based on a reliance on the transfer of technology from developed country enterprises, is capable of contributing to a diminution of this problem.

In the 15 years following the Second World War, over 60 countries gained formal independence and the total number since then has grown to nearly 80. These countries entered political independence with a backlog of crushing poverty, massive illiteracy and little accumulated capital or industrialization experience. Emancipation from alien rule was accompanied by a rising political consciousness, which expressed itself in demands for modernization. The best way of accelerating industrialization, it seemed, was to tap the vast fund of production technologies that had already been developed in the advanced countries. The technology was not free but, like the goods that it was used to produce, it was traded and could be bought or leased — mainly from transnational corporations domiciled in the industrialized countries, which had made themselves its proprietors.

A. *THE HISTORICAL PATTERN*

Traditionally, the transfer of technology to developing countries, largely in the form of direct foreign investment, has taken place in the extractive sector (petroleum, mining and export agriculture). This can be seen from the accumulated stock of foreign investment, in which the share of this sector was very high in the past and accounted for nearly one-half as late as 1967, compared with about 30 per cent in manufacturing (11). Additions to this stock (by United States firms at least) more recently, however, have been strongly dominated by manufacturing (12), reflecting in part the results of deliberate policies adopted by the developing countries.

The motivation for foreign investment in the extractive sector has been and is to secure access to critical imports of raw materials for the metropolitan countries and, although the resulting exports

have in recent years helped to generate foreign exchange resources needed for the financing of development, the direct effects on modernization, on the dissemination of skills and on the creation of employment have been quite small.

For all but a small minority of developing countries, the main feature of industrialization after the war was, following the example set by continental Europe and the United States in the latter part of the 19th century, an attempt to create international markets for manufactured goods by the establishment of a system of high tariffs and other types of restriction on imports. The fledgling industries thus created would produce domestic substitutes for goods that had previously been imported. The desire for greater economic independence was a natural outgrowth of political independence. The aim was to secure control of one's own instruments of production and to end « dependence on centres of decision' situated abroad » (13). In the absence of a sufficiently developed entrepreneurial spirit among potential industrialists, protection was felt to be necessary in order to stimulate local initiative, mobilize savings and enhance the establishment of smalll enterprises that could not become firmly established without the umbrella of tariffs.

Thus, there were two cornerstones to the strategy of industrialization : importation of technology from the industrialized countries, and the substitution of domestic manufactures for imports.

B. *TRANSNATIONAL FIRMS, DEPENDENCE AND THE CONDITIONS OF EXCHANGE*

In reviewing the results of this strategy, it is essential to keep in mind the pervasive influence of the world-wide market for technology and of the respective positions of transnational enterprises and developing countries in that market. The market has the following peculiarities : it is highly imperfect, with great monopoly advantage for the seller because of secrecy and/or the protection of patents and trade marks. The production technology (whether in the form of pure knowledge or embodied in foreign investment or machinery) is transferred under terms that are the outcome of negotiations between buyers and sellers in situations approximating monopoly or oligopoly. The final returns and their distribution depend on the relative power of the bargainers (14).

The probability of an unfavourable outcome is highest in the case of developing countries because of the asymmetry of technical know-

ledge discussed in the chapter above. Evidence of it is most vividly seen in the negligible participation of developing countries in the ownership of patents, reported in an earlier study by the UNCTAD secretariat, which shows that only 6 per cent (200,000) of the estimated 3.5 million patents in existence in 1972 were granted by developing countries, and that less than one-sixth of that total was owned by nationals of those countries. (15)

It is true that several developed countries are also heavy net importers of technology and may have few patented inventions to their credit. The seriousness of technological dependence as it applies to the poorer countries, however, is that, because of an absence of experience with modern technology generated by historical factors, there is a lack of skills. This can be of two kinds : (a) a shortage of relatively abstract, high-level skills needed in order to make technological choices — both in firms and in government — to appraise technology and to carry out research on the development of new technologies ; and (b) a lack of the more down-to-earth expertise needed in order to use tools and operate mechanical equipement.

The table below shows the decidedly low endowment of developing compared with developed countries in terms of type (a) skills. Thus, in 1970 there was an average of only about 6 engineers and scientists per 10,000 population for the 8 African countries for which data were available, compared with figures of 22 for Asia and 69 for Latin America. This contrasts with a figure of 112 per 10,000 in developed market economy countries. The poorer performance of developing countries repeats itself for every socio-economic indicator about which it was possible to obtain information. Among developing regions, Africa consistently fares the worst and Latin America generally the best, with Asia in between.

It should not be inferred from the table that the solution to the technology problem is simply to make good the deficiencies shown, e.g., by educating a greater amount of high-level manpower. The existing outflow of scientific personnel from developing countries already demonstrates a probable outcome if such a policy were undertaken in the absence of a parallel increase in the domestic demand for such skills (16). Moreover, the quantitative deficiencies in science and technology depicted in the table may be less significant than the fact that a great deal of scientific and technological activity in developing countries is unconnected with fundamental needs (17). There is no quantitative measure of the comparative lack of the second type of more mundane skills and capabilities directly connected with the productive process. As was stated in chapter 1, these capabilities are not the product of

TABLE

TECHNOLOGICAL DEPENDENCE : SELECTED SOCIO-ECONOMIC INDICATORS

(Averages expressed as medians for 1970 or latest year available)

	Developed market economy countries[a]	Developing countries and territories		
		Africa[b]	Asia[c]	Latin America[d]
I. *SCIENCE AND TECHNOLOGY*				
(i) ratio of total stock of scientists and engineers per 10,000 pop.	112	5.8	22.0	69
(ii) ratio of technicians per 10,000 pop.	142.3	8.3	23.4	72.2
(iii) scientists and engineers engaged in R & D per 10,000 pop.	10.4	0.35	1.6	1,15
(iv) technicians engaged in R & D per 10,000 pop.	8.2	0.4	0.6	1.4
(v) expenditure on R & D as percentage of GNP	1.2	0.6	0.3	0.2
II. *HIGH LEVEL MANPOWER*				
(vi) professionals and technicians as percentage of economically active pop.	11.1	....	2.7	5.7
(vii) percentage of the economically active population employed in manufacturing sector	25.4	3.5	10.5	14.1
(viii) literacy rates (per cent)	96[e]	High[f] Low[f] 20 15	32	77
(ix) ratio of primary and secondary enrolment to school age pop.	92[e]	32	56	78

Sources : (i)-(v) : UNESCO ; *Statistical Yearbook*, 1973, Table 8.3 ; and United Nations, *Statistical Yearbook*, 1974, table 199.
(vi) and vii) : ILO, Yearbook of Statistics, 1974, tables 2A an 2B.
(viii) and (ix) : *Handbook of International Trade and Development Statistics*, supplement for 1973, table 6.8.

formal technical training so much as on-the-job experience which is more difficult to produce. Consequently, their scarcity is the most acute for developing countries.

The most commonly cited advantage for developing countries provided by the transnational corporation is that it offers at one and the same time technology and a package of other crucial inputs such as financial resources, organizing capability, machinery and intermediate goods, and distribution channels for exports. It is frequently overlooked that the transnational corporation also strives to maintain this advantage by consolidating its control over the capacity to generate all of these inputs. In doing so, it deprives the developing country of the capacity to make its own technological and economic decisions. A few statistics will document the dominance that is exercized over one the of above inputs — technology. In the United States, where 70 per cent of all (public and private) expenditure on research and development in non-socialist countries occurs, the transnational corporations accounted for an average of 52 per cent of total private R & D expenditure in 1966, of which only 6 per cent occurred overseas — mostly in Canada, the United Kingdom and Europe (18). Of the 2,760 million Dollar in overseas receipts of royalties and fees for the transfer of technology by United States firms in 1972, it is estimated that between 85 to 90 per cent went to transnational corporations and three-quarters of that sum originated from their affiliated firms (19).

The impact of the transfer of technology is strongly conditioned by the multiplant (or multi-branch) spread of the transnational corporation and its unified approach to the management of its activities so as to maximize global rather than national profits. Although it may have a clear logic in terms of the efficient operation of the corporations, the location of decision-making centres outside the borders of

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FOOT-NOTES TO TABLE

a) The size of the sample in this column varies by indicator ranging from four countries in line (ii) to 25 countries in line (ix).

b) The size of the sample in this column varies by indicator, ranging eight countries in lines (i) and (ii) to 46 countries in lines (viii) and (ix).

c) Excludes China. The size of the sample in this column varies by indicator, ranging from seven countries in line (vi) to 36 countries in lines (viii) and (ix).

d) The size of the sample in this column varies by indicator, ranging from seven countries in lines (i) and (ii) to 43 countries in line (viii).

e) Includes Greece and Turkey.

f) Taking upper limit of estimates where no precise figures were given, e.g. for 10-15 per cent, 15 per cent would be be used for high estimate and 10 per cent for low estimate.

Note : The classification used in this table is intended for statistical convenience and does not necessarily imply any judgement regarding the stage of development of any particular country.

the developing countries in which these corporations operate tends to foster an international division of labour which accentuates the dominance dependence relationship described in chapter 1 above.

The discussion below of the effects of the technological aspects of recent industrializations strategies of developing countries will concentrate on three main issues : (a) the foreign exchange cost of technology transfer ; (b) the appropriateness of technology, and (c) the possibility of technological development.

C. *FOREIGN EXCHANGE COSTS : SOME DETERMINING FACTORS.*

As has been shown in previous studies issued by the UNCTAD secretariat, the foreign exchange cost of transfer of technology represents a considerable burden on the balance of payments of developing countries (20) and the over-all balance-of-payments impact of individual investment projects has often been on the negative side (21). Those findings are indirectly supported by other studies which have shown a negative value added calculated at world prices for a number of industries in developing countries (22) and a negative aggregate impact from the activities of transnational corporations on the balance of payments of host countries (23). At least three types of practices by transnational corporations tend to diminish the balance-of-payments benefits to developing countries. These include the tendency to rely on sources of finance within the host country (though this is sometimes acknowledged to mobilize domestic savings) ; the imposition of formal and informal restrictions on exports and sources of supply for their affiliates and independent licensees ; and the over-pricing of imports or under-pricing of exports by these enterprises.

In no small part, these practices represent the inevitable exercice of market power. But the ease with wich supplying firms have been able to extract excessive returns on their technology with these or other practices is due in part to the nature of import substitution policies enacted by governments of developing countries. High tariffs and restrictions shutting out competing imports of consumer goods combined with low tariffs on capital goods have permitted protected industries to price their products well above world market prices (24). For nationally owned « infant industries », the protection creating a monopoly market may have been necessary as a temporary measure permitting them to attain an efficient scale of production. It has not been justified on an indefinite duration to prolong the existence of excess capacity, or of units too small ever to operate efficiently in domestic markets of limited size (25). When, as is frequently the case, the protection has applied to the foreign affiliates of dominant, well-

established transnational firms it is simply a free gift further inflating potential monopoly profits that are then remitted through the familiar channels of transfer pricing, payments for know-how and trade marks, etc. which appear as costs on the affiliates' income statements (26). Opportunities for excessive payments for imported technology have also been enhanced by the provision of a host of other investment incentives, such as generous tax holidays, low-cost credits and underpricing of utilities. It may be said that the competition among developing countries to offer the most generous terms for the attraction of technology is itself a result of technological dependence.

D. *APPROPRIATENESS OF PRODUCTION TECHNOLOGIES*

A major cause of disappointment with the progress of the Second Development Decade has been the persistence of unemployment and the failure of the growth rate of employment to keep up with the growth of population in much of the third world. It has become evident that the rapid expansion of industrial output is not by itself sufficient to solve this problem. In the great amount of literature on the subject, the most frequently prescribed remedy is a greater reliance on efficient technologies using a high ratio of labour to capital. A strong case may exist for choosing more labour-intensive techniques, even in those cases when they are samewhat inferior to others in terms of productive efficiency, if they are preferred by workers and are more suitable to local institutions and traditions (27). In general, the industries of developing countries have tended to employ techniques which have not led to adequate utilization of domestic resources, including environmental resources. Moreover, there is a pronounced tendency for capital intensity to increase over time — partly owing to shifts in industrial patterns — which is another way of saying that the amount of investment necessary in order to create a job is becoming progressively greater (28). The technology marketed by transnational firms in import-substituting industries has been of the same labour-saving type used in industries in their own countries. In contrast, the same firms have in recent years been a major source of labour-intensive methods where they have established wholly owned subsidiaries for the export of manufactures, usually to their own countries (29). But these essentially assembly-type operations continue to represent a small proportion of manufacturing investment in the vast majority of low-income countries where emphasis has been on the exploitation of domestic markets. It can be concluded, therefore, that the powerful combination of technology, capital and organizational skills at the disposal of firms in developed countries has not contributed optimally to the solution of the employment problem and may actually have aggravated it in those instances where it has replaced traditional patterns of production (30).

The accumulating body of scattered empirical evidence on the *existence* of labour-using techniques, some in current use and others

long discarded by developed country firms, removes the absence of such techniques as a satisfactory explanation for the prevalence of capital-intensive production processes in the transfer of technology to developing countries (31). Among the other explanations, the most important is that the market prices paid for capital and labour in developing countries do not correctly portray their relative scarcities or, more generally, give the wrong incentives to firms choosing techniques of production. Technologies designed where labour is scarce are transferred unaltered to poor countries where labour is abundant because they already exist and because the heavily protected, monopolistic of oligopolistic markets of these countries obviate the need to develop new ones. Even under competition, market wage rates and interest rates on borrowed capital are an insufficient guide for choosing techniques that are the most desirable from society's point of view. Moreover, government policies such as tax incentives for investment, low tariffs on imported machinery and subsidized credit have the effect of artificially lowering the price of capital relative to labour in developing countries.

The impact of particular techniques of production is not only conditioned by the intensity with which they use labour, but also by the general social, economic and natural environments in which they are applied. This point applies especially to agriculture, a sector that has only lately begun to attract the kind of attention it deserves in countries with rising food deficits and growing unemployment. Developed country agricultural techniques based on large-scale, highly mechanized methods of cultivation in temperate climates are not adapted to the tropical conditions, low land-to-labour ratios and lack of skills prevailing in developing countries. Development literature abounds with examples of imported farm machinery that falls into disuse the moment the experts have left (32). Moreover, the socio-economic effects of imported technology depend critically on systems of land tenure, class structure and income distribution. Thus, although the introduction of high-yielding seeds through the green revolution succeeded in achieving spectacular increase in per acre yields in some case, it mainly benefited rich landlords with access to credit who farmed in areas where irrigation and fertilizers were available (33). A considerable potential exists for furthering the indigenous adaptation and development of simple technologies directed toward small-scale peasant farming and the creation of rural industry (34). However, for many Latin American and some Asian countries, land reform would be a necessary precondition.

E. *APPROPRIATENESS OF CONSUMPTION TECHNOLOGIES*

Although transnational firms have been the principal source for the transfer of production technology, it has until recently been over-

looked that they are also the main avenue for the transmission of « consumption technology » (35). A large proportion of the modern manufactured products consumed in developing countries today are either imported or were formerly imported from developed countries. Through their mastery of the techniques of advertising and product differentiation, and their application of global distribution and marketing strategies, transnational companies have helped to shape the consumption patterns of these countries. At the same time, consumer goods markets in these countries are dominated by urban middle and upper classes who have been the group most favoured by the unequal income distributions that have accompanied the type of import-substituting industrialization that has been pursued. It is these enclaves of affluence that have provided the main target for transnational firms (36).

The main charge against import substitution is that it has concentrated on the wrong products. The inappropriateness of many of the rich country products introduced and promoted in the domestic markets of poor countries derives from the fact that they embody technonological characteristics that are either unnecessary, undesired or too costly to meet the basic needs of nutrition, health, clothing and shelter (37). Labour-intensive methods of production are sometimes excluded if these modern products of high quality are to be manufactured.

The transnationals and their client firms in developing countries are not likely to be keen about or able to undertake the manufacture of goods that cater to the above-mentioned needs, for at least three reasons (38). First, although the gains to society from their doing so would be high, private profitability is low on account of the limited purchasing power of the income groups that would consume the products. Secondly, the specific production of appropriate goods tailored to the unique environments of individual developing countries would be inconsistent with the principle of efficiency based on standardazation and uniform specifications and quality characteristics. Modification of product characteristics is rendered more difficult in the case of highly differentiated goods that are covered by trade marks or brand names identified in consumers' minds, rightly or wrongly, with a certain standard of quality (39). Finally such a policy would be inconsistent with the corporate ideology of achieving a « global structure of excellence » based on the Western model (40). In sum, the efforts needed to respond to the basic wants of the great majority of the third world's population are beyond the field of interest of the transnational corporations.

F. *SELF-PERPETUATING FEATURES OF DEPENDENCE*

The conclusion of the preceding discussion is that the prevailing model of industrialization based on the introduction and application

of rich country technologies to reproduce rich country consumption patterns is both too costly and ill-suited for the satisfaction of basic material needs in developing countries.

But the technologies and the goods they produce are inseparable from one another. The acquisition of know-how from developed country enterprises, chiefly transnational corporations, demands the use of techniques of production that are biased against labour and towards the manufacture of commodities catering mainly to an affluent tiny minority of the population in the third world. Conversely, to produce these same commodities demands the application of technologies obtainable under the terms and conditions set by the enterprises. Dependence is built into this industrialization process.

Moreover, the technological dependence of developing countries may be selfperpetuating. While the transfer of technology may facilitate the expansion of industrial output in these countries, it does not necessarily further the ability to produce that output, or, more precisely, the capacity to adapt and modify existing technology and to evolve new technologies. There are several reasons for this.

First, a large part of the transfer of technology takes place as part of direct foreign investment which in many instances results in majority owned subsidiaries. So long as an industry or product group is under foreign control, the possibility of launching domestic technological initiatives in that industry remains academic. Because of the narrow, fragmented domestic markets for manufactures in many developing countries, a relatively minor capital outlay from the standpoint of a transnational company is sometimes sufficient to result in control or near control of an entire industry. In such industries, a national technology policy, if there ever is to be one will have to await and be co-ordinated with nationalization.

Secondly, the other two major sources of the technology employed in the industrial sectors of developing countries are : (a) licensing agreements concluded with nationally owned firms and covered patents and/or trade marks (disembodied technology) ; and (b) imports of machinery or intermediate goods (embodied technology) by nationally owned firms without licensing agreements. In the case of trade marks, the duration of validity has no limit. Consequently, so long as the trade mark is used, it is necessary to use the technology that goes with it.

Once the branded product has gained widespread consumer acceptance, there is little incentive for the licensee to abandon it and sustain the expense and risk of promoting his own trade mark. Because of their limited duration, patent licensing agreements offer greater opportunities for developing domestic technological skills — *a fortiori* for the use of imported machinery without licensing. But in both cases the long-term gain to society from the use of a domestic technology is greater than the private gain to the entrepreneur. In the absence of

special inducements to the contrary, the entrepreneur is likely to opt for the proven performance of foreign technology (41).

Thirdly, in the consumer goods sector the superiority of transnational enterprises is based on constant product innovation coupled with highly sophisticated advertising and marketing techniques (42). As a result, the consuming elite in developing countries is presented with a succession of new or « improved » products, each of which makes the one that preceded it obsolete. In following the kinds of policies described previously, developing countries have in effect committed themselves to the eventual domestic production of each new product and thus to the importation of the technology that corresponds to it. The technology comes both directly as pure know-how and already embodied in imported intermediate goods and machinery. The constant change together with the sophistication of some of the required technology deter its domestics replication. Hence import substitution is extremely incomplete and dependence is prolonged. This contrasts sharply with the experience of nineteenth century developing countries for which the main thrust of technology transfer and technological advance was centred in the production of machinery and intermediate goods rather than new types of consumer goods (43). The luxury consumption of the rich at that time mainly consisted of goods produced by the artisan class rather than imports, and the manufacture of capital goods which was initially highly labour-intensive, developed in an organic relationship with domestic consumer goods production for the masses.

Fourthly, since foreign technology has tended to be a substitute for technologies that might have been developed by local scientists and engineers, and since the pre-capitalist sector (i.e. subsistence, agriculture and rural craft industries) as at present organized generates very little demand for these local inputs, science and technological institutions in developing countries have become alienated from productive activities (44). Whereas in developed countries the inputs of local scientists and engineers are an investment item, in developing countries they are largely an item of consumption. In these circumstances, science and technology cannot contribute to the development of domestic technical capability.

The preceding discussion is not intended to suggest that the import of technology from developed countries is inherently undesirable, or that the solution is some kind of individual or collective autarky. Provided that a particular technology is in fact needed, the only alternative may in fact be to import it from a developed country in many instances. However, it is clear that the gains from the technologically dependent industrialization that has actually taken place have not been equitably distributed either between receivers and suppliers of technology or among different income groups. Individual countries will have to decide on the special objectives of their technological and development policies in terms of their own priorities. For the majority of deve-

loping countries, the elimination of mass poverty and unemployment will be high on the list of objectives. It is clear from the above that it will be difficult to advance toward this goal without the elaboration of a major new strategy emphasizing not only control over the transfer of technology, but also the creation of an authentic, indigenous technical capability.

NOTES :

(1) See Charles Cooper, « Science, Technology and Production in the Underdeveloped Countries : An Introduction », *The Journal of Development Studies,* October 1972. See also Osvaldo Sunkel, *External Economic Relations and the Process of Development : Suggestions for an Alternative Analytical Framework,* Discussion paper N° 51, Institute of Development Studies, June 1974.

(2) Consumption « technology » refers to the physical and other properties of goods in relation to the needs that they satisfy. See Frances Stewart, « Technology and Employment in LDCs », *World Development,* March 1974.

(3) See Amartya Sen, « The Concept of Efficiency » in M. Parkin and A. R. Nobay, ed. *Contemporary Issues in Economics,* Manchester University Press, 1975, pp. 192-210.

(4) See Paul Streeten and Michael Lipton, ed. *The Crisis of Indian Planning : Economic Planning in the* 1960*s,* London : Oxford University Press, 1968 ; and Frances Stewart (1974 *op. cit.* The concentration on these foreign goods also leaves less scope for indigenous technological and scientific developments.

(5) See Meir Merhav, *Technology Dependence, Monopoly, and Growth* Oxford : Pergamon Press, 1969, see also Albert Fishlow, « Empty Economic Stages ? », *Economic Journal,* March 1965, pp. 112-125.

(6) This is over and above the disadvantages that apply to developing countries because of the general nature of the trade relationships involved, leading to some form of « unequal exchange ». See Arghiri Emmanuel, *L'échange inégal ; essai sur les antagonismes dans les rapports économiques internationaux,* Paris : F. Maspero, 1972 ; Samir Amin, *Le Développement inégal : essai sur les formations sociales du capitalisme périphérique,* Paris : Ed. de Minuit, 1974 ; and A. Mitra, ed. *Economic Theory and Planning,* Oxford University Press, 1974, pp. 141-150.

(7) See Streeten's distinction between the « communications gap » and the « suitability gap » in Paul Streeten, « Technology Gaps Between Rich and Poor Countries », *Scottish Journal of Political Economy,* November 1972.

(8) The utilization in developing countries of local resources of particular interest to the *developed* capitalist countries has, of course, been a common feature of economic imperialism, e.g., copper mining in Rhodesia.

(9) See John Dunning, ed. *The Multinational Enterprise,* London : Allen & Unwin, 1971, and *Economic Analysis and the Multinational Enterprise,* London : Allen & Unwin 1974 ; Raymond Vernon, *Sovereignty at Bay,* New York : Basic Books 1971 ; Paul Streeten, « The Multinational Corporation and the Nation State », in *The Frontiers of Development Studies,* London : Macmillan, 1972 ; pp. 223-38 ; and Paul Streeten, « The Theory of Development Policy », in Dunning *op. cit.* (1974)

(10) Even if the firm in question has a clear idea as to what it wants to do with its privileges, the government of the developing country may not be able to gauge *ex ante* the real price involved. There is some uncertainty arising also from the complexity of intra-firm trading and transfer pricing used by multinational enterprise baffling the poorly staffed bureaucracies in developing countries — see Dudley Sears, « Big Companies and Small Countries », *Kyklos,* vol. 16, 1963.

(11) Based on OECD, Development Assistance Directorate, *Stock of Private Direct Investment by DAC Countries in developing Countries and* 1967, Paris, 1972, table 1

(12) Based on statistics tabulated in S. Pizer and F. Cutler *United States Business Investments in Foreign Countries,* Washington : United States Department of Commerce, 1960 ; and United States Department of Commerce, *Survey of Current Business,* August 1961, and August 1974.

(14) A strategy of export-based development of the manufacturing sector seemed less desirable because of the implied dependence on the markets of the « centre », the trade barriers facing the traditional items most suitable for export to these markets, and the difficulty of meeting the quality requirements for consumer acceptance of more technologically-sophisticated products. For a discussion of the origins of import substitution policies see I. Little, T. Scitovsky, M. Scott, *Industry and Trade in Some Developing Countries : A Comparative Study*, London : OECD and Oxford University Press, 1970, chapter 2.

(14) See C. Vaitsos, *Transfer of Resources and Preservation of Monopoly Rents*, Economic Development Report N° 168, Centre of International Affairs, Harvard University, 1970, for a full discussion of these issues.

(15) *The role of the patent system in the transfer of technology to developing countries*, United Nations publication, Sales N° E.75.11.D. 6, tables 7 and 12.

(16) For a discussion of the economic implications of the brain drain see « The reverse transfer of technology : its dimensions, economic effects and policy implications » (TD/B/C.6/5).

(17) See Amilcar Herrera, « Social Determinants of Science Policy in Latin America. Explicit Science Policy and Implicit Science Policy », *The Journal of Development Studies*, October 1972, See also the discussion in section F. below.

(18) Unites States Senate, Committee on Finance, *Implications of Multinational Firms for World Trade and Investment fort United States Trade and Labour*, Washington, D. C. : United States Government Printing Office, 1973, p. 557.

(19) *Ibid.*, p. 600 and *Survey of Current Business, op. cit.* December 1973, p. 14.

(20) *Major issues in transfer of technology to developing countries : a study by the UNCTAD secretariat*, United Nations publication, Sales N° E.75.11.D.2.

(21) See P. Streeten and S. Lall, « Main findings of a study of private foreign investment in selected developing countries » (TD/B/C.3/111 and Corr. 1) summarizing the results of an analysis of 159 firms in six developing countries.

(22) See ECAFE, *Interaregional Trade Projections, Effective Protection and Income Distribution, Vol. II, Effective Protection*, United Nations Publication, Sales N° E.73.11.F.12, p. 18 ; Stephen Lewis Jr., *Pakistan Industrialization and Trade Policies*, London : OECD and Oxford University Press, 1970, pp. 84-85 ; and Bela Balassa and associates, *The Structure of Protection in Developing Countries* Baltimore : John Hopkins University Press, 1971.

(23) During the period 1966-1970 when the aggregate United States balance of payments (current plus long-term capital account) as a whole deteriorated, that of transnational corporations improved by $ 2.8 billion leading to the conclusion expressed in the United States Senate study, *op. cit.*, p. 29, that transnationals »... in their transaction with the United States, exert a uniformly large, negative impact on the current accounts of balance of payments of host countries (conversely, of course, they have a favourable impact on the corresponding account of the United States balance of payments) ».

(24) It is worth noting that, apart from Czarist Russia and the United States, present-day developed countries appear to have had significantly lower tariffs than developing countries at comparable stages of development. See Little, Scitovsky, Scott, *op. cit.*, pp. 162-163.

(25) Value added calculations in eight Asian countries have demonstrated in a sizeable number of manufacturing industries that if protection were eliminated the technologies would no longer be viable. See *Intraregional trade projections, effective protection and income distribution, op. cit.*, p. 18.

(26) Cf. Constantine V. Vaitsos, *Intercountry Income Distribution and Transnational Enterprises*, Oxford : Clarendon Press, 1974. p. 123.

(27) See Amartya Sen, (1975), *op. cit.*

(28) In studying high-technology industry in Colombia, for example, one economist found that whereas it took 45,000 pesos to employ one worker in 1957, by 1966 it took 100,000 pesos of 1957 value. See *Towards Full Employment : A Programme for Colombia Prepared by an Inter-Agency Team Organized by The International Labour Office*, Geneva, 1970, p. 113.

(29) See G. K. Helleiner, « Manufactured exports from less developed countries and multinational firms », *Economic Journal*, March 1973.

(30) For a convincing theoretical demonstration of how capital-intensive technology transfer may lead to a reduction of both employment and net output see « Major issues arising from the transfer of technology to developing countries : On some implications of technology transfer for trade, growth and distribution in developing countries », a study prepared by Professor Pranab K. Bardhan of the Delhi School of Economics (TD/B/C.6/5).

(31) See D. Morawetz, « Employment implications of industrialization in developing countries : A survey », *The Economic Journal*, September 1974, for a summary of some of this evidence. See also the excellent studies prepared under the World Employment Programme of the International Labour Office, in particular, A. S. Bhalla, ed. *Technology and employment in industry : a case study approach*, Geneva : ILO, 1975.

(32) Even for a relatively more technologically sophisticated country such as India, a recent review of all existing empirical studies of that country's massive tractorization campaign failed to find solid evidence of a clear over-all advantage compared with older techniques based on animal power. See Amartyr Sen, « A study of Tractorization in India » in his *Employment, Technology and Development*, London : Oxford University Press, 1975, appendix D.

(33) See Keith Griffin, *The Green Revolution ; An Economic Analysis*, Geneva : United Nations Research Institute for Social Development, 1972.

(34) For example of such an experiment in the United Republic of Tanzania, see George MacPherson and Dudley Jackson, « Village Technology for Rural Development — Agricultural Innovation in Tanzania », *International Labour Review*, July 1975, pp. 97-118.

(35) See Frances Stewart, « Choice of Techniques in Developing Countries ». *The Journal of Development Studies*, October 1972, as well as « Technology and Employment in LDC's », *op. cit.*, by the same author.

(36) Thus, Peter Drucker, a business consultant to transnational companies, has pointed out that within the « vast mass of poverty that is India » there is « a sizeable modern economy, comprising ten per cent or more of the Indian population or, 50,000,000 people ». See his *The Age of Discontinuity* New York : Harper & Row, 1969, p. 107, cited by R. Barnet and R. Muller, *Global Reach : The Power of the Multinational Corporations* New York : Simon and Shuster, 1974, p. 169.

(37) Thus, the « brightening » agent in detergents is superfluous for making clothes clean ; automobiles consume more energy per passenger mile than any other form of transportation, ; dacron shirts are uncomfortable in hot climates.

(38) This does not mean that there have not been superficial modifications in packaging and other caracteristics in particular markets. Genuin efforts by Ford, Philips and National Cash Register have been made to develop appropriate products with relatively labour-intensive production technologies, but these appear to be isolated cases. See Stewart (1974) *op. cit.*, pp. 39-40.

(39) See « Systems, including industrial property systems, for improving the national scientific and technological infrastructures of developing countries » (TD/B/C.6/AC.2/4), para. 39.

(40) As described in Barnett and Muller, *op. cit.*, Chapter 2.

(41) There is a great deal of empirical evidence that this has frequently occurred in India See K. K. Subrahmanian, *Import of Capital and Technology : A study of Foreign Collaborations in Indian Industry*, New Delhi : People's Publishing House, 1972.

(42) In the United States, the principal objective of the research programme of 90 per cent of manufacturing corporations is reported to be development of new products and improvement of old. See W. E. Gustafson, « Research and Development, New Products and Productivity Change », *American Economic Review Proceedings*, May 1962.

(43) See David Felix, « Technological dualism in late industrializers : on theory, history and policy ». *Journal of Economic History*, March 1974.

(44) See Charles Cooper, *op. cit.*

RÉSUMÉ

Le développement du caractère asymétrique de la dépendance technologique est dans une large mesure la résultante de la révolution industrielle et du capitalisme, en particulier dans sa forme actuelle. Les relations de domination de l'époque coloniale ont contribué à développer et à perpétuer cette asymétrie.

Le développement de cette asymétrie et ses nombreuses implications ont récemment fait l'objet de débats exhaustifs de la part d'économistes de diverses écoles. Les traits caractéristiques de la dépendance

telle qu'elle existe aujourd'hui ne sauraient être dissociés du processus historique qui est à l'origine de cette asymétrie. Bien que les diverses expériences des pays en voie de développement ne soient pas du tout uniformes, ils ont cependant assez de caractéristiques communes pour que l'on puisse valablement et utilement considérer la dépendance technologique comme un problème global sans évidemment perdre de vue les variations à l'intérieur de l'ensemble.

La première partie de l'article commence avec une description de l'asymétrie, ou déséquilibre, de la dépendance technologique caractéristique des relations inégales entre pays développés et pays en voie de développement. L'inégalité apparaît dans la prédominance de la production des articles de première nécessité, la faiblesse de la production industrielle et l'incidence de ces caractéristiques sur la structure du commerce ; elle se traduit aussi par la présence d'une main-d'œuvre sous-qualifiée, la faiblesse des infrastructures technologiques et l'insuffisance des ressources financières. Tous ces facteurs ont contribué à la réduction de la capacité des pays en voie de développement de contrôler les décisions concernant des problèmes d'importance capital pour leur développement et de formuler des initiatives pour atteindre leurs objectifs de développement. Dans la seconde partie, l'examen des méthodes utilisées par les pays en voie de développement pour combler leur retard dans le domaine industriel révèle clairement que les progrès réalisés depuis la fin de la Seconde Guerre Mondiale sont très limités sinon nuls. Dans leur grande majorité, les pays en voie de développement ont tenté de recréer en leur sein les processus de production et de consommation des pays développés, politique dont le résultat fut non pas l'amélioration substantielle des conditions de vie de la majorité de la population mais plutôt la perpétuation de la dépendance technologique.

L'objet de la discussion précédente n'est pas de montrer que l'importation de la technologie des pays développés est fondamentalement mauvaise ou que la solution réside dans une sorte d'autarcie individuelle ou collective. En fait, lorsque la technologie est nécessaire, il n'y a dans beaucoup de cas d'autre solution que de l'importer des pays développés. Cependant, dans la situation actuelle, les profits tirés de l'industrialisation qui elle-même repose sur la technologie ne sont équitablement distribués ni entre les donataires et les récipiendaires de la technologie ni entre les différentes couches sociales des pays concernés. Il faudrait que ces pays définissent eux-mêmes les objectifs de leur politique en matière de développement et de technologie selon les priorités qu'ils se seront eux-mêmes fixées. Pour la majorité des pays en voie de développement, l'élimination de la pauvreté et du chômage général figurera en bonne place sur la liste des objectifs. Il sera difficile de progresser vers la réalisation de ces objectifs sans l'élaboration d'une nouvelle stratégie qui mettra l'accent non seulement sur le contrôle à exercer sur le transfert de technologie mais aussi sur la création sur place d'une capacité technique authentique.