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When this paper was first published Frances Stewart was a member of the Development Economics Department of the World Bank.

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ABSTRACT

This paper surveys the issues raised by technology transfer to developing countries. Technology is a vital part of the development process, a necessary input into all activity. Because of the historical domination of research and development by developed countries, a very large part of the technology used is transferred from developed countries. The transfer raises four major issues: those of the costs of the transfer, the appropriateness of products and techniques which are transferred, the effects of the transfer on learning and technological development in LDCs, and the effects on independence. The paper considers the consequence of the transfer and the range of policies that might be adopted, nationally and internationally, in relation to each of these issues.

It is argued that the appropriate policies will vary according to the stage of development of each country, its technological capacity and its own objectives. However, in general it is concluded that an active technology policy is called for if the costs associated with technology transfer are to be reduced and the benefits increased. While it is easy to design suitable policies on paper, it is much more difficult to ensure that they are effective in practice.

TABLE OF CONTENTS

SUMMARY

Technology is knowledge of how to do all those things associated with economic activity. Thus, the acquisition of technology is as important to the development process and as essential an aspect of the process of investment as the accumulation of financial resources. Moreover, because technology is continuously changing, with new products and processes being developed year-by-year, the need to acquire technology is also a continuous one, and one that expands with expansion in economic activity.

Two basic facts underlie the process of international technology transfer. First, the origin of the vast majority of technological developments is concentrated in a few developed countries. Although some developing countries are beginning to promote local technological development, they remain dependent on the developed countries for most of their technology. Secondly, a large part of the market for technology has been commercialized with proprietary rights acquired in the technology. Since technology has many of the characteristics of a public good, such that the marginal cost of communicating it to others is very low compared with the initial costs of development, the commercialization of the technology market has involved imposing restrictions - legal and other - on the free communication of knowledge. The result is that the technology market is highly imperfect, the price charged for technology tends to be oligopolistic, and consequently there is considerable scope for abuse, and potential for bargaining on the part of buyers. The transfer of technology consists, in part, in the transfer of the required knowledge; in part, in the transfer of various marketing rights associated with the knowledge. These include the right to use trademarks, access to specified markets, and so on. In many cases, the two are inextricably connected, so that if a buyer wishes to purchase the knowledge he also has to purchase the market rights, and vice-versa.

Technology is transferred in a number of different forms, ranging from formal (technology contracts) to informal (meetings, people changing jobs). The process is often differentiated according to the degree of packaging involved in the transfer with the most packaged transfers consisting of the bundle of services associated with direct foreign investment, and the least packaged in the direct purchase of machinery and other inputs. There are various intermediate forms including joint ventures and contracts involving associated management services and knowhow. In any particular case, the mechanism of transfer depends on the willingness of the supplier to supply the technology in different forms and the desire and ability of the buyer to buy it in a particular form. There is considerable variation in the way different countries acquire technology reflecting differences in national policies, in national capacities and in the industrial composition of the technology transferred. In some countries, e.g., historically Japan and currently the Andean Pact countries, the most packaged forms of technology transfer, notably direct foreign investment, are severely restricted. The degree of development influences the extent of packaging because less developed countries may lack the capacity to put the package together for themselves. In general, more sophisticated (technologically) industries show a greater degree of packaging than less sophisticated. Despite recent support by some LDCs for less packaging, no definite worldwide trends towards depackaging can be discerned empirically.

Developing countries' objectives towards technology transfer have evolved. Immediately following independence, most countries were keen to industralize quickly, and to maximize the technology inflow. Hence, they introduced a host of tax incentives to encourage technology inflow. As time

proceeded, it emerged that the indiscriminate import of technology had involved high costs, had led to dualistic patterns of development, had accentuated dependency and had inhibited learning effects. Consequently, new objectives evolved: in particular, many developing countries wished to regulate the inflow of technology to reduce the costs of transfer, to increase the independence of decision making and to promote local technological innovation. In addition, in response to employment and other problems, some countries recognized a need for more appropriate technology.

Costs of Technology Transfer

The nominal declared costs of technology transfer need bear little relationship to actual costs because companies which supply more than one service may choose the form in which they receive payment. For example, payments for technology may appear as royalty payments or as profits or as overinvoiced import prices. The problems of disguised payments arise in most acute form for the most packaged forms of transfer, but are also present to some extent in other forms, such as joint ventures. The high proportion of intra-firm trade and of intra-firm technology flows gives rise to the possibility of disguised payments. There is considerable evidence of overinvoicing of imports and underinvoicing of exports. While the evidence suggests that this occurs to the greatest extent in pharmaceuticals, there is strong evidence of similar practices in many other industries. Evidence of such practices has been collected in a number of Latin American countries, and in India and Greece. The industries covered include pharmaceuticals, chemicals, metal products, minerals and rubber products. It is difficult to know how much of the disguised payments should be attributed to technology transfer and how much to other factors. The need for technology transfer normally gives rise to the possibility of such payments, but their extent is influenced by recipient

governments' economic policies as well as by lack of competition in the world industry.

The process of technology transfer imposes additional costs as the result of restrictive clauses associated with it. In the case of direct overseas investment, the restrictions are implicit. For technology contracts between independent parties, they are an explicit part of the contract. There is evidence of widespread restrictions embodied in technology contracts. The restrictive clauses include limitations (or total bans) on exports, tied purchase of inputs, machinery and parts, limitations on competing supplies, and constraints which limit the dynamic effects of transfer by requiring excessive use of expatriate personnel and discouraging local r. and d.

UNCTAD estimated the overt costs of technology transfer to be 5% of non-petroleum exports of developing countries in 1968, and estimated that this proportion would rise steadily over the subsequent 10 years. While other evidence suggests that the UNCTAD estimates (particularly in relation to the rate of increase after 1968) may be overestimates, adding some estimate of the implicit and indirect costs would substantially increase the costs. For example, to add 10% of the costs of imported capital equipment and chemicals and one-fifth of the declared profits on foreign investment to the UNCTAD estimates would more than double them. The high costs do not necessarily mean, of course, that the price is not worth paying. But they do suggest that there may be considerable gains to be made from bargaining, especially in view of the non-competitiveness of much of the market.

Independence

Technology transfer limits the independence of decision making. This is most obvious in the case of direct investment, but occurs to a considerable extent with respect to transfers between independent parties where technology

contracts include very heavy restrictions on freedom of decision making. It has been claimed that technology transfer has come to replace ownership as a mechanism of control.

Learning

The ability to make independent technological choices, to adapt and improve upon chosen techniques and products, and eventually to generate new technology are essential aspects of the development process. Relatively little is known about the process of accumulation of technological capacity. Broadly, three stages may be identified: in the first, the ability to make independent technological choices is developed; in the second, minor innovations occur locally; and in the third, the capacity to create new technology is developed. In general, the stages occur sequentially. There is a complex relationship between the import of technology and the development of local technological capacity, and one that encompasses both complementarities and conflicts. Some import of technology is required as a basis for learning. But highly packaged imports tend to limit the development of the ability to make independent choices. Minor technological change may occur on the basis of imported technology - this seems to respond to a mixture of technological capacity and competitive and other pressures. The third stage - local development of technology - may be inhibited by indiscriminate imports - partly because of restrictive clauses involved in technology contracts which limit the dynamic effects; partly because the foreign technology associated with foreign trademarks tends to have a strong market advantage over local technology; hence, loca technology, even when developed, is often not used, and thus the incentive to develop it is much reduced. The most successful examples of technological development have combined selective import of foreign technology with positive measures to promote local technology. Thus the local developments are provided with the foreign knowhow they need and the protection and promotion necessary. Promotional measures include provision of infrastructure, technology plans,

subsidies and incentives to r. and d. and government procurement practices that favour local technology. Japan's technological development is a very successful case of this sort of policy: technology was imported, then adapted domestically and promoted in both public and private sectors. Other successful examples, involving a similar combination of policies, have been observed in a few cases in Mexico and India.

Policies Towards Technology Imports

Relevant policies vary according to objectives, although there is considerable overlap with some policies serving more than one objective, and the objectives themselves being mutually reinforcing. For example, policies which eliminate restrictive practices will also increase independence, reduce costs and may contribute to the learning effects of the technology.

The set of relevant policies varies with the stage of development, and particularly the technological and administrative capacity of the country concerned. Policies aimed at improving the terms of technology transfer are relevant to most countries. Although they involve administrative costs, the potential gains are large, as shown by the experience of countries which have followed them. However, policies of selectivity towards imported technology require a greater degree of technological sophistication and administrative judgment. These policies are only worth pursuing where there exists fairly considerable local technological capacity; they may best be introduced on an industry-by-industry basis.

The general economic strategy of the country is of relevance to the effectiveness and outcome of technology policies. The terms of technology transfer are likely to be more competitive, the more competitive the general environment is, and the less government policies (e.g. of protection) give rise to quasi-rents. But non-competitive elements in the world industrial structure mean that special technology policies are required in addition to general

competitive policies. As far as local technological development is concerned, the relationship between general economic policies and local technological developments is less clear. While it is often argued that heavy protection and "distorted" factor prices remove incentives for local adaption, there are a number of examples of local technological innovation occurring in a generally protected environment. Thus, India and Argentina have developed technology locally, in a few cases sufficiently to export the technology to neighbouring countries. The sort of pressures which lead to local technological innovation are of many kinds, e.g., absence of particular raw materials, and not confined to cost pressures associated with price and exchange rate policies.

A number of countries have tried to reduce the packaging element in imported technology. A major reason is to secure greater independence of decision making: this is desired in itself, and also as an essential part of the learning process so that countries may develop the capacity first to make independent technological choices, and subsequently to develop their own technology. The policy is also related to the question of costs, since it appears that costs tend to be higher the more packaged the form of transfer. The policies may be mandatory - e.g., forbidding majority foreign ownership in some or all industries - or rely on incentives. An essential complement to policies towards depackaging is the introduction of some sort of regulation over technology transfer between independent parties; otherwise, as indicated by empirical evidence, many of the problems associated with direct investment re-emerge via technology contracts. A number of countries have introduced National Registers of Technology, permitting registration only if the contracts fulfill various criteria with respect to terms and restrictive clauses. In general, restrictive clauses (e.g., with respect to export bans and tying inputs) are outlawed. Investigations of the results of these policies in two countries - Colombia and Mexico - have shown very

substantial foreign exchange gains, and the outlawing of a large number of restrictive clauses at relatively low administrative cost. But it has not yet been thoroughly established how far such policies have had de facto as against de jure success, as many of the explicit and formal restrictions may have been replaced by informal implicit ones.

Changes in the tax system may be designed to improve the terms of technology transfer. In particular, if corporate taxation is made independent of the degree of underinvoicing or overinvoicing (either by formula apportionment or by a uniformity of rates approach), the foreign exchange and revenue loss caused by these practices will be much reduced. The removal of tax incentives towards overseas investment, which have been shown to be ineffective, would also improve the terms of technology transfer.

Policies to protect and promote local technological developments involve the selective import of foreign technology as well as promotional measures towards domestic developments. Industries in which there is substantial local potential, and some likelihood of long run comparative advantage in technological development, should be selected; in these industries technology imports should be permitted where they are complementary with and conducive to local technological development and restricted where they are competitive with local developments. Technological development is an infant industry, with strong externalities, which accordingly requires protection. There are numerous - and fairly well known - promotional measures, including government subsidies, training and education and so on. None of them have proved to be particularly effective on their own,[1/] but at both macro and micro levels a combination of protection and promotion does seem to have been effective.

The system of patents and trademarks in effect gives strong protection to foreign technology as against local technology. By so doing, it also tends

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1/ See the I.R.D.C. study into Science and Technology Policy Instruments in 10 Countries (Sagasti, 1978).

to raise the cost of the foreign technology. Five-sixths of patents are held by foreigners in LDCs, and of these, over 90% are unexploited. International discussion and negotiation about the reform of the system is currently underway. Trademarks act as a powerful protective device to foreign technology because of the marketing power they bestow. LDC trademarks are relatively undeveloped; they formed half of new registrations in 1974, but this was substantially less than some ten years before. Various reforms are possible, including complete outlawing of trademarks, outlawing foreign trademarks only, requiring joint foreign and local trademarks, and imposing a heavy tax on trademarks. The main problem is to combine consumer protection with a reduction of the role of trademarks. Trademarks tend to be heavily concentrated in a few industries (notably pharmaceuticals) and action could be restricted to one or two sectors, initially. Any restrictive policies need to be accompanied by consumer education and promotion of alternative methods of guaranteeing quality, e.g. by developing government standards.

Local technological capacity in third world countries is of critical importance: it is a vital part of the development process, it is necessary for independence, to improve bargaining power in relation to the import of technology, and to generate appropriate technical change. While there appears to be a certain amount of technological choice today, the continued concentration of technical change on advanced country technology is likely to result in increasingly inappropriate techniques. Unless developing countries undertake r. and d. in alternative directions, the choice of technology available in the future will be increasingly circumscribed and irrelevant to the needs of the world's poorest. The development of a continuous process of technological change - new techniques and products - in an appropriate direction in the developing countries is essential if the choice is to be widened.

Appropriate Technology

Technology recently developed in advanced countries tends to be inappropriate, in many respects, for many LDCs. This is because it is designed to meet the needs of the advanced countries; it tends for example to be increasingly capital intensive. Its use in poor countries involves a concentration of investment resources in the modern sector, exacerbating differentials and contributing to the problems of unemployment and underemployment. Products designed for advanced country consumers are ill suited to meet the basic needs of poor people. However, the high productivity of much modern technology and the efficiency and economies of scale associated with advanced country products may make the technology the best choice, given the absence of efficient alternatives. Appropriate technology consists of technology more in line with developing country needs and resources; it consists of more labour intensive processes in the modern sector, and the development of new and improved techniques and products for the traditional sector. The promotion of more appropriate technology includes the selection of more appropriate technology among known technologies (including "old" techniques from advanced countries and secondhand machinery) and the development of new appropriate technologies.

The development strategy a country adopts strongly influences its technological options. If a country's consumption patterns are similar to those of developed countries, and if its main trading orientation is with developed countries, then the main body of technology it uses in the modern sector will need to be that of the developed countries. Consumption patterns are likely to be similar to those of developed countries among countries with an unequal income distribution, an "open" policy towards technological imports, and lack of indigenous cultural factors which inhibit the demonstration effect. Some

modification of technology is clearly possible - and indeed happens - even in this sort of situation, but modifications are likely to be largely a matter of time lags in adopting the latest advanced country technology, more labour intensive ancilliary activities, and modifications rendered necessary by differences in the size of the market.

With more equal income distribution and with obstacles (cultural, economic or legal) preventing the domination of advanced country products, the potential for appropriate and self-generated technology will be greater. Trade in manufactured products with advanced countries has generally involved the import of technology from advanced countries, at least in the initial stage. Trade between developing countries is more likely to be consistent with the use of locally generated appropriate technology. Appropriate technology consists both in modification in "modern" sector products and techniques and in up-grading "traditional" sector technology. Even in countries with advanced country oriented modern sectors, there is potential for appropriate technology in the traditional sector to help raise productivity and incomes and meet basic needs.

Policies to promote appropriate technology consist in policies determining the demand for (or selection of) different products and techniques, and policies determining the supply of technologies. On the demand side, the policies concerned are chiefly national; they include determinants of income distribution and consumption patterns, trading strategy, policies determining control over investible resources by different types of decision makers, and relative factor prices. On the supply side, they include the collection of information about different technologies and its diffusion, and research and development and the creation of new technologies. Potentially, there could be an important role for international institutions on the supply side assisting in information collection and diffusion, and in funding appropriate research.

Technology transfer between developing countries could have an important role to play in increasing developing countries technological independence and bargaining power and in promoting appropriate technology. There are some indications that such trade is expanding; third world MNCs are developing as is third world consultancy and trade in capital goods. As with similar developments, there is a danger that new imbalances and dependencies within the third world will arise as a result.

There is a complex system of relationships between past policy towards technology, policy makers and policy making. Countries which have been heavily dependent on foreign technology, particularly in the form of foreign investment, find it more difficult to regulate it than those which have relied on it to a lesser extent and have maintained an arm's length relationship with foreign suppliers. Similarly, patterns of production and consumption which are broadly inappropriate set in force strong forces making for similar inappropriate choices in the future. The extent of current freedom of decision making depends in large part on past policies. Today's policies, then, will partly determine future opions. In this context, radical delinking might be a tactical and temporary move to strengthen a country's position in future linked relationships.

International Technology Transfer: Issues and Policy Options [1]

Technology is knowledge - knowledge of how to do and make useful things.[2] At the heart of any form of economic activity from the least to the most sophisticated lies the technology or knowledge of how the activity is carried out. Before initiating any economic activity then the first prerequisite is the acquisition of this knowledge. But technology is not randomly and freely distributed throughout the world, as would appear from some economists' models. Rather, as part of the process of historical development, the development of technology has been heavily concentrated in certain parts of the world, notably the developed countries. Moreover, much of this technology has been commercialized with proprietary rights acquired in it so that it is not freely transferred but is sold commercially. The international transfer - in many cases involving the international sale - of technology is thus an essential precondition for economic development. Since technology changes continuously, with new or improved products, new materials or new uses of old materials, and new techniques of production, the need to acquire technology is not once for all, but a continuing one. Thus the question of technology transfer - how it is transferred, the terms of transfer and the effects of the transfer - is at least as critical to economic development, as the question of transfer of capital resources. In recent years this fact has been widely recognized, as shown by the many international conferences, resolutions etc. on the subject. This paper attempts to summarize some of the main issues that arise in connection with the international transfer of technology to developing countries.[3]

1/ I am grateful for comments on an earlier draft to a number of people in the World Bank: I would especially like to mention Howard Pack and Larry Westphal.

2/ Merrill defines it as 'skills, knowledge and procedures for making, using and doing useful things.'

3/ There are many problems that arise in connection with internal technology transfer-i.e. the transfer of technology or its diffusion within a nation, but these are not considered in this paper.

I. Why Technology is Transferred

The international transfer of technology takes place when knowledge in one country - which may have been developed there or acquired from somewhere else - is communicated to people in another country, for use there. The communication may occur freely outside the market, or may be a commercial transaction. Effective communication of knowledge for economic activity is not normally just a matter of communication of design sheets and formulae, but also involves an essential software element, the communication of how to use the information, which may require the transfer of skills, managerial knowhow and so on.[1/] The sale of technology occurs when some essential part of the package which constitutes the technology is in the commercial possession of some agent, who will only part with it for a price. This 'possession' may take the form of monopolization of the desired knowledge, which may occur naturally when it is first developed, and before others have caught up with the technological developments, or may be the result of legal restrictions protecting the owners of the technology, allowing them to sell it, and preventing imitators, as with the patent laws and those related to trademarks. In either case a monopolistic element enters the market enabling the owners of the technology to earn some monopolistic rents - i.e. to charge a price in excess of the actual costs of communication.[2/] The monopolistic element may pervade a much wider area than that specifically covered by legal protection, because of the bundled aspect of much technology, so that some element of the bundle which is apparently freely available without legal restriction is in practice protected by restrictions affecting some other element in the bundle. The actual costs of communication are

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1/ "Technology, used in this study, refers to the package of product designs, production and processing techniques and managerial systems that are used to manufacture particular industrial products." (Baranson, p. 13). This paper adopts this definition, but does not confine attention to industrial products.

2/ The justification for commercialization of the market for technology is that it provides the necessary appropriability to induce private R. and D. Part of the excessive price (over and above costs of communication) constitute normal returns to R. and D. and should not, therefore, necessarily be classified as monopoly profits.

by no means negligible.[1/] Technology transfer may command a price to cover these costs in the absence of any monopolistic elements in the market for technology.

Technology was defined above as knowledge of how to do and make useful things. But in practice examination of the market for technology suggests that in the process of commercialization of this market, the content of technology transfer has become more complex than this. A major element in technology transfer is the acquisition of the right to use certain trademarks and/or access to certain markets and inputs. For shorthand we may describe the acquisition of trademarks, and privileged access gained to markets and/or to inputs (which may include an assurance that the firm will be kept up to date with later technical developments) as marketing rights. These may be highly valuable to individual firms in helping gain markets or inputs. While they are often associated with the communication of useful knowledge, and form a significant part of technology contracts,[2/] they are not themselves accurately described as consisting in the communication of useful knowledge. Nonetheless, in the context of discussion of inter-

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1/ Teece (1976) estimates the costs involved in transmitting and absorbing all the relevant unembodied knowledge, and finds that these costs range from 2 to 59% of total project costs.

2/ Trademarks were an aspect of 48% of technology contracts examined in Mexico and 58% in Argentina. But the estimates are very sensitive to the methodology used. In a study of Brazil where each contract was divided into as many agreements as there were contractual elements, trademarks formed 13.2% of the total. But in Brazil trademark licenses are not allowed between parent and subsidiary company. See UNCTAD (1977b) (paras. 126 and 127)

national technology transfer, the acquisition of marketing rights forms an important element of costs and is also a significant aspect of motivation. Discussion of the international transfer of technology thus covers both the communication (or sale) of knowledge and the sale of marketing rights.

The international transfer of technology takes place when three conditions occur. First, decision makers in one country wish to use a certain technology; secondly, that technology is not available locally; thirdly, they believe it is cheaper for them to transfer the technology than to reproduce it locally. These three conditions explain the quite substantial amount of technology transfer between developed countries.[1/] But they are present to a much greater extent in relation to investment decisions in developing countries, such that a very large proportion of investment in developing countries involves international technology transfer chiefly from developed countries. The three conditions apply to a definition of technology which encompasses the marketing element just described. Condition one: investors wish to use a certain technology. For some observers it appears almost axiomatic that countries should wish to, and would benefit from, use of the latest technological developments: "Whatever the source, the increase in the stock of useful knowledge and the extension of its application are of the essence of modern economic growth....No matter where these technological and social

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1/ See the analysis of eg. Posner (1961 and 1970) describing the 'technology gap' conditions which give rise first to trade, and subsequently to technology transfer between developed countries. A full explanation of international technology transfer should go further than the above, first explaining why a decision is made to produce a particular product in a particular country, as against importing it. Technology gap, product cycle, and import substitution cum jumping tariff barrier hypotheses provide explanations of the initial decision to produce. See eg. Posner op. cit., Hufbauer (1966) Vernon (1966) and Hirsch (1967), and (1976) SPRU (1972)

innovations emerge - and they are largely the product of the developed countries - the economic growth of any nation depends upon their adoption." (Kuznets, 1966)[1/]

From the point of view of the social interest and long run development prospects of developing countries, there are three reasons why one might question or at least qualify this view. First there are biases in the development of technology: the characteristics of any technology are heavily influenced by the economic and social conditions in the economy in which it is developed.[2/] Thus technology developed for advanced societies often has characteristics which are ill suited to much poorer economies: for example, technological advances in rich societies tend to be increasingly capital-intensive, of increasing scale of production and designed to produce products intended for high income consumers. As we shall discuss more below, if imported unadapted into poor societies, these characteristics have various undesirable effects. The Kuznets view of the unquestionable superiority of the latest technology would only be invariably correct if this bias did not exist and technical advance were neutral with respect to factor use and product design, raising the productivity of all types of techniques equally, and enhancing the efficiency of all types of products equally. Nonetheless, recent technological advances do involve great gains in productivity in resource use and this fact may compensate for biases in characteristics, but it does not do so invariably. Secondly, there are significant learning effects. The Japanese case[3/] illustrates the way in which restricted import of technology may permit the local development of technological capacity. Again learning aspects will be discussed more below. Thirdly, as already stated the technology that is transferred involves more than the most recent technological advances; it

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1/ See also Gerschenkron (1962) and Spencer (1970).

2/ This point is discussed at much greater length in Stewart (1977) Chapters 1 and 3.

3/ See Ozawa (1966) and UNCTAD (1978a).

also involves the transfer of marketing rights. While the knowledge itself may be worth acquiring from a national point of view, marketing rights may not be.

These qualifications are made from the point of view of the national interest of developing countries. They do not apply directly at the level of the individual firm, where most technology decisions are made. It is not their concern that amalgamating all the micro-decisions, the free import of advanced country technology may cause biases in development patterns; individual firms respond to this sort of consideration indirectly if differences in conditions affect factor prices and consumer tastes. Long run learning effects are externalities not allowed for in individual decision making while considerations related to marketing rights enhance the individual decision maker's assessment of the value of the technology in question rather than the reverse. For the most part then, individual decision makers wish to acquire recent technology - not necessarily the latest, the exact vintage depending upon technological alternatives and the factor price/market situation in the country in question. At a national level too, governments, keen to industrialize, wish to have the 'best' technology, which is often identified with the latest.

Condition 2: the technology is not available locally. During the past two hundred years technological innovations have been dominated by a handful of countries. A study by O.E.C.D. (1970) identified 110 significant innovations in the twentieth century. All emanated from developed countries with the U.S. responsible for 60%, the U.K. 14% and German firms 11%. As these figures indicate innovations are not evenly spread among developed countries, but largely concentrated on a very few countries. Only the U.S. and the U.K. are net creditors in terms of royalty payments. The U.S. accounted for nearly two thirds of the gross receipts of royalty payments among the major recipients[1/] in 1977; the main European countries accounted

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1/ From the data fund of the I.M.F. Countries included are the U.S., Japan U.K., Austria, Belgium, France, Germany, Italy, Netherlands, Sweden, Australia, S. Africa, New Zealand, Norway, Finland and Spain. As a group these countries are in credit to the rest of the world, in terms of royalty payments, to the tune of 1,065 million SDRs. The U.S.' own net credit is far greater than this - 3,662 million SRDs.

for nearly 30%, and Japan for 3%. These figures reflect the past history of technological domination by a few developed countries. But much of this domination remains. The developed countries are responsible for 97% of world research and development expenditure[1/]. 6 nations[2/] employ nearly 70% of the world's research and development manpower and spend nearly 85% of R and D funds; only 6% of an estimated 3 1/2 million patents issued in 1972 were granted by developing countries, and less than one sixth of those issued by developing countries were owned by developing country nationals.[3/] With the exception of Brazil and India, developing countries import a high proportion of their capital goods[4/]; over 90% of LDC plant and machinery imports come from developed countries. In recent years there has been some increase in the technological capacity of developing countries - an increase which, as is to be expected, has been unevenly spread among developing countries. This is indicated by rising expenditure on research and development and, by some evidence of incipient exports of technology by some developing countries;[5/] and by increases in the export of capital goods by some developing countries.[6/] But while these developments are potentially significant, particularly in relation to policy, they are of relative insignificance in the general picture. The developed countries retain a massive preponderance in technological innovation which is a fundamental fact which must underly any discussion of technology transfer: it is this preponderance that is sometimes described as technological dependence.[7/]

1/ Annerstadt (1978). Expenditure figures are a bit misleading because of differences in salary levels: developing countries account for 13% of world scientists and engineers involved in research and development.

2/ USA, USSR, Japan, Federal Republic of German, France and the UK.

3/ UNCTAD, (1975b).

4/ See Maizels (1963) and Stewart (1977), Table 5.2.

5/ Described by Wells (1977), Diaz-Alejandro (1977) and Lall (1978).

6/ Exports of machinery and transport equipment were 37% of developing market economy exports in 1976.

7/ See UNCTAD, (1976)

Despite the fact that most innovations occur in the developed countries, there are - to an increasing extent - local LDC sources of technology. In the first place, although small in relative extent, R. and D. in the third world is increasing, and third world innovation (which extends, as in all economies, well beyond formal R. and D.) and adaptation is rising.[1/] Secondly, when a certain technology has been transferred once, internal transfer - from the initial recipient to other users - could, in theory replace international transfer. However, in practice both these potential sources of internal technology tend to be underutilized in many countries. Much LDC R. and D. tends to be misdirected, from the point of view of generating usable technologies.[2/] A considerable portion of it is basic research, which may be necessary to build up a scientific capacity, but which many observers believe has been overemphasized. Moreover, there are weak links between R. and D. and local productive activities, with a notoriously small proportion of total R. and D. being conducted by firms.[3/] It is noteworthy that of five countries which have developed Technology Plans, four specified explicitly that a significant weakness of existing efforts was weak links with the productive sector.[4/] Even where local research efforts do generate viable technologies, there is a strong[5/] tendency for these technologies to be rejected in favour of foreign sources. This rejection is largely due to

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1/ The five countries which have Technology Plans are all planning to raise the proportion of GNP devoted to R. and D. significantly, to around 1%. Most recent figures collected by Annerstadt show a significant increase in R. and D. expenditure in LDCs in 1973 as compared with earlier figures, Adaption and innovation have been identified in Korea and Taiwan (see Ranis 1972 and 1973), and in Argentina(see Katz (1978) and Maxwell (1978)). See also other sources cited in Lall (1978). While a certain amount of LDC innovation has by now been established its quantitative significance is not clear.

2/ This was the view of the USAID Report (1970); Cooper (1972), Herrera (1972) and Reddy in Bhalla (ed) (1979).

3/ See eg. Subrahmanian (1972), Carlsen (1975).

4/ UNCTAD (1978 b). The countries were India, Mexico, Pakistan and Venezuela.

5/ See Kidron, (1965) Subrahmanian (1972), Sercovich (1975), Lall (1975). Aurora and Morehouse (1974).

the market power bestowed by foreign trademarks, which is in turn engendered by consumer belief that foreign is best, and by some bad experiences with local technologies. Foreign technologies may also involve a greater marketability on world markets, and in some case access to markets which have been cartelized by foreign sources. The second potential source of internal technology is the internal transfer of techniques which have been initially imported. Both Japan and China have pursued this as a conscious policy. In the inter-war period, Japanese technology policy was summarized by the slogan: "The first machine by import, the second by domestic production".[1/] In China, Baranson reports that a U.S. "process team was shown an exact duplicate of its own - albeit, an eight-year old model - catalytic cracker and platforming refinery of a 3,000-barrel-a-day capacity apparently copied from one that UOP had previously sold to Cuba". (p. 118). But Japan and China are exceptions. Until recently many countries have followed a laisser-faire policy towards the import of technology permitting the duplicative import of technology. Restrictions in technology contracts limit the possibility of internal transfer, while it is often in the interests of the individual firm to acquire a foreign technology from the original foreign source, despite the fact (or indeed because of it) that some other local firm has already acquired it. Thus empirical investigations find that very similar technologies are sold to the same country a number of times, and sometimes that the identical technology is sold a number of times. A study of Danish[2/] foreign investment in India found that every single technique transferred was already in use somewhere

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1/ UNCTAD (1978a)

2/ See Neersø (1975)

in India. The potential internal sources of technology are thus underused and the extent of international transfer exaggerated, as a result of a laisser-faire policy towards the transfer of technology, and the market power bestowed by foreign technology.

Condition 3: decision makers believe it is cheaper to import the technology rather than reproduce it locally. Despite the real costs involved in technology transfer, costs of local reproduction - particularly at the level of the individual firm - are likely to be greater. This is in part due to the lower levels of technical sophistication and of R. and D. capacity in LDCs as compared with DCs, and in large part to economies of scale associated with R. and D., and particularly with its use. Thus it is not surprising that once a particular technology has been developed, the reduplication of the development process should be more expensive than acquiring it. Moreover, given that many investors wish to acquire the marketing rights as well as the knowledge, and that local R. and D. cannot generate this, foreign technology may be bought even when local reproduction would be as cheap.

The three conditions necessary for the international transfer of technology are thus very often present in investment decisions in third world countries This is particularly the case when the market situation is such that foreign trademarks enhance profitability, and governments pursue a passive policy towards technology imports.

II. Transfer Mechanisms

Defining technology [1] very broadly to include all knowledge related to economic activity naturally means that it encompasses a very wide range of types of knowledge, and that there are, correspondingly, very many mechanisms of transfer associated with it. In content, technology includes knowledge about infrastructure and services, agriculture as well as industry; it includes specification of what is produced as well as how it is produced. The how of production is not merely a matter of technical specifications but also includes managerial techniques, forms of organization and so on.

Much technology is transferred informally - through reading books, journals, sales literature, through personal contacts in meetings and conferences and so on and through the movement of trained people from one job to another. Within more formal categories of transfer, a distinction has been made[2] between direct and indirect mechanisms: direct mechanisms are those used when the recipient enterprises are in direct contact with the suppliers of technology; indirect transfer occurs when a company in an advanced country plays an intermediary role packaging the technology for the developed country. In practice, this distinction is too firm: there are a large variety of types of transfer involving varying degrees of packaging.

1/ The literature abounds with definitional discussions of exactly what is involved in the process of technology transfer, and of the various elements involved, e.g., the distinction into "general technology," "system-specific" technology, "firms-specific-technology" and so on (Quinn 1969). See the discussion in Cooper and Sercovich (1971). Here we avoid this type of discussion.

2/ Cooper and Sercovich.

Direct forms of transfer include direct contracting of individual experts and consultant companies, engaging engineering design and plant construction enterprises, training nationals for specific production projects, technical information activities and transfer of the process technology embodied in capital goods by importation of equipment purchased directly from machine manufacturers.[1/]

Indirect mechanisms range from the completely packaged in the form of direc investment overseas in a wholly-owned subsidiary, through joint ventures, turnkey arrangements and license and management contracts between independent parties.

License agreements encompass a considerable range of contracts which vary in what they cover, in the restrictive provisions involved, and in the form and rate of payment. Some license agreements contain provisions for some equity participation; some include management contracts, or the right of the licensor to appoint managers and/directors; licensors may sometimes appoint quality control experts, and occasionally control marketing through wholly-owned subsidiaries. License agreements often contain restrictive clauses in relation to the rights of the licensee to export, to conduct and/or use independent research, and tie-in clauses, whereby the licensee has to purchase inputs from the licensor, and so on.[2/]

The determination of the mechanism of transfer in a particular case is the outcome of the willingness of the supplier of technology to supply the technology in a particular form and the desire and ability of the recipient to acquire it in a particular form. Generally, indirect mechanisms tend to be adopted where a country lacks the capacity to undertake direct purchase, where proprietary technology is involved which will not be released, or where (for marketing or other reasons) the recipient wishes to acquire trade marks.[3/] But,

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1/ Cooper and Sercovich.

2/ Cooper and Sercovich provide a comprehensive discussion. A considerable amount of research has been done examining the nature of transfer mechanisms in particular countries - see e.g., UNCTAD (1975a), Asian Productivity Organization (1976), S.P.R.U. (1972), UNCTAD (1974), Marga Institute (1975), Sercovich (1974), Vaitsos (1974).

3/ S.P.R.U. (1972), pp. 19-20.

as just suggested, there remains considerable choice as to the nature of the indirect mechanism.

Where the interests of the recipient country differ from those of an individual recipient enterprise, the outcome may depend on who is responsible for the negotiations - government or enterprise - and how far enterprise freedom is restricted by government regulations.

The quantitative significance of different mechanisms varies as between countries, as between industries, and over time. Country variation, illustrated in the Table below for 1970, is partly a matter of national policy towards technology transfer and private overseas investment, and partly of the degree of development, and in particular the technological and managerial sophistication of the country concerned. The less developed - in terms of this type of sophistication rather than per capita income - the more packaged the transfer is likely to be, because the country may lack the capacity to put the package together itself, and because it may lack the bargaining power to insist on so doing.[1/] But independently of stage of development, the question of national technology strategy is of critical importance: some countries, such as Japan and many of the socialist countries, only permitted license agreements or direct transfers; many others have encouraged

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1/ But, taking the ratio of intra-firm to total technology payments to U. S. companies as a guide to the degree of packaging, in 1976 developed countries' packaging (with the exception of Japan) was not dissimilar to that of the developing countries (see footnote, p. 18). This may in part be due to the non-regulatory/interventionist policies of most developed market economies permitting packaged transfers. It also may be due to the fact that as countries become more developed, the technology they need to acquire from overseas becomes more sophisticated, and the tendency for packaging in sophisticated industries to be greater than in less sophisticated outweighs the effects of greater technological sophistication in reducing packaging.

direct foreign investment; [1] while a few follow an intermediate policy (e.g., India).[2] The content of licensing agreements also varies between countries: as is to be expected, countries with little independent managerial capacity are likely to have agreements which include management contracts. This was illustrated in a study of technology transfer to Ethiopia,[3] which found that the majority of agreements contained management contracts.

The nature of the transfer mechanism adopted varies with the industry. The more technologically sophisticated, the more difficult it is for countries to rely on direct transfer. The extent and nature of property rights over technology vary with the industry, as does the significance of trademarks. UNCTAD (1975a) classified industries into "modern" (requiring heavy research and development and with a recent record of technological innovation), "traditional" and "other" - both of which use well-established technologies. They found that for 13 countries, 57% of the contractual arrangements were in the "modern" classification in manufacturing, but there was a wide dispersion between countries. Relatively sophisticated countries, like South Korea, had as much as 80% of contractual arrangements in the modern industries, presumably indicating that direct transfer occurs in mature industries with well-established technologies; but in Dahomey, 80% of contracts were outside the research intensive sectors. A comparative study of pharmaceuticals, chemicals and electrical engineering in Latin America [4] found significant differences in preferences of supplying firms for different mechanisms of transfer. Broadly, these differences in preference were reflected in the actual arrangements. In the pharmaceutical industry, there was a strong preference for transfer via wholly-owned subsidiaries, and also for patent

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1/ As shown by the massive tax incentives provided.

2/ See S.P.R.U. (1972) Ozawa (1966). Subrahmanian (1972), Neersø (1975), UNCTAD (1978), Mytelka (1977), UNIDO (1978).

3/ UNCTAD (1974).

4/ S.P.R.U. (1972)

Table 1

OWNERSHIP CHARACTERISTICS OF THE CONTRACTING ENTERPRISES IN THE TECHNOLOGY RECEIVING COUNTRY, END 1970

Country	% of Contracts in Enterprises with Majority Foreign Ownership	Minority Foreign Ownership	Wholly Nationally Owned
Cyprus	48	44	8
Colombia	45	12	43
Brazil	36	#	64#
Sri Lanka	29	42	29
Peru	28	19	55
Rep. Korea	13	#	87#
Pakistan	12	8	79*
India	3	12	85
Yugoslavia	-	5	95

Source: UNCTAD (1975) TD/B/AC.11/10/Rev. 2, Table 3.

Minority foreign ownership treated as wholly national.

* Specified as "100% government controlled."

protection of the technology transferred. In chemicals, the majority of firms preferred joint ventures or pure licensing arrangements - the preference being greater the smaller the size of the supplying firm. In electrical machinery - which on the whole is a mature technology which has been widely dispersed - by far the largest number of preferences was for licensing agreements. In a study of metal working and chemical firms in three Andean Pact countries, Mytelka (1978) distinguishes between technology transfer via licensing and direct acquisition through experience of personnel, non-negotiable means (e.g., copying), the purchase of machinery and processes, journals and professional meetings. "Ownership structure, product

sector and firm size...correlated highly with the decision to license." Foreign firms clustered in industries with complex and volatile technologies; they together with mixed firms overwhelmingly licensed their technology, even where the technologies were simple and mature. Nationally-owned firms were dominant in simpler (technologically) industries: 61% of nationally-owned firms acquired technology through direct means, as compared with 17.6% of foreign firms, 12.5% of State firms and 25% of mixed firms. The firms were asked why they decided to license: 51% gave brand name acquisition as a reason; 47% the complexity of the technology, 30% prior relationship to the technology supplier, 26% cheapness, and 17% 'other' which includes advantageous bargaining conditions, reduced costs, few restrictions. Returning to the earlier distinction between that part of technology transfer which consists in the communication of useful knowledge, and marketing rights aspects, it appears that for this sample, of the total reasons given, one-third were of the knowledge communication type (complexity and cheapness), while two-thirds were other reasons, much of which could be classified as marketing rights. This does not mean, of course, that licenses obtained for e.g., brand name reasons, did not bring with them useful knowledge and quality guarantees which it would have been costly to obtain in other ways.

A study of sources of technology in S. Korea [1/] found that formal mechanisms of transfer - licenses and technical agreements with foreign technology suppliers - accounted for only a small proportion of the total. Formal mechamisms from foreign suppliers were of greatest significance in the modern sector - accounting for 21% of all important technology sources. This is a smaller proportion than other sources of foreign technology, which included technology embodied in Korean labour anad management (18.6%), foreign suppliers of capital equipment or raw materials (8.2%) and foreign buyers (6.6%). In

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1/ Pursell and Rhee (1978).

the traditional and resource based sectors formal mechanisms played a significantly smaller role. While there may be special factors in S. Korea accounting for some of the importance of informal mechanisms - for example, buyers can only play a significant role in an export-oriented economy - the study suggests we may often overemphasize the role of formal mechansims in technology transfer.

In recent years, there have been various forces making for less packaged forms of transfer - both in recipient and supplying countries. Growing industrial sophistication among recipients has increased their capacity to provide elements of the package for themselves; but they have also moved into more sophisticated (technologically) industries, where packaging is more dominant. Increasing political and economic sophistication, combined with the accumulation and spread of knowledge about the technology transfer process, has increased countries' intervention in technology transfer, sometimes involving a search for unpackaged alternatives. 1/ In some of the supplying countries, government regulations curtailing investment overseas, and fears of the riskiness of overseas investment in the light of moves among recipients to reduce equity participation, have contributed to more arms length forms of technology transfer. 2/

The evidence, however, is rather mixed. Baranson claims that "the most dramatic of the new strategies has been the adoption by some U. S. firms of an explicit policy to shift from equity investment and managerial control of overseas facilities to the sale of technology and management services as a direct means to earn returns on corporate assets." 3/ He cites examples in five major research-intensive industries. In the parts of the world where policies have been most explicitly directed against packaged forms of technology inflow,

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1/ See UNIDO (1978) and Mytelka (1977).

2/ Baranson (1978) discusses the reasons, particularly from the point of view of the supplying countries, at greater length.

3/ Baranson, op. cit., p.5.

e.g. India and the Andean Pact Countries, there is evidence of a move towards less packaged forms. 1/ But as Table 2 shows for the world as a whole, and for developing countries other than Latin America, there has been a significant increase in the proportion of U. S. technology receipts which are intra-firm. 2/ The U. S. accounted for 72% of gross receipts for technology among the U. S., Japan and Europe in 1969; the proportion has declined to 68% in 1977. 3/ It appears that U. S. technology supplies are more often intra-firm than supplies from other countries. 4/

No definite conclusions can be drawn on the basis of this evidence - which is not surprising, perhaps, given the many factors that contribute to the overall breakdown, including recipient country policy, industrial composition, 5/ country source of supplies, etc. 6/ But it does appear that there are a range of alternative mechanisms for technology transfer in many industries.

1/ See Mytelka (1977).

2/ As discussed in detail below, royalty payments are not necessarily an accurate guide to payments for technology transfer. Over time, changes in the environment may lead companies to change the form (proportionately) in which they receive different forms of payment. This may be one explanation of the declining intra-firm ratio for Latin America, where the Andean Pact prohibited the payment of royalties between subsidiary and parent companies.

3/ These figures are for receipts from technology transfer to all countries. Evidence for payments by particular developing countries also suggests the declining role of the U. S.: for example, in South Korea, the U. S. accounted for 40% of technology imports for the years 1962-66, and 21% in 1973-77; Japan accounted for 33% in 1962-66 and 53% in 1973-77. In Peru, the U. S. and Canada accounted for 60% of the royalty payments in 1971 and 35% in 1974. A study of license agreements in the Philippines for agreements before 1970, showed that 67% were with U. S. firms, 8% with Japanese firms; for the period 1971-73, 34% were with the U. S. 12% with Japan. (UNIDO, 1978).

4/ This is suggested by the fact that intra-firm payments for particular countries to all sources are substantially lower than those shown for U. S. payments: e.g., for Brazil intra-firm payments were 52% of total payments in manufacturing 1965-70; in Argentina they were 42% in 1972. (Chudnovsky 1978).

5/ See Chudnovsky (1978), Table 2 for variations in the ratio of inter-firm to intra-firm royalties according to industry in Argentina.

6/ The proportion of total payments of royalties and management fees to U.S. companies, which were intra-firm, rose sharply over the period 1960 to 1976 in the developed countries, as well as the 'other developing': In Japan, it rose from 13 to 50%, in the U.K., from 56 to 84%, in Western Europe, from 44 to 82%, Canada, 80 to 94%, in Australia, New Zealand and South Africa from 65 to 84%.

Table 2

PROPORTION OF TOTAL U.S. RECEIPTS FROM ROYALTIES AND MANAGEMENT FEES WHICH ARE INTRA-FIRM

	World	Latin America	Other Developing
1956	64	88	n.a.
1960	62	83	72
1972	76	85	80
1976	82	82	90

Source: 1956 - Hymer (1976), Table 2.2.

Rest - Chudnovsky (1978), Table 1.

III. Significant Dimensions of Technology Transfer

Objectives of LDCs in relation to technology transfer have evolved in response to experience in relation to technology transfer over the last 20 years. Initially, keen to industrialize rapidly and thereby, as they thought, acquire wealth and economic independence, most countries main aim was to maximize the quantity of technology transferred. Hence, they introduced a host of incentives, such as tax incentives, duty drawbacks, protection, and the provision of infrastructure, designed to encourage the inflow of technology from overseas, mainly in the form of private overseas investment. 1/ In other respects, a broadly laisser faire policy was followed with respect to technology transfers so that it was left to individual firms to decide the form and nature of the technology transferred. However, as the consequences of unrestricted inflow became apparent, new objectives evolved: the laisser-faire policy has therefore given way to a much more interventionist strategy at both national and international levels.

First, the high and rising cost of technology transfer drew attention to the need to introduce policies which would improve the terms of technology transfer. This was initiated by the Andean Pact group of countries, then UNCTAD, and by now the need for policies in this area has gained very wide acceptance among LDCs.

Secondly, in many countries a dualistic pattern of development was associated with the unrestricted import of advanced country technology. The capital intensity of the investment, the heavy underemployment, and the elitist

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1/ See Lent (1967), Reuber (1973) and U.N. (1972) for a description of the incentives.

consumption patterns in many countries led to emphasis on the need for appropriate technology: i.e., technology in line with the needs and resources of poor countries. Although the need for appropriate technology was largely initiated in the advanced countries, it has achieved increasing support among LDCs. 1/

Thirdly, the dependency school of development suggested that neither political independence nor industrialization was sufficient to achieve economic independence, and that at the root of the dependency relationship exhibited between periphery and center lay technological dependence. A more modest approach, which does not rest on acceptance of the whole dependency analysis, shows that technological dependence did indeed impose restrictions on the freedom of decision making that were scarcely compatible with economic independence. Hence, the creation of independent technological capacity became an aim.

Fourthly, it was increasingly felt that unrestricted import of technology inhibited the development of local technological capacity which in turn reduced long-run development prospects and engendered further technological dependence.

The 'new' objectives towards technology transfer, which have been accepted and pursued with varying degrees of enthusiasm, are in many ways in conflict with the initial objective of maximizing the inflow. 2/ They each suggest a much more interventionist policy on the part of governments, and in general a more restrictive and selective policy towards technology transfer from abroad. They each support (from different points of view) the need to develop

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1/ See the findings of the feasibility study into "A New International Mechanism for Appropriate Technology." (1978).

2/ There is a (non-coincidental) parallel between changing objectives towards economic development and those towards technology transfer. With the dethronement of GNP has gone, after a timelag, a corresponding detrocking of associated (instrumental) objectives such as maximizing technology transfer.

Third World technological capacity. In other respects, the new objectives are sometimes in conflict, and often differ in emphasis and policy conclusions. In the rest of this paper, we examine the policy options indicated by the new objectives. The paper takes four dimensions of technology transfer:

I. the terms of the transfer, or the cost;

II. the effects of the transfer on independence of decision making;

III. the effects of the transfer on local technological capacity, or the learning effects of the transfer; and

IV. the characteristics of the transfer.

Each of these corresponds with one of the 'new' objectives described. The paper considers past experience in relation to each of these dimensions, and policy options suggested (and in some cases adopted). The next sections consider the first three dimensions, which are grouped naturally together in terms of policy. The question of characteristics raises somewhat separate issues and is dealt with in Section VI.

IV. Costs of Technology Transfer

(i) Actual costs: It is difficult to ascertain actual costs of transfer. Apart from the fact that data is weak and sparse, the packaged aspect of much technology transfer and the indirect costs imposed raise problems. Where there is any degree of packaging the supplying firm is, by definition, supplying more than one service. This means that the firm has some choice in how it receives its return for each element of the package - e.g., whether it receives payment for technology as royalties, as profits, or through the transfer pricing mechanism. Declared payments nominally attributed to any one item may therefore bear no relationship to the real charge levied. To get at the total charges levied is difficult; but with rough and ready means, estimates have been made. But this does not solve the problem of how to allocate the items among the elements of the package. This is peculiarly difficult in connection with technology transfer because there is often some monopoly element involved, enabling the total charges levied to exceed the competitive charges. But the source of monopoly is not always the possession and sale of the technology; it may involve access to markets, or raw materials or so on. However, if we define the technology transfer to include marketing rights, as we have above, then it can be claimed that in large part monopolistic charges may be attributed to the technology transfer. But we should not include, as many seem to have done, competitive payments for other services which form part of the package, as costs of technology transfer.

These problems, that arise from the packaged nature of technology transfer, are most acute for the most packaged forms of transfer - viz., that of the TNC to wholly owned subsidiaries. But joint ventures also have

considerable scope for manipulating payments. Wholly owned national companies often receive technology and inputs from the same source - again it is not possible to know to what extent particular forms of payment represent the payment for technology.

A further problem is that restrictions on activities form a normal part of many technology contracts. But these impose costs, which can be substantial. For example, tied sources of inputs is similar to tied aid in increasing costs, but worse because with aid tying normally takes the form of tying to a particular country whereas with technology transfer the tying is to a particular firm. Even for aid, the costs have been estimated to be as much as 30% of the cost of the equipment. 1/ The costs are likely to be greater for private technology transfers. Other forms of restriction also impose costs which are difficult to estimate, such as restrictions on exports and on local innovation. The extent of these restriction has been established by a number of studies, but not their costs.

In view of these problems, it is perhaps not surprising that none of the (quite numerous) studies on technology transfer to developing countries have come up with satisfactory estimates of costs.

The most systematic estimates of direct costs were made by UNCTAD (1975). For 1968, they estimated that direct costs to LDCs of technology transfer were around $1,500 million for royalties and consultancy payments, which was equivalent to 5% of non-oil exports and around 0.5% of GDP. They

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1/ Bhagwati (1968).

estimated that these payments were likely to grow at around 20% p.a. on the basis of questionnaires to recipient countries. However, the technology receiving countries expected a lower rate of increase. If we assume that in fact technology payments grew by 15% p.a. from 1968-1977, they would amount to $5,275m. in 1977.[1/] Table 1 shows the UNCTAD estimates together with technology related payments. As suggested above some element of these related payments are likely to be due to technology.

In addition to these direct costs, overinvoicing of imports and underinvoicing of exports represents an additional cost. The very substantial proportion of international trade that occurs within the transnational corporation gives scope to these practices.

1/ The data are derived from questionnaires to recipient countries. More recent data collected by the IMF is too incomplete to provide much guidance. It excludes management/consultancy and the coverage is very incomplete. The estimates for royalties are far lower than those of UNCTAD (generally of the order of 1/2% to 1% of exports). It is likely that a good deal of intra-affiliate payments have been omitted in the IMF data. However, the Fund data suggest that the UNCTAD estimates overstate the costs. According to the Fund data, gross royalty receipts among the main technology suppliers from all countries grew by 99% p.a. between 1969 and 1977. Net receipts grew by 10.9% p.a.

TABLE 3

Direct costs of transfer of technology in comparison with other relevant foreign exchange flows of developing countries, 1968[a]

Flows	*Value (millions of dollars)*	*Proportion of direct payments for transfer of technology (per cent)*
Outflows		
1. Direct payments for transfer of technology (patents, licenses, know-how, trademarks, and management and other technical services)	1,500	100
2. Technology-related payments:		
(a) Imports (c.i.f.) of machinery and equipment (excluding passenger vehicles) and of chemicals	18,420	8
(b) Profit on direct foreign investment (excluding oil-producing countries)[b]	1,721	87
3. Service payments on external public debt	4,022	37
Inflows		
4. Non-petroleum exports (f.o.b.)	29,350	5
5. Total official flows	6,710	22
6. Direct foreign investment (including reinvested earnings)	2,700	56

Sources:

Line 1: UNCTAD secretariat estimates (see text).

Line 2 *(a)*: United Nations, *Monthly Bulletin of Statistics*, vol. XXVI, No. 7 (July 1972).

Line 2 *(b)*: "The outflow of financial resources from developing countries: note by the UNCTAD secretariat" (TD/118/Supp.5), *loc. cit.*

Line 3: IBRD/IDA, *Annual Report, 1972.*

Lines 4, 5 and 6: UNCTAD, *Handbook of International Trade and Development Statistics, 1972* (United Nations publication, Sales No. E/F.72.II.D.3).

[a] Data do not include Southern European countries.

[b] Including oil-producing countries: $4,934 million.

It is estimated that roughly one-third of total US exports were on an intra-firm basis in 1970.[1/] In manufacturing three industries accounted for 70% of that trade: transport, equipment, non-electrical machinery and chemicals. Fifty three percent of manufactured exports to developing countries was intra-firm, and for developing countries other than Latin America the proportion was 65%.[2/] Intra-firm trade is here defined as trade between a parent and a majority-owned affiliate. If joint ventures were included the proportion would be higher. A detailed study of Brazil and Mexico showed that the intra-firm share of exports was high and growing: in 1960 it was 68% and 54% respectively; in 1972, 73% and 82%.[3/] Imports from the parent company accounted for 50% (Brazil) and 58% (Mexico) of the affiliates' total material imports in 1972. Again, intra-firm trade was found to be particularly concentrated in technologically sophisticated industries. For the UK, a survey suggested that about one-quarter of all exports were intra-firm, and one-quarter of recurrent imports of affiliates in developing countries were supplied by other units within the corporation. Data for Norway and German firms also show a significant proportion of trade is intra-firm; generally speaking the proportions (of both imports and exports) are lower than for US firms.[4/]

1/ Lall (1973) and UNCTAD (1977c) summarize the evidence.

2/ Table 1 UNCTAD (1977c).

3/ Newfarmer and Mueller (1975) quoted in UNCTAD (1977c).

4/ See UNCTAD (1977c).

The evidence thus shows that a very significant proportion of trade is intra-firm, giving rise to the possibility of a quantitatively significant element of costs of technology transfer being disguised through the manipulation of transfer pricing. Intra-firm trade tends to be highest in the technologically sophisticated firms where the costs of technology transfer are likely to be greatest. Intra-firm trade appears to be of substantially greatest significance for US companies. However, the US is by far the largest source of technology transfer, although its predominance is declining.1/ The existence of a high proportion of intra-firm trade is necessary but not sufficient to indicate the existence of transfer price manipulation as a sizeable source of income transfer between countries. There are obvious difficulties in getting hard evidence on the existence and extent of such practices. But a growing body of evidence has now accumulated2/ showing that in some industries, it forms a significant element in international income flows.

One approach has been to try to establish the extent of such practices indirectly by regression estimates. Kopits (1976b) found he was able to explain the breakdown of income transfers as between royalties and transfer payments, statistically, by the tax incentives for the different types of remittances. But he was primarily concerned with developed countries. An econometric analysis of export prices in Latin America suggested underpricing of exports of, on average, 40% of the value of exports.3/ Other indirect evidence has been less conclusive.

1/ See page 18.

2/ Summaries are contained in Lall (1973), Kopits (1976a) and UNCTAD (1977c)

3/ Morgenstern and Miller (1974).

Direct estimates have been obtained by comparing intra-firm prices with market prices. Detailed studies have been done for Colombia and Greece - when the government instituted machinery to check on transfer pricing practices of international firms. In Colombia between 1967 and 1970, overpricing was greatest in pharmaceuticals - "the absolute amount of overpricing for the foreign firms studied amounted to a figure of six times their royalties and 24 times their declared profits":[1/] overpricing was greatest for the pharmaceutical industry, (on average 155%) where the foreign exchange losses due to overpricing of inputs were estimated to be as great as the total industrial royalties paid by all industrial sectors for technology. In electrical goods overpricing was estimated to be 54%, in rubber goods 44%, and chemicals 25%.

In Greece[2/] two groups of products were studied. In metals, metal products and minerals a sample investigation showed overpricing of imports of between 5 and 88%, with a weighted average of 19.4%; for chemicals the range was between 12 1/2 and 229%, with a weighted average of 34.5%. In the first group of products 95% of the underpricing was the responsibility of foreign owned firms; in the chemicals groups it was all in the foreign owned firms. For the mineral product group the total foreign exchange cost was estimated to be about 2 1/2 times the size of declared profits. The Greek study also investigated three export products and found underpricing ranging from 8.3% to 16.9%. The extent of underpricing was equivalent to 35% of the preceding year's profits for a 90% foreign owned firm, 26% for a joint venture and 13% for a locally owned

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1/ Vaitsos (1971).

2/ Roumeliotis and Golemis (1978).

firm with foreign connections.

Evidence of substantial underpricing of imports in the pharmaceutical industry has been obtained in India, Ecuador, Peru and Chile.[1/] The evidence for extensive use of transfer pricing to secure international income flows has been long established in the petroleum industry.[2/]

The evidence collected so far indicates that transfer pricing forms a significant source of international income flows in intra-firm transactions - at least as great as declared royalities and often as great as declared profits. While the evidence, in terms of country coverage and of magnitude, is greatest for the pharmaceutical industry, the practices are not confined to this industry but extend (in lesser amount) to all industries examined, such as rubber and mineral products, as cited above. In view of the strong incentives that firms face to price in these ways (which include the tax system and restrictions on remittances[3/] the results are not surprising.

It is difficult to assess with fairness and accuracy how far these practices inflate the costs of technology transfer - partly because the evidence though growing is still very incomplete, and partly because, as already suggested, it is difficult to know how much of the additional cost should be attributed to technology transfer and how much to other factors. However, without trying to form an accurate estimate certain conclusions follow: first, the declared royalty payments cannot be taken as a guide to the costs of technology transfer. Some element of the income transferred as overinvoiced imports/underinvoiced exports should also be attributed to technology transfer. In so far as it is technological dominance (including marketing rights aspects) which gives rise

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1/ See UNCTAD (1977c) paras. 94 to 98.

2/ Jenkins and Wright (1975).

3/ The various motives are summarized in Vaitsos (1974), Lall (1973) and Kopits (1976a).

to the market domination of a few firms and the possibility of transfer price manipulation, then it is correct to attribute the income so transferred in large part to the process of technology transfer. Secondly, the form or mechanism of the technology transfer influences the extent to which this sort of international income transfer is possible. Manipulation of transfer prices can only occur, in fully fledged form, where trade is intra-firm. But some possibilities exist in less packaged forms than the wholly owned subsidiary. Joint ventures, indeed, may have as great a possibility, and a greater (at least from the point of view of the foreign partner) reason for transferring income in this way. But the (limited) evidence suggests that joint ventures pay slightly less for inputs than wholly owned subsidiaries.[1/] The possibilities are clearly less for locally owned firms, but even here where they have strong connections with overseas firms, or where purchases of inputs (and/or access to markets for output) are effectively tied to the foreign firm, part of the costs of technology transfer may appear as inflated prices of imported inputs. However, both a priori reasoning, and the limited empirical evidence on this, suggest that the more packaged the transfer mechanism, the greater the flow of international income that occurs via transfer pricing. Thirdly, irrespective of the total sums involved, the existence of sizeable international income flows associated with technology transfer, in the form of transfer price manipulations, suggests a number of directions for policy. These will be discussed below.

Indirect costs: as already indicated the process of technology transfer often imposes restrictions on the activities of recipient enterprises which impose real, albeit indirect, costs. In the case of wholly owned subsidiary these restrictions are often implicit. But in transfers between less closely associated enterprises, they are explicit elements in technology contracts.[2/]

1/ Stopford and Wells (1972) p. 161 - 162

2/ UNCTAD (1975a) found that in both India and the Philippines provision for tied purchase of inputs was substantially greater in technology transfer between independent enterprises (20% in India, 58% in the Philippines) than between associated enterprises (10% for both wholly owned subsidiaries and minority equity in India; 9% for a wholly owned subsidiary and 25% minority equity in the Philippines); (Table 6). Vaitsos (1971) found similar differences.

Table 4 provides a useful summary of the sort of restrictions to be found.

TABLE 4

Pattern of limitations on access to technology by developing countries

Type of limitation	*Replies as to whether the country faced the specified limitation*	
	Yes	*No*
1. Tied purchases of imported inputs, equipment and spare parts	Argentina, Chile, Cyprus, Ecuador, Greece, Iran, Malta, Mexico, Nigeria, Pakistan, Peru, Sri Lanka, Turkey	Republic of Korea
2. Restriction of exports (total prohibition, partial limitation, geographical constraint)	Argentina, Chile, Cyprus, Ecuador, Greece, Iran, Malta, Mexico, Nigeria, Pakistan, Peru, Sri Lanka, Turkey	Singapore
3. Requirement of guarantees against changes in taxes, tariffs and exchange rates affecting profits, royalties and remittances	Cyprus, Nigeria, Turkey	Greece, Iran, Malta, Mexico, Singapore
4. Limitation of competing supplies by:		
(a) restriction of competing imports	Cyprus, Greece, Mexico, Nigeria, Peru	Iran, Malta, Pakistan, Republic of Korea, Singapore, Turkey
(b) preventing competition for local resources	Greece, Malta, Mexico	Iran, Nigeria, Pakistan, Republic of Korea, Singapore
(c) obtaining local patents to eliminate competitors	Ecuador, Malta, Nigeria	Greece, Iran, Singapore
5. Constraints limiting the dynamic effects of the transfer		
(a) excessive use of expatriate personnel	Argentina, Malta, Mexico Nigeria, Peru, Turkey	Singapore
(b) discouragement of the development of local technical and research and development capabilities	Argentina, Ecuador, Greece, Malta, Mexico, Nigeria, Turkey	

The first two items are of greatest relevance to the question of costs of technology transfer.

Detailed studies of technology transfer have revealed that restrictions are widespread. The SPRU[1/] study of Latin America found export restrictions

1/ SPRU (1972)

in 12 out of 19 firms in the pharmaceutical industry, 8 out of 10 companies in chemicals and the majority of firms in electronics.

A study[1/] of the Andean Pact countries experience showed that of contracts examined 77% in Bolivia, 77% in Colombia, 75% in Ecuador and 89% in Peru contained a complete export prohibition. For nationally owned firms the percentage which prohibited exports was 92%.[2/] No major differences were found between sectors.

The effect on countries' export potential varies with industrial strategy and the type of technology transfer as well as the strategy of the technology supplier. While these studies found significant export restrictions, technology transfer associated with multinational companies provides access to export mar-

TABLE 5

Provisions for tied inputs in contractual agreements for the transfer of technology

Country	*Percentage of agreements containing such provisions*
Bolivia	83
Colombia	77
Ecuador	67
Peru	62
Philippines	26
India:	
April 1961 – March 1964	15
April 1964 – March 1969	5

Sources: Colombia, Departamento Nacional de Planeación, *Transferencia de tecnología* (Bogotá, June 1970); C. V. Vaitsos, *The Process of Commercialization of Technology in the Andean Pact* (OAS, Washington D.C., 1971); and *Restrictive business practices: Interim report by the UNCTAD secretariat* (United Nations publication, Sales No. E.72.II.D.10), table 2.

NOTE. For Bolivia, Ecuador and Peru the percentages relate to the total number of agreements containing references to inputs. For India, the percentage for 1961-1964 refers to the total number of effective agreements; the percentage for 1964-1969 refers to those agreements obtaining Government approval and eventually coming into force during the period.

1/ Vaitsos (1971)

2/ In Japan, in 1962, 53% of technology contracts contained export restrictions, with much a higher proportion in some industries (90% in metal products, 85% in non-transport machinery, 80% in transport machinery and 65% in paper products): O.E.C.D., (1967).

kets in other cases, as for example with the processing technologies associated with export zones.[1/] For this sort of technology transfer the wholly owned subsidiary is more likely to gain access to international market than joint ventures.[2/]

The Table, on the previous page, based on answers to an UNCTAD questionaire shows the proportion of contracts which included a tie-in clause for inputs.

The study of the Andean Pact group of papers showed that tie-in clauses were experienced in all sectors studied, but were greatest in the pharmaceutical industry.

Adding up the costs: as already stated it is impossible to be accurate because of lack of data and conceptual and theoretical problems in estimating and attributing costs. However, it does seem clear that the overt charges for technology transfer - royalty payments etc. - are way below the total costs of the transfer. For example, to add 10% of the costs of imported capital equipment and chemicals and one fifth of declared profits on overseas investment to the UNCTAD estimates of technology costs would more than double the costs in 1968 (to 12 1/2% of non-petroleum exports). Yet in view of the evidence on intra-firms trade, transfer pricing practices, tied purchases of inputs, and export restrictions, these additions are extremely modest. For example, suppose we assume that tied purchase of capital goods adds 30% to costs of capital equipment, as might be suggested by the evidence on tied aid, then for countries with around three quarters of their inputs tied by technology contracts, the additional cost would be over twenty percent of the cost of capital equipment.

It would be interesting and useful to have accurate estimates of total costs, but even without these, it is clear that the total cost is very significant, and LDCs could make important foreign exchange savings if they were able to reduce the cost of technology transfer.

1/ See eg. Helleiner (1973).

2/ "One of the important differences between the two types of equity arrangement appears to lie in the different access to export markets. The foreign controlled subsidiary is more likely to be offered access to the global channels of distribution of the foreign firm than is a joint venture" Chudson (1974). Some reasons and evidence is contained in Stopford and Wells (1972).

(ii) The Appropriate Price: The market for technology is a peculiar one - even within developed countries; peculiarities are greater in relation to technology transfer between developed and developing countries.

The marginal cost of supplying information that has already been developed, are low:

"once new knowledge has been created it has the character of a public good, in the sense that the use of such knowledge by one person does not preclude its use by another so that optimality requires that it be made available to all potential users without charge" (Johnson)

However, since the costs of the initial research and development may be substantial, marginal cost pricing would not provide enough incentive for its development by the private sector. To this dilemma, two solutions are possible: first, that the public sector should be responsible for, or subsidize, the production of knowledge. This raises problems in securing the necessary links with users (problems widely encountered in developing countries, where much research is publically financed); although experience with defence research suggests the problems are not insuperable. The second solution is to provide legal and other protection to the owners/developers of technology so that they may acquire some monopolistic control over their technology, and consequently sell it at a price above its marginal cost. This has been the system adopted for much technological development in developed countries. It is often justified as necessary to secure a continued flow of research and development. Essentially then with this system the price charged for technology is a monopolistic/oligopolistic one. The non-competitive pricing of technology can be viewed as a mechanism adopted by developed country firms to generate returns to innovative activity in an area where competitive appropriability is low.

Developing countries have control over how they wish to finance or protect their own research, but in acquiring technology from abroad, they have to accept the system as they find it. In this context it makes little sense to

talk of the 'right', 'optimal' or 'appropriate' price. Two extreme positions have been put forward. On the one hand, it is sometimes suggested that the developing countries are so marginal in relation to the technology sales of advanced countries, that they should make a minimum or zero contribution to the research and development costs of the technology they acquire.[1/] On the other hand, others have suggested that even a small inroad into the current price of technology, will reduce the flow (the flow being variously interpreted as the flow of research and development and/or the flow of technology transfer).[2/] Both common sense and evidence suggest that the latter position is too extreme. Developing countries, taken as a whole, do provide a considerable portion of the expenses of technological development, as evidenced by the costs summarized above. But they are normally quite a way down the line, as users of new technology, frequently acquiring it not from the first developers but subsequent owners,[3/] after a considerable time lag. Sales to developing countries, then, probably form only a small part of the motivation behind the development of most technologies. Another question is how far the transfer, as against the development of technology would be affected by a reduced price. The answer to this is unknown - there can be no single answer covering all countries and all industries, but the experience of countries which have tried to bargain toughly suggests a low supply elasticity.[4/]

An essential feature of the market for technology then is that it is non-competitive; consequently there is considerable (extent unknown) area for bargaining, as the price may vary between an upper limit determined by costs of reproducing the technology and a lower limit determined by costs of imparting the information. The important potential role of policy arises from this indeterminacy.

1/ Vaitsos (1974)

2/ Carlsen and Hufbauer (1978)

3/ Vaitsos (1974)

4/ See evidence of Mytelka (1977); experience of Japan.

Technology Transfer and Independence

Independence of decision making is valued in itself by some - hence the resentment of foreign ownership of a large proportion of a country's assets. But it is also necessary for the achievement of other aims. Restrictions on freedom of decision making tend to increase costs and reduce the firm's ability to be selective about technological choice, and to learn and to generate an independent technological capacity.

Independence of decision making is obviously absent in the case of wholly owned subsidiaries of foreign companies. Nationalization of assets, joint ventures and restrictions on the shares of equity that foreign companies may hold are policies that have been adopted in large part in order to preserve independence of decision making. But close scrutiny of technology contracts of joint ventures or national firms has revealed a very considerable degree of restriction on independence of decision making. A typology of restrictions was shown in Table 4.

Vaitsos' research in the Andean Pact showed - in addition to restrictions on exports and tie-in clauses already discussed - restrictions on prices, on volume of sales, on quality control and on the sale of technology.[1] A study[2] in Argentina showed that licensing agreements with wholly locally owned firms included clauses such as: source of inputs of machinery, materials, spare parts; prices and quantity of output; export outlets permitted; restraints on the dynamic effect of the transfer - e.g. non-transference of patents, restrictions on local R and D. Similar restrictions were found in a study of Indian firms.[3] For example, 23 percent of the agreements examined involved some restrictions on local sales (type, quantity, price) while over half involved restrictions on exports.[4]

1/ Vaitsos (1971) p. 20.
2/ Sercovich (1972)
3/ Subrahmanian (1972)
4/ See also Matovelle (1974); Oxman and Sagasto (1972).

Changing the ownership structure is thus insufficient to secure independence of decision making. Indeed technology contracts have been described as "a mechanism of control of the recipient firms." 1/ Direct purchase of technology, through, e.g., use of the experience of personnel, purchase of machinery, copying imported products, avoids this sort of restriction. But for most countries, this is a possibility only for the simpler products and techniques. As noted earlier, even emong the simpler technologies, a tendency has been observed for foreign owned and mixed firms to purchase technologies via technology contracts. A different approach - now followed by an increasing number of countries 2/ - is to outlaw restrictive clauses. But outlawing cannot always ensure de facto elimination of the practices.

1/ Vaitsos (1971), p. 21.

2/ See UNIDO (1978): e.g. South Korea, the Andean Pact Countries, Brazil - see below.

Learning Effects of Technology Transfer

The ability to make independent technological choices, to adapt and improve upon chosen techniques and products, and eventually to generate new technology endogenously are essential aspects of the process of development. The process may be described as the accumulation of technological capacity; it is at least as important to economic development as the accumulation of capital.

The accumulation of technological capacity is the outcome of a complex series of forces. One significant element is 'learning by doing'; another is an educational, infrastructural and institutional setting which both permits and encourages the learning process. Both aspects are crucial, although in the past policy has tended to overemphasize the institutional side, which is most obviously amenable to government policy, and underestimate the 'learning by doing' side. Weak links between an elaborate institutional structure and industrial and learning by doing activities have tended to 'marginalize' the activities of the scientific institutions.[1/]

The accumulation of technological capacity is not a simple, easily described activity. It cannot be measured in a straight forward way at either macro or micro levels. At a macro-level, residual methods of measuring technical change, suggest the substantial significance of increases in productivity which are not explained by increases in inputs. But these methods are highly dubious because of the problems of attributing increases in output to increases in input. Moreover, in a developing country context they exaggerate the extent of indigenously generated technological change, since in part the technical

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1/ See Herrera (1973), Cooper (1973) and Sagasti (1978).

change identified is due to improved imported techniques; on the other hand, the measure in no way captures the development of independence of decision-making which is an important element in the accumulation of technological capacity. Micro-case studies throw more light on the process. Again, precise measurement is not possible, but micro-studies of technological change do pinpoint the significance of such change and also suggest the myriad causes. Maxwell's study of a steel plant in Argentina, for example, showed that (endogenously generated) technological change, was responsible for over half the increase in output capacity. The causes of the technological change he attributed to exogenously determined changes in demand (leading to the need to diversify output), exogenously determined changed in operating conditions (e.g., deterioration in the quality of available scrap), and endogenously generated changes arising from routine activities of engineers, etc. The exogenous causes were of the greatest significance. The form the technical change took varied - from major changes in process, to minor changes in procedure. The agents of the changes included people transfer from elsewhere in Argentina, the employment of foreign consultants and the firms'own engineering department.

There is a complex relationship between the import of technology and the development of local technological capacity - one that encompasses both conflicts and complementarities. The import of technology is a necessary, or at the very least helpful, part of the learning process in many countries and for many industries - either by providing an essential input into the learning process or by permitting the country to bypass the slow process of reinventing the wheel. On the other hand, the unrestricted inflow of foreign technology may severely inhibit the learning process.

The development of local technological capacity may be roughly classified as a three stage process. In the first stage, the capacity for independent search and choice is developed; in the second, minor technical changes (which may add up to major changes in terms of quantitative impact) are generated locally; in the third, new technology is developed indigenously. The third stage is unlikely to occur unless the first two are well established. Different types of capacity are necessary for each of the stages; in the first two entrepreneurial and engineering capacity are required rather than formal R. and D., while formal R. and D. may be necessary, in many cases, for the generation of new technology. Government policy which has concentrated on formal R. and D. in government financed research laboratories has tended to neglect the first two stages although they are necessary precursors to the effective use of the results of the formal R. and D.

The impact of foreign technology inflow is likely to be different according to the stage reached, local scientific and technological capacity, the form which the foreign technology inflow takes, and the industry concerned.

Unregulated technology inflow in packaged form may inhibit or delay each stage, but particularly stages 1 and 3. Yet, some import of technology is likely to be an essential input to each stage.

In relation to stage 1 - the capacity for independent technological choice - use of foreign technology, in packaged form, tends to limit independent choice. In the case of wholly-owned subsidiaries, decisions about choice of techniques remain those of the foreign company. Where technology is licensed, there is more freedom of choice but, as is to be expected, the parent company (of mixed firms), or the licensor determines the source of machinery to be used in many

cases. [1] Limitations on decision making, which as already described form part of many technology contracts, limit the freedom to make a choice and consequently the possibility of learning how to do so. The effects are not confined to the immediate decision covered by the license but tend to carry forward to the next set of decisions: thus, Mytelka found that firms that licensed their technology were overwhelmingly likely to expect that they would acquire future technology in the same form. In contrast, and not surprisingly, firms that acquired technology by direct means [2] generally were expected to be able to generate new technology in the same way.

The second stage of accumulation of technological capacity - minor changes and adaptations generated locally - is largely unrelated to the extent of foreign technology inflow. It occurs in response to local pressures for adaptation and change. Imported technology may provide the basic technology subject to this kind of technological change. Local changes are generated as a result of the need to expand and diversify output, and in response to cost pressures. Both Katz and Maxwell show significant changes of this type occurring in subsidiaries of multinational companies, where the basic technology was imported. The changes required a certain initial engineering capacity, but in turn the learning process generated through the changes created additional technological capacity. We have much too little evidence on change of this type to know whether there is any systematic relationship with quantity or form of technology transfer, any systematic relationship with competitive environment (national

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1/ Mytelka (1978). Of those licensing, 67% did not choose their own machinery - these included 91% of foreign firms, 100% of State firms and 44% of national firms.

2/ Ninety-Seven percent of firms which licensed their technology said they would be unable to develop their own technology for new products; 73% of firms which acquired technology in other ways, said they would be able to develop their own technology for new products (defined as acquiring it other than through licensing).

or international, although a priori reasoning leads one to expect some), or with other variables.[1/] Nor can we say, at this point, how far the results are cumulative leading to accelerating technical change of this type, to the next stage of technological development, or to technology exports.[2/]

The third stage - generation of new techniques - is likely to be inhibited by weaknesses in the earlier stages. One outcome of weakness in decision making capacity is inability to generate technology autonomously.[3/] To some extent, development of local technological capacity is an infant industry, requiring protection from outside competition if it is to be established. The free import of technology inhibits its development in a number of ways: it provides a reliable (and sometimes relatively cheap) source of technology as compared with the risks of own development. These risks are not just scientific ones, but include marketing risks. Techniques with a foreign trade-mark have a more certain market compared with techniques developed indigenously. Formal restrictions on local development of technology and/or the use of locally-developed techniques form part of some technology contracts.[4/] Most foreign-owned firms prefer to rely on their central research and development laboratories, and do not conduct R. and D. in the developing countries.[5/] Recently, it has been the policy of some large U.S. companies to shift some of their R. and D. overseas,[6/] but the shift has been almost exclusively to developed countries.

1/ Sercovich (1978) has suggested that the extent of such change will depend in part on the initial design (whether 'underdesigned' or 'overdesigned') which in turn depends on initial conditions.

2/ Katz and Ahblin (1978) suggest a sort of product cycle in technology: the import of technology leads to the development of local technology in response to environmental pressures, and then to the export of technology to countries with similar environments. They illustrate with a few cases in Argentina.

3/ Again, the Mytelka study supports this showing a close connection between freedom of choice of machinery and a belief in the firms ability to generate its own technology in future.

4/ See UNCTAD, (1975), TD/B/AC.11/10/Rev. 2, paras. 83-89.

5/ The SPRU study showed that foreign firms did little or no R. and D. in Latin America.

6/ See Ronstadt (1977).

Sagasti reporting on the IDRC study of science and technology policy instruments which included research in ten less developed countries, concludes that "Although technology imports do not always hamper the growth of domestic science and technology capabilities, the wholesale importation of technology without efforts to screen, control and absorb it usually stunts the growth of domestic science and technology capabilities." (My underlining)

While a selective approach to the import of technology may be necessary to protect and encourage local technological development, positive, promotional policies are also required. The most successful examples of technology promotion have combined selective imports of foreign technology with many positive promotional measures: at a macro-level Japan's policies provide a very good example. Micro examples include PEMEX in Mexico and fertilizer developments in India.1/

It is clear that the appropriate set of policies will vary according to the industry as well as local technological capacity. In some technologically complex industries, most LDCs will need to continue to rely on imported technology for some time, and at this stage are in a position only to learn to choose and to adapt in minor ways. In less complex industries, many countries may be in a position to generate technology themselves.2/

Giving special promotion (plus protection) to local technological developments may involve (as with other such promotional policies) short run costs, in terms of reduced efficiency. This is in part a question of the

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1/ Roberts (1973)

2/ Cooper (1976) provides a classification of industries along these lines.

opportunity costs of the resources devoted to technological developments, and in part of any inferiority of the local technology as compared with the foreign alternative. Exclusive use of promotional policies (with no restrictions on foreign technology) will avoid the second kind of loss, but, it seems likely, at the cost of making local efforts more ineffective.

There are three different types of reason why countries may consider these costs justified: first, because technological independence is an aim in itself. Secondly, because there are externalities of local technological developments which are not captured by the firm, but which benefit the economy (e.g., as a result of the learning experience, which individuals take to other firms). Thirdly, because short run losses are believed to be outweighed by long run gains[1/] - the infant industry argument.

1/ It must also be assumed that government objectives differ from those of individual firms either because of externalities or because of attitude towards time.

V. Policies Towards the Import of Technology

Relevant policies vary according to the objective, but there is considerable overlap: some instruments serve more than one objective, while the objectives themselves are interrelated and mutually enforcing. For example, policies which increase independence also tend to improve bargaining strength. The effectiveness of different policies depends in part on the general economic strategy of the country; it also depends on other policies towards technology. This is particularly true with respect to the promotion of local technological development, where policies towards foreign technology are only a small part of the total effort needed.[1/] Relevant and appropriate policies will vary according to the stage of development of the country, its administrative and technological capacity, and according to the industry.

As seen above, the free and unselective import of foreign technology has involved a high cost (directly and indirectly), has limited independence of decision making and, to some extent, the learning effects of the technology. Policies towards the import of technology are designed to reduce these effects.[2/]

Many of the policies considered below are primarily aimed at reducing the cost of imported technology; this may be secured by changing the form of technology inflow towards less packaged alternatives, by

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1/ See the many policies described in Sagasti (1978).

2/ "Although there is recognition of the country's dependence on foreign technology, an important objective of this legislation is to gain a degree of control over this major import, both in terms of cost and of technological impact." (UNIDO, 1978, p. 3). This statement of the Mexican Government is representative of the intentions of many governments active in this area.

avoiding duplicated imports, by outlawing restrictive clauses of technology imports, and by reducing the value attributed to the marketing aspects of technology. To date, most concentration - at UNCTAD and in developing countries - has been devoted to the question of the direct cost of technology transfer, although few countries have effective policies. The balance of the discussion below on specific policies reflects this, despite the fact that the question of accumulation of technological capacity is probably of greater long run significance than the costs of any particular transaction. However, many countries are not yet in a position to generate their own technology to a significant extent - nor do they have the administrative and technological capacity to pursue the kind of screening policies required. For these countries, the policies towards costs are the most relevant. While it may be argued that the administrative costs of such policies are high, the 'success' stories have shown that the cost savings are also high and in most cases easily outweigh administrative costs. However, more research is needed on the real effectiveness of regulatory policies, in the long run, including an investigation of the extent to which formal restrictions replace formal ones.

Some of the policies aimed at reducing the costs of technology imports will also contribute to increasing technological capacity: for example, less packaged alternatives tend to involve less costs, and also more freedom of decision making. Outlawing of restrictive clauses normally also outlaws restrictions on learning and research. Policies reducing the significance of foreign trademarks will help protect local technology. But effective policies towards promoting technology capacity extend well beyond those related to cost reductions. Selectivity towards foreign technology imports designed to protect local developments requires an assessment of local potential

in each area, permitting technology imports where these are likely to induce local innovations but preventing them where they are likely to inhibit them. This clearly is a delicate task involving considerable judgment on the part of policy makers. Many countries lack the administrative capacity and technological awareness to pursue this type of policy across the board. However, screening policies can be adopted on an industry-by-industry basis, starting with the industries where there is most local potential. Policies to promote local technological developments must also contain a strong positive promotional element, pursued simultaneously with screening policies towards foreign technology. Thus, as indicated by the varying experience in this area, policies towards technology imports and promotion are not all-or-nothing, but rather can be pursued at a different level, according to the objectives of the country and its administrative and technological capacity.

Economic Strategy and Technology Policy

The general economic strategy of a country strongly influences technological developments.[1/] This is most obvious - and most significant - in relation to the question of appropriate technology, where policies towards income distribution, trading strategy, factor prices and credit availability are critical in determining the choice of products and techniques. These relationships will be discussed more below. But the general economic strategy is also of significance in relation to the other dimensions.

1/ "Explicit science and technology instruments are those intended to affect directly the decisions having to do with the growth of local S and T capabilities; implicit ones are those that affect decision making indirectly through second-order effects. The great weight, both in number and influence, of the latter limits the potential impact of the former." (Sagasti).

Thus, the potential for charging excessive prices for technology is much greater in a non-competitive environment. Hence the worst examples of under-invoicing tend to occur in industries which are heavily protected, and in which, as a result there is considerable potential for making excessive profits. Lack of competition is partly a national problem, partly an international one. Industries which are technologically sophisticated often lack effective competition on a world basis, and in such cases national policies alone cannot be effective in eliminating the source of non-competitiveness and, therefore, the excessive prices. An important source of non-competitiveness occurs via trademarks, advertising and product differentiation. In economies, in which this type of market structure is predominant, excessive costs of technology imports are likely. Technology policies may be designed to offset these effects (e.g. by regulating the prices paid, investigating invoicing and so on), but so long as the fundamental causes remain, the policies may well prove to be only nominally effective.

The general economic and technological environment is also of significance in determining the rate of accumulation of technological capacity. But simple generalizations about the relationship between trade and pricing policies and indigenous technical change are not possible at this stage. It is necessary first to distinguish between protection/competition in the market for goods and that in the market for technology. As already suggested, some protection in the market for technology may be necessary to protect local technology, and this will extend to those goods

(notably capital goods) in which technology is embodied. But this is the reverse of the form which protection normally takes, where capital goods and technology are subject to very little or no protection, while consumer goods are subject to heavy protection.[1/] It has been claimed that "in general, import substitution policy and full-scale protection of consumer goods industry have tended to promote a passive attitude to the utilization and development of indigenous R and D efforts during the early phase of industrial development."[2/] This claim seems to be borne out by case studies of Brazil and Ghana.[3/] Yet micro-studies of technical change suggest that trading policies may not be of major significance. Examples of quite substantial indigenous technical change have been found in both open and closed economies.[4/] The success of countries such as Argentina and India - both heavily protected economies - in developing technology exports[5/] challenge the view that an open trading strategy and undistorted factor prices are necessary for the generation of technical change.

Technological developments are most likely where there already exists a certain amount of technological capacity, in the form of engineering resources and an innovative attitude on the part of entrepreneurs,

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1/ For example, in Indonesia the amalgamated tariff trade and sales tax on capital goods and basic industrial inputs is 5%, that on intermediate inputs 25% and on manufactured consumer goods, 50-70%. (See World Bank, Indonesia, Basic Economic Report, 1979).

2/ Nam Kee Lee (1975)

3/ Beranek and Ranis (1978)

4/ See the work of Katz and others in the IDB/ECLA Research Programme in Science and Technology.

5/ See Katz and Ablin (1978) and Lall (1978).

managers and workers. Given this sort of background, local innovation is more likely the greater the pressures from the local environment which make local technological change necessary or worthwhile. Such pressures include 'natural' pressures occuring as a result of differences in physical environment, market size, resource availability and cost as compared with the environment for which the foreign technology was designed and 'artificial' pressures created, for example, by restrictions on technology imports.

The general proposition that local technology change responds to such pressures in the environment is well documented in the empirical literature.[1/] This would suggest that a competitive environment (both nationally and internationally) and factor prices broadly in line with factor availability would be more conducive to technical change than an environment in which firms are highly protected and are able to survive and prosper without innovation or adaptation.[2/] However, internal competition, difference in market size and the non-availability of certain parts and materials may be at least as effective as international competition in creating the required pressures. This explains why technical innovation and adaption does seem to occur in 'protected' economies as well as in open economies. More systematic comparative data is necessary, at both macro- and micro-levels, before further and more confident generalizations is possible.

1/ Many studies have suggested that adaption and innovation tend to occur in response to necessity (e.g. the absence of particular materials, the disappearance of markets, major differences in size of market) to a greater extent than in response to less dramatic incentives offered by cost differences.

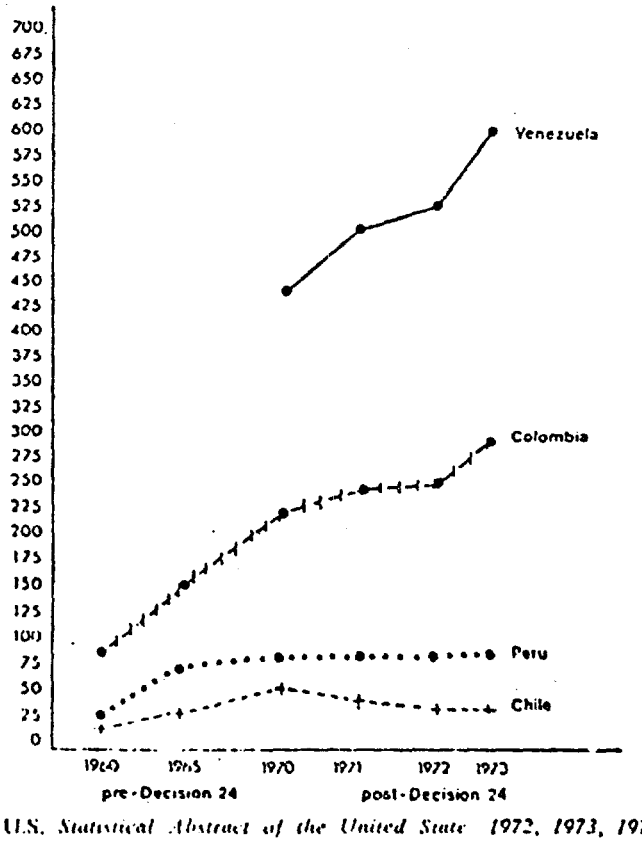
2/ See Ranis in Beranek and Ranis (1978).

Policies Towards the Terms of Transfer:

Policies towards foreign investment: direct overseas investment provides the greatest potential for hidden costs of technology transfer, and generally also involves the highest overt costs and the greatest loss of independence in decision making. Policies which permit only a minority of equity ownership on new investments, and a divestment on old are designed to reduce these effects.

Many countries regard foreign direct investment as the only means of securing the technology; but some have introduced restrictions on onwership in order to meet their technology objectives. In some, majority foreign ownership is only permitted in limited 'sophisticated' industries; in others it is prohibited altogether. In general, the aim seems to have been to regulate permitted equity ownership without adversely affecting the inflow of foreign technology.

U.S. DIRECT INVESTMENTS IN ANDEAN MANUFACTURING
in Millions of U.S. $



Source: U.S. *Statistical Abstract of the United State 1972, 1973, 1974, 1975* (Washington, D.C.: Government Printing Office).

The Andean Pact, decision 24, provided for divestment as well as minority foreign ownership in new investments. According to the study by Mytelka the divestment requirements had only had very limited effects by 1975. The inflow of U.S. direct investment does not appear to have been markedly affected by the decision, as shown in the chart.

Transfer pricing and foreign investment: the terms of technology transfer may be improved by enforcing arms length pricing on the international transactions of transnational companies for the purpose of customs and taxation. In practice, this is difficult to achieve because arms length prices are unknown and because of the administrative burden involved. Kopits argues that "with the exception of the United States, most countries have neither the willingness nor the administrative machinery to enforce arms length prices..."[1/]

Taxation policy: the tax system may be used to deal with the transfer pricing problem more directly, by introducing taxes which will be the same irrespective of the prices of imported inputs or exported output. Two approaches are possible: one is to impute the profits a company is making in a particular country by assuming them to be the same ratio to some known variable (e.g., turnover or employment) as world wide profits are to world wide turnover or employment. To be effective, this obviously requires that world wide accounts are reliably known, which is not always the case. A second approach is to introduce a uniform tax on all items, so that irrespec-

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1/ Kopits (1976a); the arms length solution has proved difficult to administer in the U.S. See O'Conner and Russo (1973) and Musgrave (1969).

tive of price manipulation, the same tax will be paid. A uniform tax rate levied on profits plus imported inputs plus royalty payments plus management fees less exports would achieve this.[1/] It would remove the tax incentive (but not other incentives) for transfer price manipulation, while eliminating the tax cost of such manipulation, and consequently improving the terms of technology transfer in the case of direct foreign investment. Some countries have prohibited subsidiary companies from deducting royalities in payment to parent companies in calculating tax liability, which is a first step in this direction.[2/]

Raising tax rates and/or removing tax incentives (holidays, investment grants etc.) would also improve the terms of technology transfer. In some cases the terms a country pays would be improved without any deterioration in the terms received by the company. This is the case where the LDC effective tax rate is below that of the DC from which the investment comes, and the DC uses the credit method of double tax relief, and does not permit tax sparing agreements.[3/] In such cases any tax loss as a result of low tax rates/tax incentives offered by LDCs simply increases DC tax revenue.[4/] Since many LDCs offer extremely generous tax incentives,[5/] and since the

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1/ See I.L.O. (1972) for discussion of a similar proposal. The proposed tax base is similar to the European value added tax, except that it excludes payments for local labor and materials.

2/ An obvious objection to the uniformity proposal is that it would remove a country's freedom to vary its rate of tariff on different items, since the tariff on imports would be incorporated into the uniform tax.

3/ These arguments are elaborated in Stewart (1978).

4/ Apart from gains the company makes by deferring tax payments; these may be substantial and long lived if tax havens are involved.

5/ See e.g., Lent (1967), Reuber (1973).

U.S. uses the credit method of tax relief and does not allow tax sparing relief, this is the situation for a large proportion of investment in LDCs. In such a situation, the LDCs should bring their tax rates into line with those ruling in the DC country from which the bulk of their investment comes. If they wish to give special incentives, they should do so in the form of subsidies (e.g., to employment) which would have the added advantage of encouraging the sort of investment they wish for.

There have been numerous studies testifying to the extreme ineffectiveness of tax incentives in LDCs in encouraging investment.[1/] "The most striking conclusion of the survey was that the foreign investors, almost without exception, stated that taxation concessions played no role at all in bringing them to Singapore".[2/] Studies in Argentina, Mexico, Jamaica, Guatemala and Nigeria come to similar conclusions. Not a single study suggests that tax incentives have been effective. They persist, nonetheless, increasing the cost of technology transfer to the countries concerned. One reason is that each country believes it is on a kinked demand curve, such that if it raised its tax rate and removed incentives it would lose a large share of investment to neighboring countries. To get round this belief (which may well be a misconception) regional agreement is required in removing tax incentives and raising tax rates. Alternatively, countries could act individually but maintain incentives by giving subsidies instead of tax allowances.

1/ E.g., King (1970), Hinricks (1974), Chen-Young (1967), Phillips (1968), Hughes and Seng (1969).

2/ Hughes (1969)

Taxation may also be used (as discussed more below) to encourage research and development and labor intensive techniques of production.

International Codesof Conduct: recent international initiatives have been to negotiate International Codes of Conduct both with respect to multinational corporations and to the transfer of technology.[1/] These codes are intended to set standards for behavior in the case of MNCs in relation to disclosure, taxation, employment behavior etc.; in the case of the Code of Conduct for Technology Transfer in relation to payments for technology, restrictive practices and so on. A major issue is whether the Codes should be mandatory or voluntary; if voluntary their impact is likely to be minimal, although they may perform an educational role and encourage national action where major departures from the Code are noted. Some have argued that mandatory Codes might impede progress in LDCs "since a general and widely accepted Code would have such a low common denominator that it would actually retard certain changes in the third world".[2/] It has been suggested that these Codes should form part of a wider international investment regime; the aim of such a regime would be to provide an international framework in which foreign investment would be regulated. The regime, it is argued, would reduce uncertainty (and might include features such as guarantees, insurance etc. that would ensure this), would provide

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1/ The U.N. resolution on the establishment of NIEO (1974) called for a code of conduct in relation to TNCs. A draft International Code of Conduct on the Transfer of Technology has been prepared in UNCTAD and is due to be discussed shortly. The U.N. center for Transnational Corporations is in the process of drawing up a Code for TNCs.

2/ Vaitsos (1975).

for the fairer distribution of benefits and costs, and would thus encourage the regulated flow of technology and finance, benefitting all three parties TNCS, developed countries and developing countries.

Policies towards technology contracts: the policies just discussed are concerned with technology transfer in the form of direct investment. But as ownership restrictions become effective, technology transfer increasingly becomes an arms length transaction between national (or joint) companies and foreign suppliers. It then becomes important to regulate this so as to prevent this form of technology transfer having the undesirable effects described. To this end, a number of countries have begun to intervene actively in the inflow of technology by establishing national registries of technology, reviewing and renegotiating technology contracts, and outlawing various restrictive practices. These policies may be designed to have the joint effects of increasing the bargaining power of national companies, reducing costs of technology transfer, protecting local technological developments, increasing the learning effects of imported technology and reducing the loss of independence in decision making. As suggested above, some of the objectives are mutually reinforcing.

There are National Registries of Technology in the Andean Pact countries (established in 1971), Argentina (1971) Mexico (1973), S.Korea (1976) and India (1977). In other countries, other parts of the government machinery may effectively act as a national registry (e.g., Portugal). National registries require the registration of all technology contracts with foreign suppliers; this registration may only be permitted after

government approval, which may only be given if the contract fulfills certain conditions and is on reasonable terms. The Andean Pact Decision provided for the exchange of information between registries thus strengthening the potential of each national registry.

It is worth investigating one country's experience in some detail in order to illustrate how registration may contribute to objectives. In Mexico the legislation prohibits technology agreements as follows:

1. when the purpose is to transfer technology already freely available in the country (objectives: cost and protection of of local technology);
2. when the price is unjustified (cost);
3. when provisions are included which permit the supplier to regulate or intervene in the administration of the transferee (independence);
4. when there is an obligation to assign to the supplier of the technology the patents, trade marks, innovations or improvements received by the transferee (learning and independence);
5. when limitations are imposed on technological research or development (learning and independence);
6. when there is an obligation to acquire inputs from any given source (costs and independence);
7. when exports are prohibited against the best interests of the country (costs and independence);
8. when the use of complementary technologies is prohibited (costs, independence and learning);

9. when there is an obligation to sell exclusively to the supplier of the technology (costs and independence);
10. when the transferee is required to use permanently, personnel designated by the supplier (independence, learning and costs);
11. when the volume of production is limited, or sale or resale prices imposed (independence and costs);
12. when the transferee is required to appoint the supplier as exclusive sales agent in Mexico (independence and costs);
13. when unreasonable terms of duration are established (costs and learning);
14. when the parties shall submit to foreign courts for decisions in interpreting contracts (national independence).

Since the law came into effect in 1973, the Registry has examined about 4,600 agreements. 35% were rejected for excessive payments or restrictive clauses; 60% were rejected if one excludes majority foreign owned enterprises. The table indicates the most frequent reasons for negative resolutions.

	As % of Rejected Agreements
1. Excessive or unjustified payments	68.5
2. Excessive duration of agreements	31.6
3. Prohibition to use non-patented technology or to manufacture goods, at the end of the agreement	30.7
4. Submission of agreements to foreign laws or courts	18.5
5. Grant-back clauses on innovations produced by licensee	16.8
6. Export restrictions contrary to the interest of the country	14.5

It is claimed that the policy has substantially reduced foreign exchange costs of technology, opened export markets, increased tax revenue, reduced prices of capital goods and produced "growing consciousness among Mexican entrepreneurs, who have understood better the importance for productivity and profits, of obtaining full information on technological alternatives, conducting a careful evaluation and selection of products, processes, and licensors, and negotiating terms of contracts from the strongest possible position."1/

The Mexican experience appears to confirm the pioneering efforts in Colombia where a Comité de Regalias was established in 1967. Between 1967 and 1971 the Comité de Regalias of Colombia evaluated 395 contracts of which 334 were negotiated, modified and eventually approved and 61 were rejected. In the process of negotiation, payments of royalties were reduced by about 40%. Between th- latter part of 1970 and the beginning of 1971 the Comité reduced by 90% tie-in clauses, eliminated export restrictive clauses, eliminated by 80% minimum royalty payments, prohibited tax deduction for royalties and established maximum percentage royalty rates.2/

For most part these policies have been directed at reducing the cost of technology transfer. Experience of these and other countries suggests considerable foreign exchange gains can be made by national policies to regulate the terms of technology transfer. It should be noted, however, that the gains be in large part only nominal. Registries and other regulations determine the formal contracts, but informal arrangements may

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1/ UNIDO (1978) p. 53.

2/ Vaitsos (1971)

negate their effects.[1/] Efforts to regulate the transfer could be strengthened in their content (e.g. some countries prohibit the duplicated transfer of the same or very similar technology) and through an international dimension. With international exchange of information on technology bargains, each nation's capacity to regulate the terms of the inflow would be strengthened, as would its knowledge about alternative sources of technology. Such international cooperation could best be started on a regional basis. The Andean Pact contains provisions for such cooperation. International cooperation would be particularly useful for countries with a weak administrative structure, which can do little on their own.

The effectiveness of such regulatory measures depend largely on two factors: first, on how fast technology suppliers replace their formal restrictive activities by identical informal activities; secondly, on how toughly the local administrators pursue the policies. In the context of an economy which relies heavily on the import of technology, local administrators very often become embroiled in the interests of the technology suppliers and are then unable to treat them with the arms length objectivity that is required. The piecemeal dismantling (or weakening) of some of the efforts to regulate the inflow of technology (of which we see signs with respect to the Andean Pact and Mexico, for example) suggest that early successes may exaggerate the full impact of regulation. We need more information on these areas.

Promotion of Technological Accumulation

The main purpose of most of the policies just described - and the way in which they tend to be interpreted by those countries which carry

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1/ According to Sagasti, Registries only control the formal contract: "A potential licensee who needs technology is in fact at the mercy of the licensor who has the technology. No amount of government intervention can restrict the pressures imposed by a licenser, and most licensees submit voluntarily to the demands, although the formal contract may not reflect any controls." (p. 19).

them out - is to control and improve the terms on which foreign technology is transferred, rather than to promote local technological developments. Some of the policies would also contribute to this objective as shown, for example, by the details of the Mexican provisions. But more comprehensive policies are necessary if the promotion of technological developments locally is the main objective: indeed for countries which have the capacity and intention to pursue this as a major objective the cost issue - on which so much attention is currently focussed - becomes of subsidiary importance.

There may be, as already indicated, many routes to the achievement of a sustained process of indigenous technical innovation. Contrast, for example, the different paths pursued historically by the UK, the US, Germany and Japan.[1/] Moreover, there is considerable uncertainty as to either necessary or sufficient conditions in developing countries today. But the following seem to be the types of policies likely to be conducive to technological change:

a. Policies which protect local technological developments by permitting only selective import of foreign technology;

b. Policies which remove legal restrictions on local developments, and reduce the excessive market value attributed to foreign as against local technology: i.e. policies towards patents and trademarks. Trademark policies may also contribute to the cost reduction objective.

c. Policies which promote local technological developments by providing the required infrastructure, education, institutions, incentives and so on.

1/ For an excellent overview see Ranis in Beranek and Ranis (1978); see also the individual essays in that volume and Landes (1972).

(a) Selectivity towards technology imports. Most successful 'second comers' technologically have relied on the selective import of technology from abroad. According to Rosenberg the U.S. was "highly discriminating in borrowing patterns and highly selective in the uses to which imported technologies were put."[1/] In 19th Century U.S. this was achieved without deliberate government intervention, as a result of relatively high levels of local mechanical and innovative abilities, reacting with the very substantial differences in resource availability compared with technology supplying countries, notably the U.K. Japan's policy of selectivity was a much more conscious and deliberate part of government policy. Between 1868 and the 1950s, Japan regulated and restricted technology imports ruthlessly, while promoting local technological capacity by education and learning by doing. The aim was to import technology from abroad only once, and then learn to develop and adapt the technology herself. The import of technology was "effected by diverse means ranging from sending missions overseas to seek and purchase machinery to more sophisticated technical licensing agreements with foreign technology suppliers" ..."the importation of machinery ... immediately became the object of imitation and trial manufacture, and eventually of domestic production."[2/]

The net effect was a steady rise in the level of technology imports and a change in their composition to ever more sophisticated industries.

1/ "The Role of Science and Technology in American National Development," in Beranek and Ranis (1978.)

2/ UNCTAD (1978a), para. 17.

In some ways, developing countries today face a more difficult situation and have more need for protection of local developments than the early latecomers. The scientific and technological gap between their own capacities and that of the advanced countries is greater, and the commercialization of technology and the domination of the technology market by a small number of transnational corporations has gone much further. Successful protection and promotion requires a dual policy of selectivity towards imports and promotion of local developments.

Selectivity involves some form of control over technology imports which may be achieved in a variety of ways: the centralized purchase of all technology imports provides one model (involving obvious administrative problems - it is probably a better model for socialist than mixed economies); an alternative is for some form of compulsory registration (as with the National Registers described above), where permission for technology imports is given only if the technology import can be shown to be complementary to (rather than competitive with) local technological efforts. An efficiency criterion may be added to prevent excessive protection leading to very inefficient technology.

Mytelka's research into the Andean Pact country experience suggests that the development of local capacity to choose and generate technology may require unpackaged non-contractual technology transfer. This is difficult to induce; however, promotion of local consultancy firms, specializing in packaging, would reduce dependency on foreign sources for packaging.

For the most part, according to Sagasti, screening of foreign technology has been weak because the agencies involved lack firm and clear criteria for selection.[1/] South Korea has recently introduced selectivity permitting the input of technology only if it fulfills various criteria; technologies which duplicate existing technologies, or which would easily be developed locally are not to be imported. However, it seems in practice that a very liberal interpretation is adopted and most requests for technology imports are granted. While the import of technology is in theory, subject to regulation, the S. Korean Technology Transfer Centre conducts an active survey to identify foreign technologies that are needed, and has specified 1958 technologies needed over the next five years necessary for the production of 1,500 items in the machinery, electronics, metal and chemical industries.[2/]

(b) Two types of legal restriction provide an especial handicap to local technological developments - patents and trademarks:

Patents: the international patent system was intended to protect and encourage innovations. But the system does not appear to work in the best interests of developing countries. Of the world total, 6% of patents were granted by developing countries, and of these 5/6 are held by

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1/ Sagasti (1978)

2/ UNIDO (1978a), pp. 57-64

foreigners, mostly TNCs, and only one sixth by developing country nationals. The commercial value of those held by nationals is relatively small. Among patents issued to foreigners by LDCs, the vast majority (over 90%) are not exploited. Patents thus, for the most part, tend to prevent competition and local innovation, rather than encourage it.[1/] Currently moves are under way to secure reform of the international patent system: the proposed reforms include the introduction of investors certificates, exclusion of some products/processed from patentability, limitations on patent duration, stricter provisions for compulsory licensing and revocation as remedy for non-use, removal of restrictions on imports of articles and products manufactured by a process which is patented in the country, and strengthening disclosure requirements.

International reform along these lines is preferable to individual national initiatives, but if it fails, or proves insufficient each country (or group of countries) has the power to enforce their own system, as have a number of countries including Japan, Italy and the Eastern block countries.

1/ See Vaitsos (1972), and UNCTAD (1975b): "patent practices of developing countries, following international standards, have legalized this peculiar situation which has come to act as a system of reverse preferences granted to foreign patent holders in the markets of developing countries".

Trademarks: trademarks act as a certificate of origin and a guarantee of quality. But the costs to LDCs are high. While the private benefits of acquiring a trademark to a particular entrepreneur, in terms of market power, may be great, there are social costs. The system encourages the import of foreign technology from companies responsible for well known trademarks, even where there are alternative sources of technology, domestically or from less well known and less costly sources overseas and thus reinforces foreign technological domination. It tends to favor the established and well known, making it more difficult for newcomers to compete. It leads to expenditure on advertising, some of which is informative, much persuasive, which developing countries can ill-afford. According to one estimate a group of developing countries spent, on average, 0.77% of GNP on advertising,[1/] (which is more than expenditure on R. and D.). Moreover, products originating in developed countries tend to be most heavily advertised which means that inappropriate products tend to be overpromoted in relation to traditional and appropriate products.[2/] In general, the question of trademarks is most critical for consumer goods, and of lesser significance for capital and intermediate goods.

In developing countries 50% of new trademarks issues in 1974 were registered by foreigners (88% in Africa, 65% in Asia and 34% in Latin America), a sizeable increase over 1964 (when 27% of new trademarks were registered by foreigners). The vast majority of trademarks registered by foreigners are from developed-market economies (95%); 1% are owned by nationals of other developing countries. Chemicals, food, tobacco and textiles account for 60% of the new registrations.[3/]

1/ UNCTAD (1977b) p. 58.

2/ The situation is notoriously bad in the drug industry where brand name/ advertised drugs are widely prescribed, although the costs are sometimes 50 times or more those of generic equivalents. See Lall (1975).

3/ UNCTAD (1977b).

Trademarks are said to be a powerful tool for the promotion of exports. However, developing countries have not, for the most part, used this tool to promote their own trademarks: insofar as trademarks have been used, they have been mainly of foreign origin.

Policies Towards Trademarks: some of the abuses associated with trademarks would be eliminated by policies which eliminated restrictive practices in technology contracts. But other action would be required to reduce this source of monopolistic power, to protect the development of local technologies, and to reduce other undesired effects of the trademark system. The following represents a broad range of possibilities.

i. Total abolition of trademarks in all sectors, or in selected sectors. The major problem here is the need to provide alternative systems of protection for consumers: these are difficult to devise and costly to administer. One possibility would be to provide govennment 'utility' certificates to products fulfilling required standards.

For political and administrative reasons, this does not seem to be a likely policy for most countries in relation to all sectors. However, selected sectors are especially suitable for such policies. In particular, it is a possibility for the drug industry and has been recommended by the Hathi Committee in India, which proposed that India's basic drug needs could be met by 116 generic drugs, as against 15,000 drugs currently marketed.1/ Since there is sectoral concentration of trade mark registration, action of this sort in one or two sectors might do much to prevent

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1/ Policies to replace branded drugs with generic drugs were introduced in Sri Lanka in 1972. The State Pharmaceutical Corporation purchased 47 drugs at an average cost of 28% of the price quoted by the former transnational suppliers. But after a major campaign, the policies were partially reversed in 1977. In Afghanistan a recent statute imposed the use of generic names for pharmaceuticals.

abuses.

For most sectors, however, we may assume that the system is likely to remain, and therefore policies need to be devised to reduce abuses:

ii. Limitations on permitted advertising.

iii. Consumer education.

iv. Alternative sources of quality control, such as government approval certificates, and legislative standards.

v. Compulsory licensing of trademarks such that all who wish may produce with the trademark on payment of some specified fee.

vi. Raising the fees for registration of trademarks, particularly in relation to renewals.[1/]

These policies are applicable to all trademarks, foreign or national.

Other policies may be devised to give special protection to local trade marks:

vii. By a differential system of charging fees.

viii. By banning foreign trademarks, totally or selectively.

ix. By the development of joint trademarks. In both Mexico and Brazil policies to encourage joint trademarks have been introduced. In Mexico joint trademarks are mandatory, in Brazil optional, the option to be exercised by the licensee. Joint trademarks permit the sharing of the benefits from good will created by the marks, and assist in the development of the local trademark. But they are unlikely to have major effects on consumption patterns or local technological developments.

1/ Fees charged for registration in developing countries are on average half those charged in developed countries. In developed countries renewal fees are as high or higher than initial fees; in developing countries many countries charge a lower fee and some charge no fee at all.

The question of trademarks is one of the most important issues in relation to technology transfer in the area of consumers goods and medicines; it is closely related to the question of costs, since consumer preference for well known trademarks permits technology suppliers to earn quasi-rents; it is related to the question of the development of local technological capacity, as established trademarks provide an obstacle to the development and use of local technologies; and it is also relevant to the question of appropriate products and techniques. Yet is is a relatively new area, in terms of policy. Few policies have been tried and partly as a consequence many have not been fully developed. Policies here are closely tied up with many other areas of policy - towards consumption patterns, and international trade as well as technology. In this area (as in others) it is fairly easy to see the direction in which countries should go if they are to share the rents earned,but more difficult to see how to protect local developments. International action to develop agreed LDC product standards and systems of quality control, independently of trademarks, is one possible way forward.

(c) Policies to promote local technological innovation.[1/] Policies to promote local technological developments are clearly an essential counterpart of policies towards technology imports. The range of policies adopted to promote technological development are well known. On the supply side,

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1/ The main focus of this paper is on the international transfer of technology. Consequently, the sections devoted to local technological developments are shorter than a balanced treatment would require. More discussion is contained in the section on Appropriate Technology below.

they include building up scientific and technical infrastructure, providing general and technical education and training, promoting local consultancy firms and developing Technology Plans. On the demand side, they include government procurement policies, tax and incentive policies and industrial policies. In addition to these 'explicit' science and technology policies there are also - as discussed above - general economic policies which influence the rate of local innovation. Unfortunately, while the relevant promotional policies are well known, there is considerable controversy surrounding almost every one of t' em. Sagasti's survey of science and technology policy instruments concludes that "evidence gathered in the Science and Technology Policy Instruments project shows overwhelmingly that the explicit S and T instruments (with the exception of personnel training) have little impact on technological change particularly at the early stages of industrialization." The major impetus in most LDCs has been towards building up institutions for basic research, seeing these are the first step in the innovative chain: but whether this is an essential part of technical innovation, or a sensible way of developing countries to spend scarce resources is now subject to considerable controversy: "the less developed world is strewn with scientific institutes and other expensive white elephants which contribute neither to science nor to technology."[1/] Technology Plans are becoming increasingly fashionable, but like general economic plans, their effectiveness depends on the policies and projects they produce rather than the Plan document itself, which may often prove a waste of scarce administrative resources.

1/ Ranis in Beranek and Ranis (1978). His paper summarizes the arguments for and against basic science in LDCs.

Many tax incentives have proved redundant:[1] the most successful are the most specific, as in Peru and S. Korea. But as with most tax incentives, there is a strong possibility that they will simply induce firms to categorize expenditure as 'R. and D.' in order to qualify for the incentives, without making any real changes. Moreover, such incentives tend to leave out the more mundane minor innovative activities, which may have at least as much to contribute to the innovative process, and may be an essential precursor of major innovation.

Government procurement policies represent one of the most powerful tools available for promoting the use of local technology.

Four conclusions appear to stand out from experience with respect to promoting local technological change: first, that links with industry are essential, if promotional efforts are not simply to add to the zoo of white elephants. Such links may be achieved through contract research, in-house research or strong informal links between the scientific and technological activity.[2] Secondly, that there has been some tendency to overdo basic science as against applied science and technology. Thirdly, that there is a critical mass of scientific and technological activity necessary before the work has any substantial effects. Some of the apparent failures of many LDCs may be because this critical mass has not yet been reached. It has been suggested that certain countries - notably Argentina, India, Brazil, S. Korea and Mexico - have now achieved the minimal critical

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1/ Sagasti (1978)

2/ Japan provided such links by developing 'model' government owned factories and then selling them to the private sector, when they were successful. In S. Korea, KIST has manifold informal links with industry.

mass for indigenous technological development.[1] Fourthly, countries should specialize in science and technology, consciously choosing the areas which they intend to develop, and concentrate promotional activities and selectivity towards foreign technology imports, in these areas.[2]

Administration

The discussion of policies has briefly reviewed a large number of actions LDC governments might take, if they adopt an active technology policy. Some of them would impose heavy administrative costs since they involve investigating technology contracts one by one: policies towards costs and those involving screening foreign technology imports would be especially costly from an administrative point of view; they would also (particularly the screening policy) require considerable technical expertise, which is especially scarce in most LDCs. Thus the administrative costs involved are by no means trivial; it is therefore necessary to establish that such resources are available, and that their use in this respect would be worthwhile. Here one needs to distinguish between policies directed towards improving the terms of the transfer and those towards screening imports to promote local developments.

Many countries are not yet at a stage in which very much screening makes sense. For this there must be a certain amount of local technological capacity. The development of such capacity requires the sort of promotional

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1/ Sagasti (1978)

2/ Cooper (1976), Sagasti (1978) and Ranis in Beranek and Ranis (1978) all come to this conclusion.

policies just discussed, and is likely to take place initially on the basis of imported technology. Hence, countries which are particularly weak administratively (especially in relation to the special skills required of technology administrators) are also those where screening policies are premature. They may be desirable in one or two industries but screening for these cases would not require excessive administrative resources. But these countries, which rely heavily on imported technology and lack much capacity themselves, are precisely those where policies towards controlling the terms of transfer are likely to generate the greatest gains. Moreover, the established magnitude of the gains are such that even quite heavy administrative resources (which may themselves be bought from abroad, for example from more advanced LDCs) would be justified. But where the administrative base is weak there is much to be said for introducing general policies - such as taxation and policies towards protection and trademarks - which reduce the foreign exchange loss through technology purchase and therefore the need for administrative policies to control it. As already suggested, regional and international cooperation may ease the administrative burden.

Countries which are more developed, in technological terms, are those for which the screening policies are more relevant, but they also have more techno-administrative resources to support them. Moreover, as they gain in technological strength, the importance of policies towards the terms of transfer diminishes because the individual enterprises become increasingly capable of striking a satisfactory bargain for themselves and hence the

terms tend to improve without so much government intervention.[1] An effective screening policy does require considerable expertise and judgement, but given that the policy may be initially concentrated on a few industries, the costs need not be excessive.

Aspects of Political Economy

Many of the policies described involve challenging very powerful interests: some of these interests are outside the developing countries, but in many cases they have been internalized and are well represented within the country concerned. The history of attempts to control the terms of technology transfer is strewn with failures of 'will,' which is a somewhat amorphous way of describing successful resistance, on the part of the interests involved, to attempts to control them. The following few examples provide indications of what can happen.

In both Sri Lanka and Brazil, plans to replace brandname drugs with generic drugs were diluted after powerful political campaigns which had strong foreign support.[2]

In Mexico, the near monopoly position of a successful national firm in the steroid hormone industry, which led in research and development, was broken as a result of strong protestations by U.S. Companies, and

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1/ Sagasti concludes that countries which are more technologically sophisticated "suffer less from the restrictions that normally accompany the imports of technology and pay less for knowledge than do firms in countries where these capabilities have not been developed " (p. 49). But the experience of the U.K. both in relation to oil and natural gas technology, and to pharmaceuticals (La Roche) show that eternal vigilance is required.

2/ See Agarwal (1978)

pressure from the U.S. Government. As a result shortly after the industry was dominated by foreign subsidiaries, which secured the plant barbasco, on terms which meant that much of the rent from this rare plant was taken out of Mexico. Later, government attempts to regain control over the industry for Mexican firms failed partly due to political opposition.[1/]

Mytelka (1977) illustrates aspects of political economy with respect to three Andean Pact countries, following their common policy of Decision 24. Peru, with a stronger national bourgeousie, succeeded in divesting in accordance with this policy between 1970 and 1975, while changes in Ecuador and Colombia, where foreign interests were relatively stronger, were negligible.

Certain conclusions are suggested by taking the political economy dimension into account: first, from a political point of view the ability to control the terms of technology transfer is likely to be greater the more arms length (and the less) previous relationships with technology suppliers. Thus, paradoxically, from this point of view, less developed countries with little technology transfer may be in a stronger position than those where interests are firmly entrenched. Secondly, certain types of policy may be easier to secure, from a political point of view, than others. General promotional policies are likely to be more acceptable than specific restrictive policies. This is not just because they are likely to be less effective (although doubtless this is part of the story) but also because their effects are normally more widely spread and therefore specific opposition is less likely to be aroused. Thirdly, discretionary policies are more subject to

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1/ Gereffi (1978)

abuse (and to thwarting by e.g., bribery) than general policies. This suggests that general tax changes may be more effective than particular contract-by-contract negotiations. But, although they may be more effective if properly conceived and introduced, for this very reason, they are likely to be subject to very great opposition.

The political economy aspects do not provide a reason for not trying to introduce desirable changes: they suggest that political forces should be taken into account in formulating policies and the need for strong 'will' to carry them out, needs to be emphasized.

VI. The Characteristics of Technology

The characteristics of technology are largely determined by the nature of the economies for which they are designed. The most significant determinants of the characteristics of new technology are the income levels, resource availability and costs in the society in and for which the technology is designed, and the system of organization of production, and the nature of the technology in use in the society. In each of these respects, societies of advanced countries differ from those of poor countries. Consequently, technology designed to suit advanced countries tends to be ill adapted (or 'inappropriate') to the conditions prevalent in poor countries. The transfer of such technology to poor societies tends, as a result, to cause various distortions and inefficiencies.

In discussing 'characteristics' of technology, one should include all the relevant features which determine its resource use, productivity, and impact on production and consumption patterns. These features include the nature and design of the product, the scale and organizational system for which the technology is designed, its resource use, including capital and labor intensity, materials and fuel use, skill requirements, and the infrastructural and complementary inputs it requires. The traditional economists' characterization of techniques according to their capital or labor intensity forms only one, and quite often a relatively insignificant, aspect of the total characterization.

The income levels of a society broadly determine consumption patterns, both as to the type of products consumed and as to the nature of products within each broad category of need. Countries with the same

average income level may differ in consumption patterns because of differences in income distribution and cultural and institutional differences. Nonetheless, average income levels are an important determinant of consumption patterns. The design of products in advanced countries, then, is broadly in line with their income levels. When products are transferred to poorer societies, their characteristics tend to be out of line with average income levels. This results in imbalances in consumption patterns: the imbalance partly takes the form of maldistribution of income and consumption, so that a small proportion of the population earn incomes similar to those of rich societies, and have correspondingly similar consumption patterns. Another form of imbalance is that which occurs in expenditure patterns at low income levels: a high proportion of expenditure may be devoted to goods designed for higher income levels, while other needs are relatively neglected.[1/]

The view that products are designed for particular income levels, and may be inappropriate for societies with much lower incomes, does not mean such products confer no net benefits on these societies and should be rejected. In some cases, this may be the situation. But in others, the products may extend choice and increase welfare. Given the massive research and development devoted to new products[2/] in advanced societies, the near

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1/ A recent study by J. Wells (1977) quotes a survey in Sao Paulo, Brazil, which found that between 1959 and 1969/70 'there was a significant rise in the share of household expenditure devoted to domestic appliances... an analysis of (physical) per capita food consumption shows that there was a downward trend, indicating that levels of nutrition among the working class deteriorated absolutely.'

2/ All investigations into motives and outcome of R. and D. in advanced countries show that much the largest proportion is devoted to new products or improvements in old products. See Gustafson (1962) and Mansfield (1969).

complete neglect of research into products specifically appropriate to poor societies, and the economies of scale associated with the mass production of many of these new products, many modern products increase the efficiency of need fulfillment, even for low income consumers, as compared with the previous range of choice. There are cases where the modern products may decrease welfare. But the main argument about appropriate products is not that new products from advanced countries decrease welfare absolutely,[1/] but that they tend to have high-income characteristics, and result in consumption imbalances compared with new products specifically designed for the conditions and income levels of poor societies.

In general, it is to be expected that new products would increase welfare by increasing the range of choice open to consumers. But if the new products completely displace (or raise the costs substantially) of old products with more appropriate characteristics, or if consumer choice is distorted by advertising exclusively devoted to one class of products, consumers in poor societies may actually be made worse off than before the new products were introduced.[2/] This is particularly likely to be the situation

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1/ Because of their high income characteristics, new products do tend to benefit higher income groups disproportionately thus leading to a relative deterioration in income distribution, but not one that is normally captured by the statistics.

2/ In my study of maize milling, I found that the most recently developed product was more expensive, less nutritious and required a more capital intensive and large scale technology. It was the only branded product and the only one advertised. Consumers were switching to it in a substantial way. This was not only due to advertising. It lasted longer and many consumers preferred the taste. Similar examples are to be found in the drug industry where new products, which are much more expensive than the old generic equivalent, are heavily advertised, and also have some additional benefits (e.g. in terms of reduced side effects). See Speight (1975).

where there are major indivisibilities, so that decisions are non-marginal. Very often this applies to decisions involving government expenditure such as major irrigation projects, hospitals, road and transport systems, military systems and so on.

The higher level of incomes in advanced countries also influences resource availability and costs. The labor force tends to be highly educated; real incomes and the opportunity cost of employing labor is high. Thus techniques designed for these conditions tend to involve high levels of worker education and skills, and high levels of productivity. Moreover, the high incomes generate a corresponding high level of savings per head, and therefore of investible resources. In comparison with average per capita resource availability in LDCs, the technology, therefore, requires savings per workplace far in excess of those available and makes education requirements greater than those the country can afford. If the technology is transferred unmodified to poorer countries, investment resources and expenditure on the development of human resources have to be disproportionately devoted to a small proportion of the population.

The organization system of advanced countries - with large units of production managed by a professional managerial class - influences the type of technology that the system produces. Inevitably, new techniques that fit in with this structure tend to be developed, rather than techniques designed for a radically different system. But the system is very far removed from traditional societies in most LDCs: to adopt the technology efficiently, the advanced country productive system has to be reproduced.

This involves dependence on imported managers, heavy expenditure on managerial education, and leads to an apparent dearth of managerial and entrepreneurial talent, and, often, a scale of production that is disproportionate to market size leading to oligopoly/monopoly and excess capacity.

Another important determinant of the characteristics of new techniques is the technology already in use. This imposes demands on any new technique, in terms of scale and characteristics of output, if the output is to serve as inputs elsewhere in the system, and determines the availability and nature of inputs. The technology in use in most advanced countries demands standardization and reliability. The net result of the many connections between different parts of the productive system is that there is (within broad limits) technological determinism; techniques which do not fit in become inefficient, not because they are absolutely inefficient, but because they are inefficient within the context of the technology in use. As far as LDCs are concerned, this means that their choice is much more circumscribed than might appear. Having made an initial decision to adopt some part of modern technology, this often dictates that other parts should also be adopted. Hence, while a careful study of available choice of techniques suggests that the choice is reasonably extensive, the real choice in the context of a particular technology and market system may be much narrower.

To summarize briefly: techniques designed for modern advanced countries tend to produce high-income products, require high levels of investible resources per employee, high levels of education and skills, be of a large scale and require sophisticated management techniques, be associated with high levels of labor productivity, and be linked, through inputs

and outputs, with the rest of the advanced technology system. If these techniques are transferred unmodified to LDCs, the result will be a concentration of resources, of savings and expenditure on human resources and infrastructure, on a small part of the economy. Incomes will tend to be concentrated in this area, leading to markets for the high-income products the system produces. Resources available in the low-income country will tend to be underutilized, including raw materials as well as labor.

Many of the well-established characteristics of the dual economy can be seen as following from the characteristics of advanced country technology: the capital-intensity of productive techniques, the heavy reliance on imported managers, skill deficiencies, un and underemployment and a relative (often absolute) deprivation of the economy outside the modern sector. Only economies which are growing very rapidly and are selective about the choice of techniques and adept at modifying them are able to overcome this dualism, by absorbing a growing proportion of their workforce into the modern sector. South Korea and Taiwan provide the obvious examples. In other economies, dualistic tendencies have been partially offset by a deliberate attempt to protect the non-modern sector, providing it with resources and protected markets to prevent it being undermined by the modern sector. This is the policy of 'walking on two legs' pursued most extensively by China (and to a less marked extent by India). In China employment expansion in the modern sector has been similar to that in many other developing economies, lagging well behind growth in output, while the technology adopted has tended to be capital intensive.[1/] Overall employment

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1/ See Sigurdson (1977) and Rawski (1978).

policies have succeeded because of the absorption of labor in the agricultural and rural non-agricultural sectors.

There is a growing body of literature that questions the rather simplistic technological determinist argument advanced above. It is argued that in many industries a wide choice of efficient technologies has been established by empirical research.[1/] Recently, Pack has argued that countries could make significant gains at the macro-level in terms of employment, output and savings, by policies leading to the adoption of the most appropriate techniques in existence. It has long been established that there is considerable potential for labor intensity in ancilliary processes, even if the core technology is more fixed.[2/] Old techniques from advanced countries offer more labor intensive and small-scale alternatives than the most recent techniques. While this sort of argument supports the view that there is a wider range of choice than the completely determinist view implies, other considerations suggest that the potential for selecting labor intensive techniques may be exaggerated by calculations based on the micro-case studies. In the first place, many of the studies show that considerations of product standards/characteristics may rule out the labor-intensive technologies.[3/] Secondly, the labor intensive techniques are often only economic at small scale.[4/] Thirdly, entrepreneurs do not have information about the complete

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1/ See e.g. Bhalla (1975), Jenkins (1975), Pack (1978a), White (1978).

2/ See Ranis (1973).

3/ See Stewart (1977), p. 199.

4/ Ibid. See Boon (1964, 1975), Pack (1978a).

'shelf' of techniques in existence; their access to information about different techniques depends on their channels of information. There tends to be a bias in channels of information towards technology currently in use in the supplying countries - i.e. the advanced countries. Appropriate techniques, which are often older techniques from advanced countries, or techniques recently developed in LDCs are less well promoted.

Fourthly, many of the studies neglect the determinants of choice or selection mechanisms. It is often assumed that the only relevant selection mechanism is the relative price of capital and labor, and that is in the control of the government. In fact, the determinants of choice are far more complex. The nature and scale of the market is one critical determinant. Products sold on the international market or to high-income consumers may need to use the most recent technology in order to compete.[1/] Because scale of production and the nature of the market are of importance in determining choice of product and technique, the factors determining these are significant. Income distribution and trading strategy help determine the nature and scale of markets for different types of product. The distribution of investible resources between enterprises of different size and type is also of relevance.[2/] The very substantial wage differentials between enterprises of different sizes suggests that the real wage level may be outcome as well as (partial) cause of technological choice. Moreover, a

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1/ Cooper et. al (1975) show that the more labor-intensive techniques may have to be ruled out for 'certain quality demanding segments of the market'. Sercovich shows in case studies in Argentina that firms were frequently forced to abandon attempts to use local technology by the need to compete in product differentiation to maintain their share of the market. High quality products are not invariably produced with capital intensive technology. In Egypt, El-Karanshawy found that it was the capital-intensive methods of producing carpets that found it difficult to find an international market. The processing zones use modern but labor intensive techniques to produce exports.

2/ See evidence on how choice of technique varies with size of enterprise in World Bank (1978).

number of recent studies of technological choice have shown that the most rational choices - both in terms of profit maximization and appropriateness of techniques are sometimes rejected in favor of less profitable and less appropriate techniques.[1/] Thus investigation of the decision mechanisms involved is required if choice of technique is to be altered in a more appropriate direction.

Fifthly, the studies establishing a range of choice are essentially static, depicting the situation at the point in time when they were made. But the so-called 'shelf' is moving as technical change proceeds, and some parts of the shelf are moving much faster than others. In particular, with the current world balance of R. and D., the modern capital intensive part of the shelf is moving forward, in terms of new products and efficiency of technique, as compared with the labor intensive part; and the 'modern' end is also getting increasingly capital-intensive, larger scale, and the products more sophisticated as incomes rise in the advanced countries. Thus while there may be scope for some push in the direction of labor intensity and other dimensions of appropriateness in some products, the aggregate effects are likely to be swamped by dynamic changes in the opposite direction.

Policies to Secure More Appropriate Technology

More appropriate technology may be roughly defined as technology whose resource use is more in keeping with LDC resource availability, and whose products are more suited to low-income consumers. This means that more appropriate technology will be more labor intensive, less skill intensive

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1/ See studies of Timmer et. al (1975), and Pickett et. al (1974).

smaller scale, use more local materials, and produce simpler low-income products than most of advanced country technology currently being transferred to low-income countries.[1/] Technology may be more appropriate in one respect, and no more so in others; or more in some respects, less in others. It is then a matter of judgment as to whether it is to be preferred. More appropriate technology may be less efficient, either in the economic sense that it is less profitable, (socially and/privately), or in the stricter sense (which has been defined as technical inefficiency) that it uses more of all resources to produce the same output. If it is socially or technically inefficient[2/] as compared with the 'inappropriate' alternative, then the economy would suffer from some output loss in adopting it. In such a situation it would only be worthwhile adopting if it were believed that learning effects would be such as to outweigh initial inefficiency, or that income distribution and similar effects are such as to outweigh the loss in output. If we assume that these effects may be incorporated into the measure of social efficiency (and that we can give some meaning to this concept), then an economy should only adopt more appropriate techniques if they can be shown to be socially efficient. In discussing ways in which appropriate technology

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1/ Some of the characteristics of 'appropriate technology' briefly described above (for a fuller discussion see Stewart (1977), Chapter 4) have been subject to considerable debate; probably most controversial are two - the question of scale and that of 'appropriate' products. The Strathclyde research believes that scale is irrelevant to appropriateness. Above it is defined as one criterion among others, on the grounds that small-scale productive units are more in keeping with the entrepreneurial and managerial abilities and market size of most LDCs. The appropriateness of products is also left out of the Strathclyde discussion - and of most of the case studies examining choice of technique. It is included here for reasons discussed above.

2/ Both these concepts present problems - which may be extremely serious in deciding whether a particular technology is efficient in one or other senses. But it is a useful shorthand here, to indicate that efficiency is an important consideration, but one that needs to be qualified to include income distribution and learning effects.

may be promoted, it is assumed that what is in question is the promotion of socially efficient appropriate technology.

Broadly, one may distinguish two types of appropriate technology: appropriate technology for the 'modern' sector, which consists in the adaptation of modern sector advanced country technologies in more labor intensive directions; and appropriate technology for the traditional sector, which upgrades and improves traditional technologies. Both have been neglected in terms of information collection and dissemination, research and development. Promotion of more appropriate technology in both categories may involve improvements in information dissemination, minor or major modification of existing techniques, or the development of entirely new techniques and products. For completeness perhaps a third category should be included: more appropriate systems of public services, including more appropriate products and delivery systems.

It is difficult to establish orders of priority for the various categories, and perhaps unnecessary to do so. The potential for improvements in the traditional-technology area are great, given the almost complete neglect in the past; this area is likely to help those in greatest poverty more directly than modifications in modern sector technology. Successful innovations in this area should improve the productivity of the poorest and, if widely disseminated, could reach very large numbers of people. Appropriate innovations in the modern sector would speed up growth of employment in this sector but are unlikely to improve the lives of most of the very poor, in the short run: in essence they are likely to expand

the numbers in middle-income occupations. Innovations in this area have to compete with simultaneous R. and D. in developed countries, which may render the results obsolete - particularly where there is product innovation and competition in trade - and may also make it difficult to ensure that the appropriate techniques are widely adopted. On the other hand, if a process of innovation were engendered in this sector, it could become self-sustained, leading to learning by doing and further innovation.[1/] In so far as LDCs' ultimate future lies in the modern sector, then innovation here may be critical. Since the bulk of investment is likely to remain in the modern sector in middle-income countries, innovations related to this sector would be likely to affect a larger proportion of investment. Appropriate innovation in the modern sector is also vital if developing countries are to avoid having to follow future technological developments in the advanced countries, which are likely to be in an increasingly inappropriate direction.

Policies to promote appropriate technology may be roughly categorized into those that affect the demand for different types of technology and those that affect the supply.

A different set of policies, with respect both to demand and supply, is relevant to promoting appropriate technology according to the sector being considered: this is because the three sectors - traditional, modern industrial, and public sector - contain different types of decision maker, with different objectives, constraints and capacities. Among obvious differences, the nature of markets served differs between traditional and

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1/ As appears to have happened, for example, in the case of the Swaraj tractor - see Morehouse (1978).

modern sectors and consequently the type of product in demand; the size of investible resources and managerial capacities differ so that different scales of production occur; factor prices and access to technology differs, with the traditional sector facing low labor costs and high capital costs, while often in the modern sector capital is subsidized and labor costs (relative at least to the traditional sector) are high. In the modern sector, there are normally strong links with foreign sources of technology. The links are weak or non-existent in the traditional sector. All these factors affect the selection of technology.

In the modern sector in many countries, as many studies suggest as well as much casual evidence, changes are needed in selection mechanisms as well as in information/development related to appropriate technology. In the traditional sector, information, education and credit is required. The sectors also differ in their potential capacity to generate the information search and technology development themselves. For the most part, the traditional sector lacks the capacity for self-generation and new technologies must be developed from outside, but with strong links with the potential users.[1/] The need for outside institutional support applies to information collection as well as technology development. But the modern industrial sector in many countries is potentially capable of doing a considerable portion of the search and research itself, and would benefit in terms of take-up of the results and learning effects by so doing. In this sector, then what is needed is an incentive structure and support system for internally

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1/ As for example in the work of ASTRA in Bangalore.

generated activities. Efforts of independent institutions financed from outside often fail because they are not used by local entrepreneurs.

Most of the policies affecting demand are internal to particular countries. They include changes in income distribution, which affects the monetary demand for different types of product; changes in trading strategy, which similarly affects demand for different types of product; changes in credit/tax policy affecting the control over investible resources of different types of decision maker; and changes in factor prices. Government policy towards consumer demand - e.g. education of consumers, limitations on advertising, policies towards trademarks - also affect choice of products and technique; and in the very large number of decisions over which government has direct control, the government may directly affect the choice of technology.[1/] Most of these changes, as stated, are internal: only trading strategy has a direct international dimension. Here there are a number of options:

a. The classic import substitution strategy. This normally amounts to import reproduction rather than import substitution, and since it involves complete replication of goods previously imported, it also involves replication of methods of production. The consequence is capital-intensity of production and inappropriate products.

1/ Little systematic research has been done comparing state and private sector decision making with respect to choice of technique. The limited evidence available suggests that state corporations in mixed economies choose at least as inappropriate technology as the private sector (see El-Karanshawy for a study of carpet weaving in Egypt where the State-owned firm was introducing mechanized methods to compete with traditional hand-woven methods in the private sector). It also appears that the State sector is more likely to depend on foreign sources of technology than private nationally-owned firms - see Mytelka (1978) and Morehouse (1978).

b. Export orientation, particularly towards the North. This, at least in the short run, should involve a more labor intensive technology (although not the production of more appropriate products) than the straight I-S policy. As time proceeds, so long as innovation remains the virtual monopoly of the North, the policy is likely to require continual adjustment and increasing capital-intensity, but of a lesser extent than a policy of progressive I-S, which keeps up with the latest product developments in the North.

c. Appropriate import substitution - i.e. the substitution of locally produced 'appropriate' goods for those previously imported. To some extent, this was the policy of Japan in the thirties, and of China in the 1960s and 1970s. The technology and products should be more appropriate, but there may be losses in inefficiency because of the absence of modern research into appropriate products[1/] and because of restrictions on trade. It is really only feasible for large countries.

1/ Japan was able to avoid this source of inefficiency by taking 'modern' products and modifying them. See UNCTAD (1978a).

d. South-South trading links combined with a policy to promote appropriate products and techniques and to restrict the import of inappropriate products and techniques. This is likely to involve reorientation of trading strategy in manufactures away from North-South to South-South. The option is similar to appropriate import substitution but it is on a South basis, rather than that of a single country. 1/ It thus enables the South to exploit the advantages of international trade, while maintaining South protection, and increasing the appropriateness of technology. The South-South trading relationship would include trade in technology and capital goods. There are various degrees of stringency with which this option may be pursued. At one extreme, it requires complete delinking with the North, apart from primary production. At the other, it involves greater preference on a South-South basis but without further restrictions on North-South trading links. Current moves to promote South-South links are in line with the latter strategy.

1/ Paul Streeten drew my attention to the pertinent quotation from D. H. Robertson: (Robertson was discussing trade between the U. S. and the U.K.).
"The simple fellow who, to the advantage of both, has been earning a living by cooking the dinner for a busy and prosperous scientist, wakes up one day to find that his master has invested in a completely automatic cooker, and that if he wants to remain a member of the household he must turn shoe-black. He acquires a kit and learns the techniques, only to find that his master has invented a dust-repelling shoe, but would nevertheless be graciously willing for him to remain on an empty the trash-bins . Would he not do better to remove himself from the orbit of the great man and cultivate his own back garden? And if he can find some other simple fellows in the same boat with whom to gang up and practice the division of labor on a less bewildering basis, so much the better for him."

The supply of different technologies: a false, but nonetheless helpful distinction is often made between information/research and development. The distinction is false because information collection merges into search, and search into research. 1/ There are weaknesses, absolutely and relative to what is happening at the inappropriate end of the technology spectrum, in each of these activities in relation to appropriate technology.

Information

Commercial channels provide the main sources of information to entrepreneurs in the Third World: for the most part, these are developed country sources - TNCs, consultants, machinery salesmen - all of whom are far more familiar with, and are more likely to benefit from investment decisions incorporating fairly recent techniques designed in and for advanced countries. 2/ There are a growing number of voluntary bodies who try to provide information services in relation to appropriate technology, but their efforts are small, somewhat amateurish, and they are not incorporated into the main stream of

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1/ For example, the Strathclyde study in collecting information about the existing range of technical change devoted a minimum of two people for one year to the process. As they devised 'synthetic' alternatives to those techniques already in existence (i.e., new combinations of existing processes), their efforts came closer to research than search. To establish the viability of some of the new synthetic combinations would require testing, etc., essentially a development activity.

2/ See Roberts (1972) and Bhatt (1975).

entrepreneurial decision making in the Third World. [1] The development of Third World consultancy firms, some Third World TNCs and machinery suppliers are beginning to provide more appropriate sources of information.[2] But the total level of these efforts are small, and while it seems that the information provided does tend to be related to more appropriate technologies than most of the advanced country resources, this is not always the case. [3] A few consultancy firms in the advanced countries are beginning to specialize in this field.

It is clear that there is a need for a more systematic system of information collection and dissemination in relation to appropriate technology. A number of proposals for such a system have been put forward. [4] Some are of the data bank variety. Others consist of an information cum consultancy service. It seems the latter are more likely to be effective, as data banks are difficult to use, and do not provide the essential software advice which is needed. The most promising proposal for international action was that developed in the World Bank: the technology referral service. [5] Promotion of Third World sources of technology is another important aspect of policies to promote information sources of more appropriate technology. Although Third World capital goods

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1/ Some of these are described in Stewart (1979)

2/ See Lall (1978), L.T. Wells (1977) (1978),(1979) and Lecraw (1977). Lecraw does a detailed comparison of Indian and other TNCs and finds that their technology is more appropriate (i.e., more labor intensive, on a smaller scale and produces simpler products).. Wells (1979) finds LDC firms' investment in Indonesia are considerably less capital-intensive than developed country multinational investment; they are also concentrated in less research-intensive industries and in industries with less product differentiation.

3/ It is widely claimed that the capital goods industries in Brazil, India and also South Korea show very little adaptation as compared with capital goods industries in advanced countries. See Pack (1978b) and Stewart (1977), Chapter 6.

4/ Summarized in Stewart (1979).

5/ This proposal, in abeyance at the moment, linked the provision of information to financial screening institutions in developing countries, thus providing the important tie-up with decision making, which is lacking in most proposals.

industries have been castegised for failing to be 'appropriate' and to innovate, on balance they are probably more appropriate than most advanced country technologies; and they may become more so in the future, as innovation is encouraged.

The promotion of Third World sources of technology is largely a matter of internal policy of developing countries and of their trade and technology regulations vis-a-vis other Third World countries. Developed countries may assist by support for capital goods industries and Third World consultancy in their aid policies, and by relaxing aid tying to include machinery bought from Third World sources.

The Development of Appropriate Technology

Some appropriate technologies have been developed in the developed countries, while much current R. and D. in LDCs is not directed at the development of appropriate technology. Hence, one could conclude that R. and D. in LDCs is neither necessary nor sufficient for the development of appropriate technology. Nonetheless, there are very strong arguments favoring developing appropriate technology in LDCs; first, because the learning effects would then be generated within the developing countries; secondly, because links with LDC entrepreneurs are easier to maintain; thirdly, because resource costs and availability of developing countries are more likely to be incorporated in the design of the new technologies. For example, although there was no explicit intention to develop appropriate technology, the indigenous development of an Indian tractor involved far lower capital costs than advanced country technology. The aim, therefore, should be to promote a process of research, development and technical change in developing countries which will produce more appropriate technologies. This aim is in line with the objective of creating technological capacity in LDCs. While this does not exclude all efforts in developed countries, it indicates where the main thrust should be. The best way of generating this process of technological change will vary according to sector and to country. Among LDCs there are very marked differences in current technological capacity. Some countries - particularly among the human resource rich middle-income countries (but also including India) - have many of the inputs required to generate such change. Others lack institutional capacity, and human resources. 1/ Given these marked differences in capacity, there is a dilemma: one possibility would be to concentrate efforts in those areas where the resources are already present, encouraging

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1/ For a discussion of obstacles to technical change for appropriate technology in LDCs, see Reddy (1979) and IMAT (1978).

the export of appropriate technology from them to other less well endowed countries. Unavoidably, this will form one aspect of a strategy to promote appropriate technology; but in order to avoid new forms of dependency emerging within the Third World, and to generate the technological capacity essential for long-run development, efforts to promote appropriate technological change should also be promoted in the resource-deficient areas.

Clearly, relevant policies will differ in the two cases, as may relevant technologies. In some ways the distinction is similar to that made earlier between developing technology for the modern sector and that for the traditional sector. In the middle-income human resource rich countries, for the most part the technologies may be developed using internal resources. International assistance may be required in a catalytic way to induce current institutions to redirect their efforts to appropriate technology.[1/] Much of the earlier discussion on the development of technological capacity is relevant here (see pp. 61-73). It was suggested there that a three pronged policy was required, consisting of selectivity towards technology imports, changing the legal and marketing system so as to favor local technology, and promotion of local developments through provision of infrastructure government subsidies, incentives and so on. Especial attention needs to be placed on securing strong links with the productive sector preferably by getting the research and development carried out within firms. Specific tax and incentive policies may be effective. For example, in Peru, a tax of 2% is levied on net pre-tax income of industrial firms which is used to finance central research. The tax is repaid to firms who use it to finance R. and D.; the net proceeds go

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1/ See IMAT (1978) for a definition and description of the type of catalytic effort required.

to finance a central fund for R. and D.[1] A recent survey[2] found that 60% of the Peruvian firms sampled engaged in R. and D. compared with 11% of firms in Ecuador and 23% of Colombian firms, which may indicate the effectiveness of the incentive.

The results of such R. and D. may not be appropriate according to all, or even sometimes any, of the criteria discussed above. But as argued above, it is likely to result in more appropriate technology than much imported unmodified technology.[3] This is because local costs and resource availability unavoidably influence technology design, even when there is no conscious intention to do achieve this. But much depends on the structure of incentives and markets within the economy. If the market is protected, market share depends on differentiated modern advanced country products, and factor prices are 'distorted,' then locally-generated technologies may not be substantially different from imported technologies. This is especially likely if the import of foreign technology is not restricted. But with a more appropriate set of selection mechanisms, more appropriate results are likely.

International assistance may be needed to help provide resources of both finance and manpower to create institutions to promote appropriate technology in the traditional sector.[4]

1/ Sagasti (1975)

2/ Mytelka (1978)

3/ In the case of the local development of technology to make a tractor in India, the capital costs were estimated to be about half that of the imported technology, for the same level of output. An indigenously designed casting process involved Rs. 1,000 in contrast to Rs. 500,000 in imported equipment. (Morehouse, 1978).

4/ See suggestions in IMAT (1978).

In countries lacking institutional or human capacity for technical change, much more outside assistance will be required, initially, to generate local appropriate technologies. In these countries, the immediate prospects may not be very good, but the efforts are worthwhile to generate the local learning process.

Many proposals have been put forward for international assistance for the development of appropriate technology. 1/ The most developed proposal, at this stage, is the proposed International Mechanism for Appropriate Technology. The feasibility study on this, defines IMAT's activities as essentially catalytic, raising funds and providing assistance to national efforts in LDCs.

Efforts to develop appropriate technology need to be accompanied by improvements in the dissemination of information so that the results may be widely commuicated.

Development and communication of appropriate technology hardware forms only a small part of the changes needed: as already suggested, changes in selection mechanisms are essential, so that newly developed appropriate technology is used. Moreover, there is what is known as the software element in the use of technology, i.e., all the managerial and associated services which may be ill-adapted to the new technology, and which must be adapted or it will fail. Social/cultural and political obstacles to the use of appropriate technology are sometimes argued to be of greater importance than the availability of hardware.

1/ Eg. Austin Robinson's proposal to U.N.D.P. (1976)

VII. Some Conclusions

1. In recent years, there has developed widespread recognition of the need to regulate the inflow of foreign technology into developing countries from advanced countries. This recognition has arisen from the growing evidence that unrestricted transfer has involved high costs, has restricted the independence of decision makers, has limited the learning effects of technology transfer, and has inhibited the development of local technological capacity. An active policy regulating the inflow of technology is necessary to mitigate these effects. Recognition of the need to regulate the inflow has been largely independent of the question of appropriate technology and is shared by many countries which place little emphasis on appropriate technology.

2. Despite some overlap, policies designed to improve the terms of technology transfer should be distinguished from those designed to protect and promote local technological developments. Most emphasis, to date, has been placed on policies to regulate the terms.

3. An essential feature of the technology market is that it is imperfect - natural and legal imperfections enable the 'owners' of technological knowledge to appropriate returns to this knowledge. These imperfections - which are normally justified as necessary to generate adequate returns to research and development - mean that the price levied tends to be oligopolistic and subject to bargaining.

4. Policies designed to improve the terms of technology transfer may be mandatory, or rely on incentives and persuasion. There are broadly two areas of policy: one, is aimed at decreasing the packaging

of technology transfer so as to increase local bargaining power, to reduce dependence and learn how to put the package together locally, and to make control over terms easier; the other is improving the terms of transfer of each form of technology transfer. As policies towards depackaging become effective, regulation of the terms of unpackaged transfer becomes important. The tax system may be designed to improve the terms of transfer, in both packaged and unpackaged form. National registration of technology contracts, together with requirements regulating the terms and outlawing restrictive practices before registration is permitted, and prohibiting duplicative imports, improve the terms of unpackaged transfers. Some countries have made very significant foreign exchange gains by such policies which would appear easily to justify the administrative costs involved. However, it is not yet clear that the de jure regulations (e.g. outlawing various restrictions) are always carried out de facto. Regulations do not cover the many informal transfers mechanisms, which may be of greater total significance than formal mechanisms.

5. Policies which regulate the terms of technology inflow will be insufficient to promote local technological development. Countries which have local technological potential need an active policy to promote local technological change. Such a policy includes positive promotional measures - such as the provision of infrastructure, subsidies and tax incentives, education and government procurement policies - and a selective policy towards the import of foreign technology. Such a selective policy involves the discriminating import of foreign technology in those areas where local potential exists, by encouraging the import of technology which is likely to generate local learning and innovation and is complementary

with local efforts, and restricting it where it is competitive with local capacity and is likely to inhibit it. The combination of positive incentives and selectivity towards foreign technology was the successful strategy of Japan; similar policies are now being initiated in S. Korea, although regulations towards technology imports appear to be liberally interpreted. This combination of policies has been adopted successfully for particular technological developments elsewhere. But many LDCs which have the potential (i.e., human resource rich countries) for technological capacity are underusing it, and continuing to rely primarily on foreign technology, which is allowed free entry, so long as the costs are not excessive. There is a sharp contrast in the protection given the local production of goods by many countries with the lack of protection to local technology. Selective policies of this kind need considerable administrative and technical expertise; they should be introduced on an industry-by-industry basis, where strong potential local technological capacity exists.

6. The system of patents and trademarks tends to give protection to foreign technology suppliers. International reform of the patent system to avoid this is currently in process of negotiation. But the question of patents is probably of less significance than that of trademarks. Trademarks tend to reinforce the technological dominance of foreign suppliers and contribute to inappropriate consumption patterns. LDC trademarks are relatively undeveloped,

although they formed half new registrations in 1974. To promote local technology it is necessary to reduce the dominant position of foreign trademarks. A variety of policies are possible ranging from total restrictions to financial incentives. It is difficult to devise a system which preserves the benefits - as quality guarantor - of trademarks, while reducing the costs they impose.

7. Although many of the policies towards technology inflow must, in the final analysis, be pursued at the national level, there is considerable potential for international cooperative action. International cooperation in the exchange of information may strengthen each country's knowledge of alternatives and practices elsewhere. The international (or regional) harmonisation of practices with respect to transfer pricing, taxation and regulation of technology contracts will prevent any single country losing a disproportionate share of foreign technology inflow, which might occur if they act alone. International action may work to identify alternatives to well known sources of technology. This may be particularly valuable for LDCs at an early stage of development, which lack the capacity to search for alternatives and package the technology for themselves. The ability to regulate the inflow of technology depends on the level of development of the country concerned. Countries which have undertaken active policies have been mainly middle income, with considerable administrative and managerial capacity and local entrepreneurship.

8. Local technological capacity in third world countries is of critical importance: first it is a vital part of the development process. Secondly, it is necessary for independence and to improve bargaining power in relation to the import of technology. Thirdly, it is necessary to generate appropriate technical change. While there appears to be a certain amount of technological choice today, the continued concentration of technical change on advanced country technology is likely to result in increasingly inappropriate techniques. Unless developing countries undertake R. and D. in alternative directions, the choice of technology available in the future will be increasingly circumscribed, and irrelevant to the needs of the world's poorest. The development of a continuous process of technological change - new techniques and products - in an appropriate direction in the developing countries is essential if the choice is to be widened.

9. Technology recently developed in advanced countries tends to be inappropriate, in many respects, for many LDCs. This is because it is designed to meet the needs of the advanced countries; it tends for example to be increasingly capital intensive. Its use in poor countries involves a concentration of investment resources in the modern sector, exacerbating differentials and contributing to the problems of unemployment and underemployment. Products designed for advanced country consumers are ill suited to meet the basic needs of poor people. However, the high productivity of much modern technology and the efficiency and economies of scale associated with advanced country products may

make the technology the best choice, given the absence of efficient alternatives. Appropriate technology consists of technology more in line with developing country needs and resources; it consists of more labour intensive processes in the modern sector, and the development of new and improved techniques and products for the traditional sector. The promotion of more appropriate technology includes the selection of more appropriate technology among known technologies (including 'old' techniques from advanced countries and second hand machinery) and the development of new appropriate technologies.

10. The development strategy a country adopts strongly influence its technological options. If a country's consumption patterns are similar to those of developed countries, and if its main trading orientation is with developed countries, then the main body of technology it uses in the modern sector will need to be that of the developed countries. Consumption patterns are likely to be similar to those of developed countries among countries with an unequal income distribution, an 'open' policy towards technological imports, and lack of indigenous cultural factors which inhibit the demonstration effect. Some modification of technology is clearly possible - and indeed happens[1/] - even in this sort of situation, but modifications are likely to be largely a matter of time-lags in adopting the latest advanced country technology, more labour - intensive ancilliary activities, and modifications rendered necessary by differences in the size of market.[2/]

1/ See evidence of Pack (1976) on adaptation in Kenya.

2/ Scale has been established as the main source of adaptation among TNCS (Reuber (1973).

With more equal income distribution and with obstacles (cultural, economic or legal) preventing the domination of advanced country products, the potential for appropriate and self-generated technology will be greater. Trade in manufactured products with advanced countries has generally involved the import of technology from advanced countries, at least in the initial stage. Trade between developing countries is more likely to be consistent with the use of locally generated appropriate technology. Appropriate technology consists both in modification in 'modern' sector products and techniques and in upgrading 'traditional' sector technology. Even in countries with advanced country oriented modern sectors, there is potential for appropriate technology in the traditional sector to help raise productivity and incomes and meet basic needs.

11. Policies to promote appropriate technology consist in policies determining the demand for (or selection of) different products and techniques, and policies determining the supply of technologies. On the demand side, the policies concerned are chiefly national; they include determinants of income distribution and consumption patterns, trading strategy, policies determining control over investible resources by different types of decision maker, and relative factor prices. On the supply side, they include the collection of information about different technologies and its diffusion, and research and development and the creation of new technologies. Potentially, there could be an important role for international institutions on the supply side assisting in information collection and diffusion, and in funding appropriate research.

12. Technology transfer between developing countries could have an important role to play in increasing developing countries technological independence and bargaining power and in promoting appropriate technology. There are some indications that such trade is expanding; third world MNCs are developing

as is third world consultancy and trade in capital goods. As with similar developments, there is a danger that new imbalances and dependencies within the third world will arise as a result.

13. There is a complex system of relationships between past policy towards technology, policy makers and policy making. Countries which have been heavily dependent on foreign technology, particularly in the form of foreign investment, find it more difficult to regulate it, than those which have relied on it to a lesser extent and have maintained an arms length relationship with foreign suppliers. Similarly, patterns of production and consumption which are broadly inappropriate set in force strong forces making for similar inappropriate choices in the future. The extent of current freedom of decision making depends in large part on past policies. Today's policies, then, will partly determine future options. In this context radical delinking might be a tactical and temporary move to strengthen a country's position in future linked relationships.1/

1/ China's recent history can obviously be interpreted in this light.

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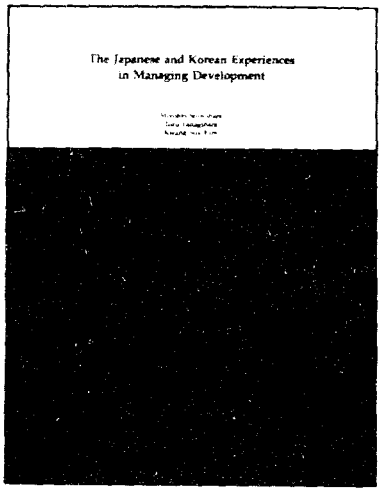

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Spanish: La estructural del crecimiento economico: un analisis para el periodo 1950-1970. Editorial Tecnos, 1978.

ISBN 84-309-0741-6, Stock No. IB 0523, $8.95.

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Paul Isenman and others

Since economic growth alone has not reduced absolute poverty, it has been necessary to consider other strategies. The strategy examined in this study—human development—epitomizes the

idea that poor people should be helped to help themselves. Four chapters provide an overview of alternative strategies; a detailed look at health, education, nutrition, and fertility; lessons from existing programs; and an examination of broader issues in planning.

Oxford University Press. 1982. 96 pages (including statistical appendix).

LC 82-2153. ISBN 0-19-520389-5. Stock No. OX 520389. $7.95.

Reforming the New Economic Mechanism in Hungary

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A retrospective look at Chenery's thought and writing over the past two decades and an extension of his work in *Redistribution with Growth* and *Patterns of Development*. Develops a set of techniques for analyzing structural changes and applies them to some major problems of developing countries today.

Oxford University Press, 1979; 2nd paperback printing, 1982. 544 pages (including references, index).

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Emanuel de Kadt, editor

The first serious effort at dealing with the effects of tourism development in a broad sense, concentrating on social and cultural questions.

A joint World Bank-Unesco study. Oxford University Press, 1979. 378 pages (including maps, index).

LC 79-18116. ISBN 0-19-520149-3, hardcover; ISBN 0-19-520150-7, paperback. Stock Nos. OX 520149, $24.95 hardcover; OX 520150, $9.95 paperback.

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Robert Goodland

At the current time, approximately 200 million tribal people live in all regions of the world and number among the poorest of the poor. This paper describes the problems associated with the development process as it affects tribal peoples; outlines the requisites for meeting the human ecologic needs of tribal peoples; and presents general principles that are designed to assist the Banks staff and project designers in incorporating appropriate procedures to ensure the survival of tribal peoples and to assist with their development.

1982, 118 pages (including 7 annexes, bibliography).

ISBN 0-8213-0010-5. Stock No. BK 0010. $5.

The Tropics and Economic Development: A Provocative Inquiry into the Poverty of Nations

Andrew M. Kamarck

Examines major characteristics of the tropical climates that are significant to economic development.

The Johns Hopkins University Press, 1976; 2nd printing, 1979. 128 pages (including maps, bibliography, index).

LC 76-17242. ISBN 0-8018-1891-5, hardcover; ISBN 0-8018-1903-2, paperback. Stock Nos. JH 1891, $12.50 hardcover; JH 1903, $5 paperback.

Spanish: Los tropicos y desarrollo economico: reflexiones sobre la pobreza de las naciones. Editorial Tecnos, 1978. ISBN 84-309-0740-8, Stock No. IB 0529. $5.

Twenty-five Years of Economic Development, 1950 to 1975

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A broad assessment of development efforts shows that, although the developing countries have been remarkably successful in achieving growth, the

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The Johns Hopkins University Press, 1977; 3rd printing, 1981. 136 pages (including statistical appendix, references). LC 77-17243. ISBN 0-8018-2134-7, hardcover; ISBN 0-8018-2092-8, paperback. Stock Nos. JH 2134, $16.50 hardcover; JH 2092, $7.95 paperback.

French: Vingt-cinq annees de developpement economique: 1950 a 1975. Economica, 1978. ISBN 2-7178-0038-7, Stock No. IB 0546, $7.95.

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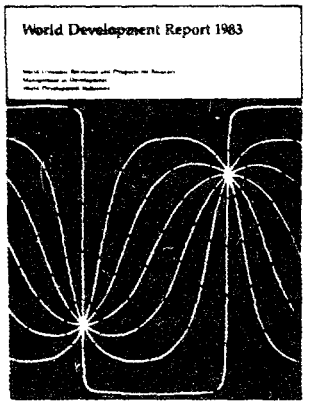

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