THE TRANSFER OF INDUSTRIAL TECHNOLOGY TO WESTERN PACIFIC DEVELOPING COUNTRIES*

Hal Hill and Brian Johns

This paper reviews recent evidence on technology transfer to the rapidly growing Western Pacific region, where most developing countries have adopted relatively liberal policies towards the importation of technology and equity capital. In recent years Japan has emerged as a major supplier of technology to the region. Moreover, there have been important changes in the international technology market, which has become larger and more competitive. Nevertheless, many aspects of technology imports have been criticised, including the conditions attached to its sale, and its appropriateness for low income countries. The arguments for limited regulation of technology flows are assessed and the economic and administrative difficulties pointed out. From the host country viewpoint, the policies influencing diffusion of technology within the country seem to be at least as important as the policies directly bearing on technology transfer from overseas.

INTRODUCTION

Technology transfer is a major concern of less developed country (LDC) governments: although it is difficult to determine the precise nature of the relationship, it is generally recognised that technological progress is one of the key determinants of the rate of economic growth; and a very small proportion of research and development expenditures occurs in LDCs. Consequently, the nature of the technology being transferred from developed countries, the terms and conditions on which LDCs receive that technology, and their capacity to absorb and adapt the technology to their own requirements are all important issues for LDC

*The views expressed are those of the authors, and may not be attributed to the Bureau of Industry Economies or to the Australian Government. We acknowledge gratefully the research assistance of Michael Cunningham and Michelle McLean. Helpful comments on an earlier draft were received from participants at the 15th Pacific Science Congress (Dunedin, New Zealand), to which a version of this paper was presented, and from Peter Morris.

governments. The objective of this paper is to analyse these issues with special reference to the industrialisation of the rapidly growing LDCs of Northeast Asia (Hong Kong, South Korea, Taiwan) and of ASEAN (Indonesia, Malaysia, Philippines, Singapore, Thailand). Many of these issues are of relevance to other developing regions and we shall therefore be referring to the general literature on the subject. We shall also refer to the experience of Australia which, although a high income country, is, like most LDCs, a net capital and technology importer.

In Section 2 of the paper we attempt to quantify technology flows into the region's LDCs on the basis of Japanese and United States technology data. In Section 3 we examine two contentious and much discussed issues related to the transfer of technology, and on which LDCs have been most critical of present institutional arrangements. These are the pricing of technology and conditions attached to its use, and the appropriateness of production processes and products being transferred to low income, labour surplus economies. Next, we address an issue to which much less attention has been given, that of intra-country — as distinct from inter-country — transfers and the domestic diffusion of technology. Finally, the role of Australia in technology trade is examined briefly.

A word on definitions is appropriate before we proceed further. We are adopting a general definition of technology such as that used by, for example, Strassmann, who maintains that "it refers not only to tools, a stockpile of utensils, but to a kind of tool-using behaviour, a set of methods for making specific goods".[1] We are therefore interested not only in the physical transfer of technology, as embodied in the trade in machinery and equipment, but also in the organisational, managerial and technical competence to operate this technology efficiently, and to adapt the imported technology to local production conditions.

TECHNOLOGY FLOWS TO THE WESTERN PACIFIC

Although the Western Pacific LDCs are a heterogeneous group in terms of size, per capita income, resource endowments and industrial structure, most have relatively open economies. This is reflected in their policies towards capital and technology flows, which are generally encouraged subject to certain monitoring and regulatory provisions, and to some sectoral limitations.

There are numerous channels of international technology transfer. In the private sector these include technology transfer

between firms in the context of direct foreign investment (DFI), and technology licensing arrangements independent of equity investments. The latter includes cases where a firm is licensed to use the production technology and products of another firm, as well as cases where technical assistance is rendered less formally by overseas suppliers of equipment, raw materials and finance. Similar transfers also occur in the case of public sector enterprises. In addition, there is usually a technology transfer component in government aid programs, in the form of manpower training and other spin-offs. A third major source is multilateral agencies, such as the United Nations and the World Bank. To these three may be added the exceptional historical experience of Japan where copying, through the import and disassembly of machinery and equipment, was an important means of acquiring new technology.[2]

How may these technology flows be quantified? Summary compilations of international technology flows, comparable to those of trade flows, do not exist. Nor is there a single satisfactory definition of technology flows, especially concerning the transfer of human capital resources. But as an approximation we may refer to data on royalty and licensing payments to the region's major technology suppliers, Japan and the United States. Ideally one would want to supplement these by corresponding information from the recipient countries, but in practice the data are scattered and the definitions generally not consistent. Limited information on the latter is presented for three ASEAN countries in Table 1. The data apparently exclude multilateral agencies and are expressed in terms of number of agreements rather than value. But they are at least indicative of the major importance of developed countries, in particular Japan and the United States, as sources of imported technology in the region.

Table 1. Major Sources of Technology, Selected ASEAN Countries (% of total number of agreements)

Source Country	Recipient Country		
	Malaysia (no date given)	Philippines (1978–79)	Thailand (1980–81)
Japan	31.7	20.6	36.3
United States	14.6	46.0	18.8
United Kingdom	13.6	6.7	7.7
Other Developed Countries	26.1	22.7	25.6
LDCs	14.0	4.0	11.6
Total	100	100	100

Source: Mingsarn Santikarn, 'Trade in technology: ASEAN and Australia', paper delivered to Workshop on Trade in Services, ASEAN — Australia Project, Australian National University, Canberra, 19 July 1982.

The United States data cover affiliated transactions (that is, payments from overseas subsidiaries to US parent companies) and, for certain years, unaffiliated transactions (Table 2). Thus, the main conclusion to emerge from the data is that developing Asian and Pacific countries constitute a tiny proportion of US technology exports and, while the real value of receipts increased for all industries, those for manufacturing declined, thus mirroring trends in US DFI. The great majority of US technology exports to go developed countries, while among LDCs Latin America has traditionally been the major recipient. The manufacturing sector accounts for the major proportion of this total and, within this sector, an even higher proportion goes to developed countries.

Data relating to unaffiliated transactions are not provided at the same level of disaggregation and these are in any case of less importance. Although there have been suggestions in the literature that both multinational corporations (MNCs) and LDC governments may prefer licensing agreements to direct equity investments (see below), the value of unaffiliated transactions to the total has been decreasing as a proportion of total technology receipts, at least until 1978.

The Japanese data, although not directly comparable, present a somewhat different picture. Compared with the United States, Japan is a relatively modest technology exporter (Table 4, row 1). For example, in 1980 its technology exports were only about one-tenth of the United States, assuming the latter's ratio of unaffiliated to affiliated transactions was similar to 1978. But Japan's exports have been rising rapidly, in real terms more than doubling from 1972 to 1980.[3] Moreover, although it remains a net technology importer (Table 4, row 2), its exports have been increasing very quickly relative to its imports, and it is likely to become a net exporter within a few years.

There are also substantial differences between Japanese and United States technology exports by region and, to a lesser extent, by industry group. Japanese technology exports are directed predominantly to LDCs and particularly the Western Pacific, where four countries (Taiwan, China, Indonesia and South Korea) have recently accounted for between one-quarter and one-fifth of its total exports (Table 5, part (a)). Japan's technology exports are also more heavily concentrated in manufacturing (Tables 5, part (b), and 3), although this has been declining. The biggest difference concerns chemicals and related products, but there are also differences in other industry groups.

In the early 1970s the United States was the major source of technology imports by Western Pacific LDCs, providing more than

Table 2. United States Fees and Royalty Receipts ($US millions)

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1. *Affiliated Transactions*									
(a) All industries									
Total	2,513	3,023	3,543	3,530	3,767	4,806	5,042	5,780	5,867
Developed Countries	1,949	2,360	2,770	2,793	3,029	3,854	4,028	4,841	4,805
Developing Countries	519	611	722	686	695	881	913	1,227	1,331
of which Asia & Pacific	108	94	118	126	112	213	259		
(b) Manufacturing									
Total	1,552	1,855	2,098	2,110	2,336	2,814	3,123	4,068	4,007
Developed Countries	1,366	1,662	1,887	1,923	2,177	2,610	2,913	3,655	3,510
Developing Countries	186	192	211	187	159	204	209	413	497
of which Asia & Pacific	44	37	44	44	24	55	58		
2. *Unaffiliated Transactions*									
All industries	712	751	757	822	920	1,065			
Manufacturing	635	670	678	723	792	952			
of which developing countries other than Latin America						55			

Source: U.S. Department of Commerce, *Survey of Current Business*, Washington, various issues.

Table 3. United States Fees and Royalty Receipts by Industry Groups (% of total)

	1972	1976	1978
Manufacturing	66.6	67.3	67.2
of which:			
chemicals and related products	13.8	14.1	13.9
primary and fabricated metals	3.0	2.4	2.0
machinery	26.1	27.8	28.7
transportation equipment	6.8	7.0	6.5

Source: As for Table 2.

double that of Japan. However, in the case of manufacturing they were of similar importance, owing to Japan's heavy orientation towards this sector. By 1980, Japan's had become a much more significant source of technology, and the major one in the case of the manufacturing sector.

Differences between Japanese and United States technology exports and DFI have been much discussed in the literature, but in the absence of a full analysis of the DFI statistics we shall refer only briefly to this debate. The essential differences are that Japan is more heavily engaged in LDCs, particularly in Asia, and within manufacturing its projects tend to be relatively labour-intensive, to be undertaken by small and medium-scale Japanese firms, and to locate in less technology-intensive activities compared with United States firms. Several Japanese economists have argued that, on the basis of Japan's unique investment and technology transfer experience, currently accepted monopolistic theories require a reformulation, and that for LDCs 'Japanese style' technology transfer is preferable to that of the United States.[4] This, it is argued, is because the technology, is better suited to the factor endowments of the recipient country, and therefore can be more readily assimilated. Further, Japanese activities are often more trade-creating since they frequently involve the off-shore movement of labour-intensive industries rendered uncompetitive in Japan.

Although the positive analysis broadly conforms to the facts up to the late 1970s, the normative implications of the thesis are more contentious. United States DFI and technology may, in certain circumstances, be equally trade-creating and, in any case, this is not necessarily a criterion of economic welfare. More importantly, such differences that do occur between the two countries appear to arise primarily because the United States and Japanese economies have been at different stages of technological and economic development. As Japan catches up and indeed overtakes the United States in some fields of technology, the differences between the two

Table 4. Japanese Technology Exports and Imports

	1972	1973	1974	1975	1976	1977	1978	1979	1980
Technology Exports[1] ($US millions)	140	187	196	224	281	348	580	608	704
Technology Exports as % of Imports	24	29	36	39	47	49	64	55	67

[1] The data have been converted to US dollars at the existing exchange rate to facilitate direct comparison with Table 2.

Report on the Survey of Research and Development, Statistics Bureau, Office of the Prime Minister, Tokyo, various issues.

Table 5. Japanese Technology Exports by Region/Country and by Industry Groups
(% of total)

	(a) By Region/Country				(b) By Industry Groups		
	1972	1976	1980		1972	1976	1980
Asia[1]	36.3	38.4	34.0	Manufacturing	94.5	91.4	83.5
of which:				of which:			
Taiwan	3.1	5.6	6.2	chemicals and related products	38.9	31.3	20.0
China	0.9	9.0	6.0	electrical equipment and machinery	13.9	11.6	14.5
Indonesia	13.9	5.4	4.8	transport equipment	5.2	8.6	13.7
South Korea	4.5	8.4	3.3	iron and steel	10.4	16.5	11.2
Thailand	6.8	3.5	2.6	machinery	6.9	2.8	6.0
Philippines	0.7	1.4	2.2	ceramics	2.5	2.1	5.0
Oceania	0.9	1.9	2.0				
of which:							
Australia	0.9	1.8	1.7				

[1] Excludes West Asia

Source: As for Table 4.

can be expected to narrow. The decreasing proportion of Japanese technology exports in manufacturing, changes within that sector, and the increased importance of recipient regions other than Asia (on all of which see Table 5) are indicative of this trend.[5]

In fact, it is likely that what Kojima identifies as 'Japanese style' technology transfer will in the future be undertaken increasingly by the more advanced LDCs. Several Northeast Asian economies have already become quite significant sources of investment and technology to neighbouring less industrialised countries. There have been relatively few studies of this phenomenon, but it appears that the motives for and nature of such overseas projects are similar to those of Japanese manufacturing projects prior to the early 1970s. Most of the investment has been occurring in relatively labour-intensive, low technology industries, and generally on a smaller scale compared with developed countries. For political reasons host governments are generally well-disposed to such investments as a counterweight to large developed country investors.[6]

'APPROPRIATE TECHNOLOGY' AND THE REGULATION OF TECHNOLOGY TRANSFER

Very few countries pursue a policy of 'technology autarky'. For most LDC governments the issue is not whether they should receive technology, but rather the nature of the technology, the terms and conditions on which they receive it, and the source country or institution. The recently published Brandt Commission Report, *North South: A Program for Survival*, for example, while critical of many aspects of 'north-south' economic relations, emphasised the need to increase the transfer of technology to LDCs and criticised instead existing institutions and arrangements. In the Western Pacific region, non-socialist LDCs have relatively open economies and are the major recipients of technology, but even the more inward-looking regimes recognise the need for an infusion of foreign technology.[7] In this section we shall examine two of the most frequent criticisms of technology transfer arrangements.

(a) The regulation of technology transfer

Several LDC governments have been showing an increased preference for technology licensing rather than direct equity investments. One reason is economic nationalism. Another is that governments see licensing as a means of achieving greater control

over technology. A third reason is that licensing arrangements are believed to reduce the risk of administrative problems, such as transfer pricing.

Despite their increasing preference for technology licensing, however, LDC governments — at international meetings, the Group of 77 — have, in recent years, been critical of the conditions under which they receive technology. The technology, they argue, is overpriced, royalty payments have created balance of payments difficulties, the options in terms of 'unpackaging' the technology are limited, and unduly restrictive conditions (conditions which would be prohibited under anti-trust laws in developed countries) are attached to its use.

In response, most governments have established regulatory bodies which monitor and approve technology transfer agreements. Internationally, they have been arguing for a universal code of conduct regarding technology transfer, the drafting of which has been in progress since 1974. The basic objective of the LDC negotiators, in the words of one participant, is for an

> increase of the bargaining power of local recipients when negotiating for technology. The underlying concept is that the market for technology is imperfect, and that enterprises of developing countries are in a disadvantageous position vis-a-vis the suppliers, generally located in industrialised countries.[8]

Several LDC governments, after introducing transfer of technology regulations, have claimed considerable success in reducing royalty payments and in removing restrictive conditions.[9] Nevertheless, claims regarding cost savings should be viewed with caution for obvious reasons.

Paradoxically, at a time when regulation of technology flows by LDC governments is increasing, there is evidence to suggest that the international market for technology is, in some respects, becoming larger and more competitive. This is principally because of increasing diversity in supply sources, both with regard to direct equity investments and technology supplied by unaffiliated companies. The rapid increase in Japanese technology exports in the 1970s has already been referred to. Some Western European and Comecon countries have also emerged as sources. Several of the newly industrialised countries have commenced exporting less advanced technology, filling a role played by Japan a decade or more ago. Recent empirical work indicates that LDC suppliers may have a comparative advantage in standardized, relatively unsophisticated technology, owing to their lower cost of skilled labour, the greater suitability of the technology to host country

factor endowments, and their willingness to 'unpackage' the technology.

Recent surveys of international technology licensing do support the argument that the market, while characterised by substantial imperfections, is becoming more competitive. Contractor, for example, concluded from his survey that:

> Maturing technologies, more intense competition among greater numbers of international suppliers, growing sophistication of technology recipients, and a greater involvement of governments are creating a more rigorous, if larger, global technology market.[10]

The study also found that the nature of the technology package transferred to LDCs varies according to the recipient country's level of industrial development. In particular, less assistance is required by the more advanced LDCs to ensure efficient utilisation of the technology, and over time the capacity to absorb the new technology increases. This at least would suggest that some 'unpackaging' of technology flows is occurring. Much depends on the nature of the industry, however. Recent technological developments in the micro-electronics industry, for example, and the international structure of that industry may render it difficult to unpackage the technology.[11] It is therefore hazardous to speculate on likely future trends in the degree of technological unpackaging.

Looking to the future, the real value of international technology flows is likely to increase substantially for several reasons.[12] For one thing, there is simply the increased pace of technological diffusion, and an increase in the number of companies wishing to employ the technology. For another, as already noted, some governments are displaying an increased propensity to regulate and restrict foreign investment and to prefer instead technology licensing agreements. This preference is facilitated by the reduced bargaining power of MNCs in some areas because of the increase in the number of potential technology suppliers. Finally, MNC preferences themselves may be changing. A recent survey by Baranson reached this conclusion, attributing it to political uncertainties in some important investment recipient countries, and to the growth of host country restrictions on DFI, noted above.[13]

It remains to be seen how important these arguments are in the case of the Western Pacific. These surveys have been primarily concerned with developed countries and Latin America. The less restrictive postures of governments in the region and the general economic and political stability may mean these arguments are less applicable than in other regions. There is little doubt, of course, that

real technology flows will increase, but this may not necessarily be at the expense of increased DFI.

These changes in the international technology market have important theoretical and policy implications. At a theoretical level they require modification to (but not fundamental reformulation of) existing theories of DFI. The current monopolistic theory, based on Hymer's contribution, maintains that foreign investors possess 'ownership specific' advantages, in the form of technology, products, managerial expertise and so on, the economic rents from which are maximised through direct equity investments.[14] Hymer's theory was developed a quarter century ago, however, when United States technological supremacy was unchallenged. The emergence of alternative sources of technology, while not necessarily invalidating the theory, does at least suggest that competitive pressures may reduce the value of these rents in certain industries. The changes also require some modification to the 'product cycle' theory of DFI developed in the 1960s. The more rapid international diffusion of new technologies and the proliferation of innovating source countries is shortening and perhaps changing the nature of the cycle.[15]

What are the implications of these changes for policies concerning technology regulation? In the case of relatively simple process technology, the case for direct government regulation would not appear to be particularly strong because there are generally a sufficiently large number of suppliers. Governments may wish to scrutinise contracts and provide information on alternative supply sources, but providing the domestic technology recipients are purchasing in a competitive market environment, little is likely to be achieved by direct intervention, the costs of which may well be quite substantial. However, in some areas there is little doubt that there are significant market imperfections (small numbers of sellers, product differentiation, lack of information), and there may be a case for government supervision.

Nevertheless, the problems associated with government intervention in the technology market should not be underestimated. This is an area in which lack of information is an inherent problem, for otherwise one reason for technology imports would disappear. It is difficult for regulatory agencies to determine the magnitude of economic rents accruing to the suppliers of technology. Government intervention is likely to affect both the supply and demand for technology. The former may arise through the number of suppliers willing to comply with the regulations, and the latter because the potential domestic user of the technology may fear that, once it is revealed to sections of the bureaucracy, it

no longer has exclusive control over that technology. The intervention may also affect the mix between DFI and technology licensing because agreements in the context of equity investments are more difficult to scrutinise. These problems are likely to be especially serious given the limited technical resources of most LDC bureaucracies.

(b) Multinationals and appropriate technology

Another contentious aspect of technology transfer to LDCs concerns the appropriateness of MNC technology. This is a large and complex issue on which an extensive literature exists.[16] We adopt a definition of appropriate technology similar to that of Morawetz: "for each process or project, it is the technology which maximises social welfare if factors and products are shadow priced".[17] Many studies have identified what they consider to be excessively capital-intensive (that is, inappropriate) techniques in low wage LDCs. In evaluating the reasons for this apparently inappropriate technology, the findings of the empirical work can be classified into four main categories. Briefly, these are:

- Firms in LDCs do not have an effective choice of technique. This is a variant of the 'rigid factor proportions' hypothesis, developed in the context of theories of technological dualism, which asserts that technology choices are limited by the absence of efficient labour-intensive techniques in many industries.
- Firms are induced to adopt inappropriate technology. According to this view, inappropriate government policies, which artificially cheapen the price of capital and foreign exchange and increase that of labour, distort relative factor prices and encourage the adoption of these techniques.
- Firms consciously select inappropriate technology. This view maintains that non-economic factors such as status and prestige are instrumental in the selection of technology.
- Firms adopt technology that may appear to be inappropriate, but in reality is appropriate either from a private or social point of view when all factors are fully costed. These cases include MNCs for which the costs of adaptation to the local economic environment may not be warranted in view of the likely benefits (for example, the opportunity to use second-hand machinery discarded in the host country plant). Another is the adoption of more capital-intensive techniques to resolve labour management problems associated with labour-intensive operations.[18]

This classification illustrates that the issue of MNCs and technology choice is only a subset, and perhaps a minor one, of the broader debate on appropriate technology. Nevertheless, several aspects of MNC choice of technology remain highly contentious. The most widely-discussed aspect concerns their factor proportions. It is alleged by some that MNCs adopt excessively capital-intensive techniques for low-wage developing countries.[19] The alleged excessive capital intensity of MNC operations may be based on comparisons of production technologies in plants in both LDCs and developed countries; it may refer to the technology of MNCs in LDCs compared with that of local firms; or it may refer to the industries and activities in which MNCs locate in LDCs. This is a large topic on which much research has been undertaken recently. Our intention here is to make some general comments on the basis of this recent research.

At an economy wide level MNCs would be expected to have a higher average capital-intensity than local firms. However, such a simple comparison between MNCs and local firms is of course inconclusive unless one standardises for industry, product and the scale of operations. It is also necessary to take account of the period of operations of MNCs, because over time there is likely to be increased technological diffusion to local firms.

There are, in addition, a number of other factors which need to be considered in assessing the technology choice of MNCs. MNCs may face different relative factor prices from their domestically-owned counterparts. In particular, their long-term cost of capital may be lower to the extent that they are able to obtain their capital on more favourable terms than domestic firms. They also tend to pay higher wages than local firms. Government regulations may also have some effect. MNCs may receive capital-cheapening fiscal incentives not available to domestic firms, and restrictions on capital remittances may leave MNCs with little choice other than to plough back profits into their operations.

MNCs may at least initially be more capital-intensive because they are unfamiliar with the local economic environment. The process of adaptation and assimilation occurs gradually, as technicians realise the scope for efficient, capital-saving modifications to plant. Finally, even if MNCs are more capital-intensive, their technology may not necessarily be inappropriate. The main criterion is that their technology choice be socially optimal at inputs and outputs which are shadow-priced. (One element here, for example, is the possibility that capital-intensive techniques may substitute not for unskilled labour, an abundant factor in LDCs, but scarce skilled labour.)

What do the empirical studies say about these questions? First of all, it should be noted that there are formidable data problems in such studies, which themselves may account for different results. A major problem concerns the measurement of capital: secondary data on capital generally refer only to book value estimates, which are of little use, and there is the question of what to include in capital stock (machinery only, all fixed capital, or total capital). There are also difficulties in obtaining data at a suitable level of disaggregation for product categories, stages of production and the labour force.

As we might expect, the evidence from the studies is not conclusive. A few examples will illustrate this point. A Korean manufacturing case study, comparing US and Japanese MNCs and local firms, found no significant difference in production technologies.[20] A Philippine case study concluded there were differences, which were attributed mainly to differences in relative factor prices.[21] Another study came to a similar conclusion but argued that the reason was a 'permissive' economic environment — the absence of competitive pressures — which did not compel foreign firms to seek and adopt the most efficient techniques.[22]

Similarly, comparisons of the operations of MNCs in their own country and in LDCs has produced mixed results. Lipsey, Kravis and Roldan, using (rather dated) data from Sweden and the US, concluded that the firms used more capital-intensive techniques in their own country than in other developed countries, which were in turn more capital-intensive than those in LDCs.[23] By contrast, a recent study of Australian investment in the Philippines concluded that most of the firms' techniques did not differ significantly from those in use in Australia.[24]

Several of the survey articles referred to earlier have synthesised the main findings from this literature. White's summary on MNCs and technology choice was typical of the conclusions reached:

> the evidence is clearly mixed. Although the MNCs may not be the heroes of appropriate technology, they are far from the villains that many make them out to be. They have the management expertise, and they are frequently willing to use it to adapt to labour-intensive processing.[25]

Perhaps the most important conclusion is that the selection of appropriate technology depends largely on the adoption of 'appropriate' government policies, including the pricing of factors of production, the nature of fiscal and other investment incentives offered to firms, and the creation of competitive market structures. The latter, in particular, should be emphasised. Numerous case

studies have illustrated firms' (all firms, not just MNCs) preference for a 'quiet life' by adopting capital-intensive techniques which will minimise labour supervision problems, unless forced by competitive pressures to seek out the most efficient (often more labour-intensive) technique.

Two other considerations arise in the context of MNCs and appropriate technology, apart from that of factor proportions. One is the MNCs' net contribution to such dynamic externalities as skill diffusion and learning processes. MNC operations have sometimes been criticised on the ground that there is little 'spillover' of labour skills to domestically-owned firms. This argument is based on evidence that the MNCs typically have low rates of labour turnover among their skilled workers, partly because they offer higher wages and better working conditions than domestic firms.[26] If, in addition, the MNC's are principally engaged in activities which receive above-average protection or relatively favourable tax treatment, their presence may actually cause a diversion of skilled labour from domestic firms which are more internationally competitive. Clearly, then, the net contribution that MNC's make to the development of domestic labour skills depends not only on the skill-intensity of their operations but on relevant government policies. While the diffusion of labour skills from MNC's may be of little significance to the country's industrial development programme in the short run, greater benefits may be expected to accrue in the long run.

A second criticism of MNC's and technology transfer, made by Stewart and others and which in our view may have more validity, concerns the transfer of inappropriate products.[27] According to this argument, which derives partly from the monopolistic theory of DFI cited earlier, the MNCs' 'ownership-specific' advantages frequently take the form of product differentiation on the basis of quality specifications, packaging and brand names, reinforced by advertising and sophisticated marketing techniques. In these circumstances it is possible that the introduction of new products may have adverse welfare consequences for certain groups of consumers. This may arise if these products contain a relatively small proportion of 'essential' characteristics and a relatively larger proportion of 'luxury' characteristics per unit of consumer expenditure (compared with traditional products), and if their introduction drives out the latter products and so limits consumer choice. Much depends on the latter qualification, the importance of which has not been documented extensively.

If this analysis is correct, from the point of view of low income consumers the most important area concerns food products, where

the degree of processing of staple foods and the introduction of 'international' brand name goods may have detrimental effects on nutrition levels. This issue of inappropriate products is also related to that of technology choice since the production technologies of many of the old 'non MNC' goods are more labour-intensive than the newer ones. There may well be a case here for direct government regulation of MNC entry and product composition, especially because it may be difficult to achieve the required degree of 'fine tuning' through indirect measures such as differential sales taxes.

Inter-Versus Intra-Country Technology Flows

So far we have emphasised international technology flows, rather than internal research and development and the diffusion and assimilation of new production technologies. This is an area on which there has been less research. One approach has been to undertake econometric investigations of the relationship between the international transfer of technology to a country, and its domestic research and development effort. In general, the finding has been that a complementary relationship exists; that is, that imported technology stimulates greater domestic research. But there are considerable data limitations associated with such exercises. They have generally been undertaken only for developed countries and the results appear to depend in part upon whether time series or cross-section data are employed.[28]

Another approach relates to inter-sectoral linkages between firms. This is now a subject of some policy relevance. LDC governments, frustrated with the difficulties in promoting small and medium-scale industries directly and impressed by Japan's remarkable industrial growth, are now giving increased attention to policies which encourage the development of sub-contracting networks. Attempts by developing Asian countries to encourage the internal diffusion of technology through these policies have met with mixed success. In India, where they have been in operation for well over a decade, the large assembler firms have played an important role in upgrading the technological capabilities of small and medium supplier firms. The Indian experience may, however, be of limited relevance to some of the Western Pacific LDCs. Despite its low per capita income, India has one of the largest industrial sectors among LDCs, and it is heavily protected against overseas competition. Moreover, successive governments have had a strong commitment to the development of small and medium enterprises and sub-contracting networks.

In smaller, less industrialised economies there may be greater difficulty in establishing these linkages. The process of backward integration and development of capital goods industries — industries whose production processes and products are better suited to sub-contracting — has generally commenced only recently. Government policies, while emphasising the desirability of establishing such networks, frequently have the opposite effect in practice. The domestic market is usually small and exports limited, which renders local firms uncompetitive in products where economies of scale are significant and also inhibits the development of exclusive supplier relationships. Finally, the assembler firms themselves often have only limited manufacturing experience. Many started as importers of the goods they now produce and later, under government pressure, switched to assembly of imported parts and components. Many of these activities do not require substantial manufacturing know-how.[29]

There is an obvious danger that enforced sub-contracting programs may result in high cost, low volume production, and poor product quality. Nevertheless, the establishment of a strong base of supplier industries is an important element of the industrialisation process, and such programs may be justified as part of a package which also aims to promote these firms through appropriate training and technical assistance programs, and which attempts to foster greater standardisation across industries. Much depends on the selection of industries that are within the technological capacity of supplier firms. A number of obvious industry characteristics may be identified: where economies of scale are not of major importance, where production technology does not require competence in advanced science, and where product designs are not undergoing rapid changes.[30]

In recent years there has been a proliferation of export processing zones in LDCs, mainly in Asia and Latin America. Employment and balance of payments considerations have generally been paramount from the point of view of LDC governments. However, MNCs are generally the major investors and the zones do raise technology transfer issues, particularly with regard to spin-offs to local firms outside the zones. Most studies of these zones have found that the spin-offs are limited, because firms in the zone generally have limited forward and backward linkages with the domestic economy.[31] This may in part be a reflection of their relatively recent establishment. One of their contributions in the future may arise through the movements of skilled and semi-skilled workers into the domestic economy, although so far much of the activity in the zones consists of labour-intensive assembly processes

which do not require skilled labour. It is difficult to estimate the potential technology transfer benefits, as one of the few systematic benefit-cost analyses of one such zone acknowledges.[32]

In the absence of detailed country studies, it is difficult to reach any form generalisations regarding the internal diffusion of technology. A recent Korean case study does, however, take up this and related issues. Examining the importance of foreign influences in Korea's rapid inudstrialisation, they argue that, with the exception of some high technology activities, the role of foreign investment and technology transfers was relatively small, although foreign buyers were very important in the export-oriented industries. They conclude that:

> Korea's export-led industrialisation has been overwhelmingly and in fundamental respects directed and controlled by nationals . . . The purchase of technology through licensing has been of modest importance as the initial source of process technology . . . Very importantly, there has been a great deal of assimilation of technological know-how, in that there has been diffusion from domestic sources rather than repeated transfer from abroad.[33]

From LDCs' point of view, the Korean experience would suggest that an overriding concern with international transfer of technology issues is partly misplaced. Of equal importance is internal diffusion.

Paradoxically, while most recipient countries are attempting to encourage the international transfer of technology, some of their policies are in fact hindering the domestic diffusion of this technology. This is occurring in several ways. One explanation for the limited linkages between export processing zones and the domestic economy is government restrictions on the operations. The tariff structure can also be an important factor discouraging local sourcing. In some countries the effective rates of protection on final products are higher than those on intermediates, encouraging large assembler firms to source their inputs overseas rather than locally. Another related factor concerns industry structure. In the automative, appliance and machine goods industries of some countries, government regulatory policy has resulted in a highly fragmented, uneconomic local industry which provides little incentive for assemblers to develop local suppliers.

AUSTRALIA IN THE TECHNOLOGY TRADE

The analysis so far has been with reference to Western Pacific LDCs. For the purposes of comparison, it is instructive to refer

briefly to the Australian experience. This is of relevance for two reasons. First, although Australia is a high income country, it is, like LDCs, a substantial net importer of technology. Secondly, it is sometimes suggested that Australia may perform as a 'technology intermediary' in relation to its neighbouring LDCs.

There are two sources of statistics on Australia's technology trade. These are the official balance of payments statistics and a triennial survey undertaken by the Australian Bureau of Statistics entitled *Survey of Research and Experimental Development.* Neither source is entirely satisfactory. In the former there are definitional problems associated with the measure of technology adopted, while only three surveys have been undertaken in the case of the latter. We shall use the *Survey* results because, despite the limited number of observations, they are more satisfactory for our purposes.[34]

A summary of the *Survey's* results is presented in Table 6. Australia is a substantial net importer of technology for all sectors and years. Manufacturing is the largest recipient of imports, and by far the largest source country is the United States. In contrast to Western Pacific LDCs, Japan is a very minor source, presumably because of Japan's less extensive DFI in Australia, and because of Australia's very different industrial structure compared with these LDCs. Australia's technology exports are minimal and, while a full breakdown by recipient country is not provided, it is likely that the expanding 'other' group (Table 6, part (b)) refers mainly to LDCs. The Australian experience indicates that there is no necessary correlation between per capita income and net technology imports. In particular, for relatively small economies, such as Australia and most Asian LDCs, the scope for undertaking expensive across-the-board research and development programs may be limited, and for many industries it may be more economic to buy the technology on the international market.

What of Australia's role as a technological intermediary to the region? Parry and Hughes have independently advanced similar 'two-stage technology transfer' theses, according to which small developed countries like Australia may act as a kind of an intermediary in facilitating the scaling down of production processes originating in large industrialised countries to better suit the requirements of small market LDCs.[35] Parry, for example, maintains that:

> A product or process which is introduced by the multinational enterprise subsidiary in the intermediate economy undergoes some adaptation for the specific requirements of that intermediate

Table 6. Australian Technology Payments and Receipts

(a) *By Sector*

	($A million) Payments			Receipts			Balance		
	1976-77	1978-79	1981-82	1976-77	1978-79	1981-82	1976-77	1978-79	1981-82
Manufacturing	55.8	79.5	80.6	7.5	8.8	10.0	−48.3	−70.7	−70.6
Other	13.7	30.8	21.2	1.7	6.6	4.4	−12.0	−24.2	−16.8
Total	69.5	110.2	101.9	9.2	15.4	14.4	−60.3	−94.8	−87.5

(b) *By Country*

	(% of total)			
United States	54.3	63.0	28.2	22.7
United Kingdom	20.9	13.5	16.3	12.0
Japan	3.1	2.8	5.0	4.1
West Germany	7.5	8.2	1.7	1.8
France	4.3	2.3		
Canada	1.8	1.0	3.5	1.8
New Zealand	8.0	9.3	24.5	39.8
Total	100	100	100	100

Source: Australian Bureau of Statistics, *Research and Experimental Development, Business Enterprises, Australia*. Canberra, various issues (data for 1981-82 are preliminary).

> economy. . . . In this case *process* technology which is adapted to take account of smaller intermediate-economy market size will, where feasible, be scaled down to meet the requirements of that market size. In this situation there is a likelihood that this adaptation for the intermediate economy by the multinational enterprise subsidiary will be relevant to the scale requirements of the developing host nation.[36]

The data in Table 6 do provide limited support for this proposition. Australian firms have undoubtedly developed much expertise in producing for and serving a relatively small, fragmented market, and this factor, combined with geographic proximity, may render it an attractive technology source for neighbouring LDCs.

Nevertheless, Australia's contribution should be kept in proper perspective. Australia's technology exports to the region are a tiny fraction of those from Japan and the United States (compare Table 6 with Tables 2 and 4). Moreover, Australia's technology imports from Japan are very small so that the thesis does not apply to this country, which is the fastest growing source of technology to the region. Moreover, apart from market size and proximity, the Australian economy has little in common with LDCs — relative factor prices, consumer tastes, and the general business environment all differ substantially. Like the community as a whole, Australian companies have until recently had little experience in developing Asian countries. There is no reason to presume that they are in a better position to adapt their technology than globally-diversified MNCs with extensive manufacturing experience in LDCs.

CONCLUSION

The purpose of this paper has been to examine the transfer of technology to Western Pacific LDCs and several important policy issues which arise in the context of technology flows. Several conclusions should be emphasised. Technology flows have increased considerably, as illustrated by the Japanese and United States data. There is little doubt that this trend will continue, and that most LDCs in the region are likely to remain substantial net importers of technology. The Australian experience illustrates that such a situation is not confined only to low income countries. The international technology market, while characterised by substantial imperfections, is gradually becoming larger and more competitive. Several studies have suggested that both LDC governments and MNCs may increasingly prefer licensing agreements to DFI, but

limited data for the United States does not reveal the existence of such a trend.

The problems of control of technology and technology unpackaging have not evoked the same policy responses in developing Asian and Pacific countries as they have in Latin America. This may reflect the longer and more concentrated exposure to DFI in the latter countries, and its heavy concentration in import-substitution activities. Attempts to regulate international technology flows directly have not always achieved their intended objectives. Nevertheless, policy measures may be needed to assist in increasing the net benefits obtainable from the utilisation of imported industrial technology. In particular, attention may have to be paid to methods of improving the diffusion of the foreign technology to the domestic economy.

NOTES AND REFERENCES

1. W. Paul Strassman, *Technological Change and Economic Development*, Cornell University Press, Ithaca, 1968, p. 2.
2. The Japanese experience of technology imports has been extensively documented. See, for example, B.L. Johns, *The Transfer of Foreign Technology to Australia and Japan*, Australia — Japan Economic Relations Research Project, Research Paper No. 36 Canberra, 1976; and Susumu Watanabe, *Technological Linkages Between Formal and Informal Sectors of Manufacturing Industries*, International Labour Office, World Employment Programme, Working Paper No. 34, Geneva, 1978.
3. Part of the increase may be attributed to the appreciation of the yen relative to the US dollar over this period, but the real increase valued in terms of yen was nevertheless still very substantial.
4. The best known are Kojima and Ozawa. See Kiyoski Kojima, *Japan and a New World Economic Order*, Charles E. Tuttle and Co., Tokyo, 1977; and Terutomo Ozawa, *Multinationalism, Japanese Style*, Princeton University Press, Princeton, New Jersey, 1979.
5. For a useful critique of the Kojima hypothesis see Sueo Sekiguchi and Lawrence B. Krause, 'Direct foreign investment in ASEAN by Japan and the United States', in Ross Garnaut (ed.), *ASEAN in a Changing Pacific and World Economy*, Australian National University Press, Canberra, 1980, pp. 421-47, the comments by Ronald Findlay and Ben Smith, and references cited therein.
6. This is a fruitful area for future research. Limited information is provided in the following references. Tamir Agmon and Charles P. Kindleberger (eds.), *Multinationals from Small Countries*, MIT Press, Cambridge Mass., 1977; K. Kumar and M. McLeod (eds.), *Multinationals from Developing Countries*, Lexington Books, Lexington, 1982; Sanjaya Lall, 'The emergence of Third World multinationals: Indian joint ventures overseas', *World Development* 10, 2, 1982, pp. 127-46; Sanjaya Lall, 'Developing Countries as Exporters of Industrial Technology', *Research Policy* 9, 1, 1980, pp. 24-52; and UNCTAD, *Organisational Forms of Transfer of Technology to Developing Countries by Small and Medium-sized Enterprises: A Case Study of Equity Joint Ventures and Technology Agreements in Latin America*, TD/B/C.6/77, Geneva, 1982.
7. Even North Korea, generally regarded as one of the most inward-looking societies, has turned recently to the United Nations for assistance with an

integrated technology program (see *Far Eastern Economic Review*, 3 February 1983). Burma, another extremely inward-looking country which prohibits DFI in all sectors of the economy except off-shore petroleum exploration, has also stepped up technology sharing agreements with other countries (see Hal Hill, 'Industrialisation in Burma in historical perspective', *Journal of Southeast Asian Studies*, forthcoming March 1984).

8. Carlos M. Correa, 'Transfer of technology in Latin America: a decade of control', *Journal of World Trade Law*, 15, 5, 1981, p. 391. For a summary of the issues involved in the debate, see this paper and Dennis Thompson, 'The UNCTAD code on transfer of technology', *Journal of World Trade Law*, 16, 4, 1982, pp. 311-337.
9. For example, in its first full year of operation, it has been claimed by a senior government official that the Philippine Technology Transfer Board reduced technology licensing fees by almost $40 million through directing the renegotiation of agreements. See Lilia Bautista, *Transfer of Technology Regulations in the Philippines*, UNCTAD/TT/32, Geneva, 1980.
10. Farok J. Contractor, *International Technology Licensing: Compensation, Costs and Negotiations*, Lexington Books, Lexington, 1981, p. 133.
11. See, for example, Romeo Bautista, 'The silicon chip: not a development panacea', *Far Eastern Economic Review*, 27 January 1983.
12. On this point, see Richard E. Caves, Harold Crookell, and J. Peter Killing, *The Imperfect Market for Technology Licences*, Discussion Paper No. 903, Harvard Institute of Economic Research, Harvard University, Cambridge, Mass., 1982.
13. Jack Baranson, *Technology and the Multinationals*, Lexington Books, Lexington, 1978. One issue which Baranson does not examine in detail in the MNC choice between licensing and DFI is the impact of the host country commercial environment and, in particular, difficulties in supervising technology licensing agreements. The legal environment in many LDCs is in practice uncertain, contractual obligations involving non-resident foreign firms are sometimes difficult to enforce, and there is widespread abuse of patents and trademarks. (On the latter, see the special issue on trademarks in developing countries, *World Development*, 7, 7, 1979). MNCs may see DFI as a means of mitigating these problems.
14. Stephen Hymer, *The International Operations of National Firms: A Study of Direct Foreign Investment*, MIT Press, Cambridge, Mass., 1976.
15. For a recent discussion of this point by one of the originators of the theory, see Raymond Vernon, 'The product cycle hypothesis in a new international environment', *Oxford Bulletin of Economics and Statistics*, 41, 4, 1979, pp. 255-67.
16. Reviews of this literature include the following: David Morawetz, 'Employment implications of industrialisation in developing countries: a survey', *Economic Journal*, 84, September 1974, pp. 491-542; James Pickett (ed.), *The Choice of Technology in Developing Countries*, special issue of *World Development*, 5, 9/10, 1977; Samuel M. Rosenblatt (ed.), *Technology and Economic Development: A Realistic Perspective*, Westview Press, Boulder, Colorado, 1979; Frances Stewart, *Technology and Underdevelopment*, Macmillan, London, second edition, 1979; and Lawrence J. White, 'The evidence on appropriate factor proportions for manufacturing in less developed countries: a survey', *Economic Development and Cultural Change*, 27, 1, 1978, pp. 27-59.
17. Morawetz, *op. cit.*, p. 517.
18. For an elaboration of these arguments, see Gordon C. Winston, 'The appeal of inappropriate technologies: self-inflicted wages, ethnic pride and corruption', *World Development*, 7, 8/9, 1979, pp. 835-46.
19. See, for example, Stewart, *op. cit.*
20. Byung Soo Chung and Chung H. Lee, 'The choice of production techniques by

foreign and local firms in Korea', *Economic Development and Cultural Change*, 29, 1, 1980, pp. 135-40.

21. R. Hal Mason, 'Some aspects of technology transfer: a case study comparing United States subsidiaries and local counterparts in the Philippines', *Philippine Economic Journal*, 9, 1, 1970, pp. 83-108.
22. Samuel A. Morley and Gordon W. Smith, 'Limited search and the technology choices of multinational firms in Brazil', *Quarterly Journal of Economics*, 91, 2, 1977, pp. 263-87.
23. Robert E. Lipsey, Irving B. Kravis and Romualdo A. Roldan, 'Do multinational firms adapt factor proportions to relative factor prices?', in Anne O. Krueger (ed.), *Trade and Employment in Developing Countries: (2) Factor Supply and Substitution*, University of Chicago Press, Chicago for the National Bureau of Economic Research, pp. 215-55.
24. Hal Hill, 'Foreign investors from small countries: a Philippine manufacturing case study', *Philippine Economic Journal*, 21, 2, 1982.
25. White, *op. cit.*, p. 45.
26. See D. Germidis, *Transfer of Technology by Multinational Corporations*, Development Centre, OECD, Paris, 1977, 2 vols.; and for a comprehensive review of the Philippine experience, Charles W. Lindsey and Ernesto M. Valencia, *Foreign Direct Investment in the Philippines: A Review of the Literature*, Philippine Institute for Development Studies, Working Paper No. 81-11, Manila, 1981.
27. The strongest argument on this issue has been advanced by Jeffrey James and Francis Stewart, 'New products: a discussion of the introduction of new products in developing countries', *Oxford Economic Papers*, 33, 1, 1981, pp. 81-107, upon which much of this paragraph rests.
28. For one such study, see Tuvia Blumenthal, 'A note on the relationship between domestic research and development and imports of technology', *Economic Development and Cultural Change*, 27, 2, 1979, pp. 303-306.
29. For an interesting case study of the Indian experience, see Sanjaya Lall, 'Vertical inter-firm linkages in LDCs: an empirical study', *Oxford Bulletin of Economics and Statistics*, 44, 3, 1982, pp. 261-71. For a similar study in a smaller, less industrialised economy, see Hal Hill, 'Vertical inter-firm linkages in LDCs: a note on the Philippines', *Oxford Bulletin of Economics and Statistics*, 44, 3, 1982, pp. 261-71.
30. For a discussion of these and related issues, see Howard Pack, 'Fostering the capital-goods sector in LDCs', *World Development*, 9, 3, 1981, pp. 227-50.
31. For a survey of these zones, see *Export Processing Zones in Developing Countries*, United Nations Industrial Development Organisation, Working Papers on Structural Change No. 19, Vienna, 1980, UNIDO/ICIS, 176.
32. Peter G. Warr, 'The Jakarta Export Processing Zone', Australian National University, Canberra, 1982, mimeo.
33. Larry E. Westphal, Yung W. Rhee and Gary Pursell, 'Foreign influences on Korean industrial development', *Oxford Bulletin of Economics and Statistics*, 41, 4, 1979.
34. For a description of these sources, see I.R. Haine, 'The technological balance of payments — Australian statistics', paper presented to Workshop on the Technological Balance of Payments, OECD, Paris, 14-15 December 1981.
35. Thomas G. Parry, 'The multinational enterprise and two-stage technology transfer to developing countries' in R.G. Hawkins (ed.), *Technology Transfer to Developing Countries*, JAI Press, Greenwich, Connecticut, 1982, pp. 175-92; and Helen Hughes, 'Technology transfer: the Australian experience' in Agmon and Kindleberger, *op. cit.*, pp. 101-27.
36. Parry, *op. cit.*, pp. 179-80. But Hughes, *op. cit.* is less sanguine about the prospects for such a development.