TECHNOLOGY TRANSFER REVISITED: RECENT TRENDS AND DEVELOPMENTS*

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Technology transfer between countries is a complex process which takes many forms. This paper examines aggregate statistics to give a picture of recent developments in international licensing, R & D performed by foreign firms and foreign direct investment. These general developments provide the context for the evolution of firm strategies and the elaboration of government policy.

Keywords: technology transfer, licences, balance of technological payments, research and development, foreign direct investment

INTRODUCTION

Invest in a foreign country, licence to a suitable partner or export from the home country? These are the basic questions facing firms considering expanding into international markets. The choice of the firm is determined by a complex set of factors including the size of the firm and the industry in which it operates, its competitive strength, market power and managerial style, the size of the market into which it is expanding, and government policies in the host country. Furthermore, technological factors are increasingly important in determining the form and nature of international expansion. Although technology transfer is rarely the prime aim of firm strategy, the research intensity of firm operations, whether the firm is a technological leader or laggard in its field, and the technological capabilities of foreign partners and the foreign country will influence the expansion strategy adopted, and ultimately the technological impact on the host country.

Governments, too, increasingly recognise that national competitive status is determined by the quality and quantity of technological inputs into production and distribution of goods and services, and by the nature of national and international technological co-operation and competition. One important determinant of national technological performance is the speed and effectiveness of transfer,

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application and domestic diffusion of technology developed in other countries.

There are three conceptually distinct ways for firms to transfer new and improved products and production methods between countries. Transfer takes place through:

- subsidiaries or through joint ventures set up with local partners. A subsidiary is most likely to be 100 per cent owned by the parent where the technology is advanced or where the firm can exploit technological or other advantages in the host economy;
- licensing or sale of patents, other intellectual property rights and know-how. Licensing agreements increasingly involve equity links or affiliation between firms. When they are between unrelated firms, the technology is in many cases standardised or there may be barriers to foreign direct investment or imports; and
- machinery and equipment sales or supply of 'turn-key' plants. Foreign direct investment, licensing and technical services often accompany trade in machinery and equipment.

Considerable preparation and technical effort to adapt technology to local conditions, and in education and training and developing on-the-job experience, must accompany all international technology transfer. These activities take place within the firm in the case of transfer to subsidiaries. Between independent firms they may be part of the technology supply agreement with foreign licensees, purchasers or importers of technology, or be carried out under separate agreements. Ancillary training, education and experience-building are the key to successful transfer and improvements in national performance and long-term competitiveness.

Despite increasing interest in the international flows of technology, there are no widely accepted and uniformly collected measures of these flows. Information that does exist has been developed largely to illuminate regional or development issues (for example, North-South economic and technological differences),[1] or is based on data collected from a small sample of firms.[2] The little regularly-collected statistical data that exists has not been examined extensively. The following discussion is based essentially on national statistical material — it sets out some broad trends and developments which are changing the structure of international technology flows, drawing on data on the technological balance of payments, on research and development performed by foreign firms and on foreign direct investment. These data are considered separately below, although for many firms licensing, foreign R & D and production are inter-related parts of their international strategies. Detailed references are not given in the following sections; national sources of data are given in the Notes and References section.

INTERNATIONAL PAYMENTS FOR PATENTS, LICENCES AND TECHNICAL KNOW-HOW

Many countries collect data on international payments and receipts for patents, inventions, processes and related items. These transactions are often described as 'technology trade', and, despite some drawbacks with these data, in many ways they are the most direct measure of technology flows and international technological links between firms and countries. However, data are only roughly comparable among countries, in some cases being collected as part of R & D surveys, in others from the balance of payments. Furthermore, they are heavily influenced by parent-subsidiary transactions; payments between related firms are affected by profit remittances, exchange rate fluctuations, taxation law and the location of international holding companies. Thus payments may reflect economic and financial conditions more than technological relations between countries. There may also be agreements to supply or exchange technology for which there are no international monetary payments and no statistical record.

General Trends

Most countries are net importers of technology in money terms — they have a deficit on international payments for patents, licences and technical know-how (see Table 1). Countries which have a strong technological base, including France, Germany and Japan, are slowly reducing the relative size of their deficits, particularly as their stock of overseas investment grows. However, they are still net importers of patents, licences and technical know-how: data for France and Germany show that deficits are largely attributable to payments by affiliates to parent firms. The United Kingdom and the United States have consistent surpluses in technology transactions — their receipts far outstrip payments. Construction of statistics for Switzerland suggest that it too has a surplus. In Sweden, firms performing R & D (essentially large firms) now have a surplus on technology transactions — Swedish firms have been rapidly expanding their foreign direct investment. All of these countries are the home of large, active multinational firms; each has a large stock of foreign investment in other countries and their investment stock is larger than that held by other countries in them.

International payments for patents, licences and technical know-how were worth $US11 billion in 1982, $US12 billion in 1983. The volume of these payments rose by 2 per cent per year between 1975 and 1983; in constant terms payments rose from $US9.7 billion in 1975 to $US11.4 billion in 1983 for countries shown in Table 1, measured at 1980 prices and exchange rates. The United States,

Table 1

INTERNATIONAL RECEIPTS AND PAYMENTS FOR PATENTS, LICENCES, TECHNICAL KNOW-HOW AND RELATED ITEMS: SELECTED OECD COUNTRIES

(millions US$)

		1975	1976	1977	1978	1979	1980	1981	1982	1983
Australia[1]:	Receipts		8		13			13		
	Payments		101		145			134		
	Balance		−93		−132			−121		
Austria:	Receipts	11	18	22	25	30	30	24	33	29
	Payments	76	79	96	110	125	138	99	116	154
	Balance	−65	−62	−74	−85	−95	−108	−75	−83	−125
Belgium/Luxembourg[2]:	Receipts	97	105	131	145	175	184	187	190	212
	Payments	180	195	246	288	350	454	424	420	402
	Balance	−83	−90	−115	−142	−176	−270	−237	−230	−190
Canada[3]:	Receipts	53		63		94	130	128	190	
	Payments	190		243		324	362	410	417	
	Balance	−137		−180		−230	−232	−281	−226	
France:	Receipts	459	529	627	768	857	923	906	853	820
	Payments	550	669	685	828	1000	1104	991	995	908
	Balance	−91	−140	−59	−60	−143	−181	−85	−142	−88
Germany[4]:	Receipts	308	289	335	430	492	556	485	492	514
	Payments	720	693	816	964	1065	1144	948	907	972
	Balance	−421	−404	−481	−534	−573	−588	−464	−415	−457
Italy:	Receipts	72	80	151	134	175	224	198	160	148
	Payments	385	320	430	680	536	635	570	598	600
	Balance	−313	−241	−280	−545	−361	−411	−372	−437	−452

		1975	1976	1977	1978	1979	1980	1981	1982	1983
Netherlands:	Receipts	184	209	231	291	371	418	386	341	342
	Payments	280	356	359	445	556	641	592	574	516
	Balance	−96	−145	−128	−154	−185	−223	−206	−233	−174
Spain:	Receipts	50	61	59	73	114	152	181	143	127
	Payments	301	467	378	297	517	619	567	719	616
	Balance	−251	−406	−319	−325	−403	−467	−387	−576	−489
Sweden[5]:	Receipts	29		34		32		68		82
	Payments	33		35		36		64		38
	Balance	−4		−1		−4		+4		+45
United Kingdom[6]:	Receipts	491	602	632	744	808	953	974	878	932
	Payments	483	478	518	625	673	823	805	726	731
	Balance	+9	+124	+115	+119	+136	+131	+169	+153	+201
United States[7]:	Receipts	4008	4084	4503	5312	5747	6617	6863	6878	7531
	Payments	473	482	434	610	764	762	693	200	230
	Balance	+3535	+3602	+4069	+4702	+4983	+5855	+6170	+6678	+7301
Japan:	Receipts	224	281	345	575	607	702	791	743	1019
	Payments	570	597	703	905	1100	1056	1177	1132	1182
	Balance	−346	−316	−358	−330	−493	−354	−383	−391	−162

Source: National sources, except Belgium.

Notes:
1. Financial years, i.e. 1976 = 1976/1977. From R & D survey.
2. Adapted from Deutsche Bundesbank, includes films.
3. R & D firms only.
4. Excluding copyrights, trademarks.
5. From R & D survey.
6. Technological and mineral.
7. Including management fees. From National Science Foundation, *International Science and Technological Update,* Washington DC, January 1985.

United Kingdom, France, Germany and Japan are the suppliers in 85 per cent of these transactions. The United States is the source of between 50 and 75 per cent of technology for most importing countries.

How important is independent licensing that does not involve equity links between licensee and licensor compared with foreign direct investment? No aggregate data exist, but it can be estimated that sales of products manufactured overseas under independent licence are equivalent to 7 to 10 per cent of manufacturing sales from foreign direct investment. This estimate is calculated on the assumption that the average royalty rate paid by licensees is 5 per cent of sales. Estimated values for four major technology-supplying countries are:

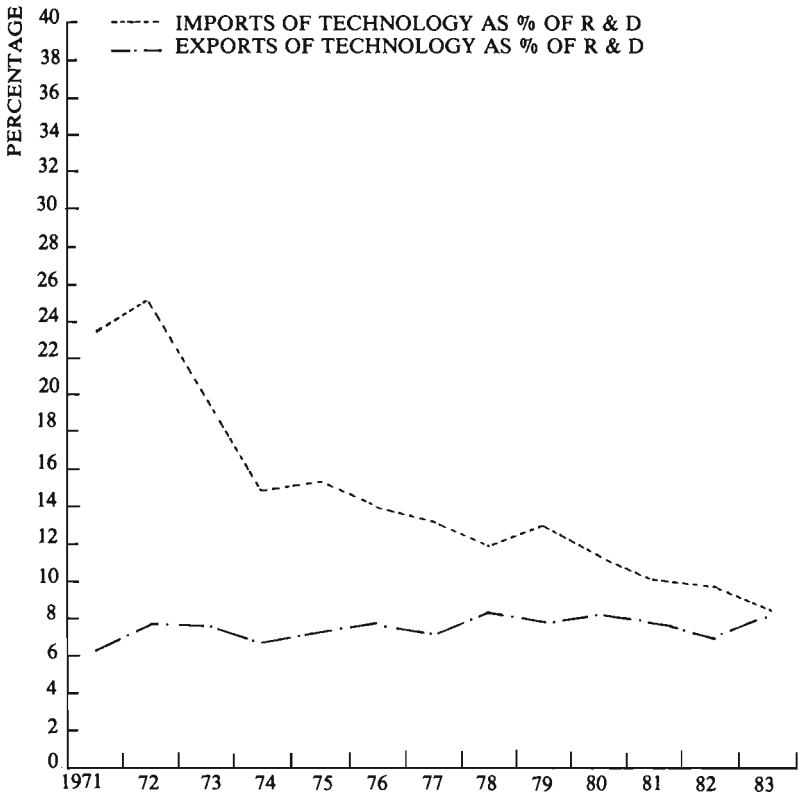
- German foreign licensed sales 8.5 per cent of turnover of foreign direct investment in 1983;
- Japanese foreign licensed sales 8.6 per cent of manufacturing sales from foreign direct investment in Fiscal Year 1983 (assuming one quarter of licence receipts are from independent licensees);
- United Kingdom 10.1 per cent in 1981[3]; and
- United States firms 9.1 per cent in 1977.

Furthermore, technology transactions are lower in value than domestic R & D expenditures in countries with a well-developed technology base. International receipts and payments for technology are of the order of 10 to 20 per cent of business enterprise R & D expenditures for countries that are major performers of industrial R & D. However, countries which rely more extensively on foreign technology make relatively larger payments for technology compared with their R & D efforts. Technology payments by firms performing R & D are around 40 per cent of their R & D expenditures in Australia; total international technology payments are over 200 per cent of R & D expenditures for Portugal and Spain.

But the reliance on imported technology is not necessarily permanent. Japan has been a major importer of foreign technology licences and has very successfully adapted and applied imported technology in manufacturing industry. To achieve these results Japanese firms have consistently increased their own R & D efforts to use, improve, develop and perfect imported technology. Technology imports fell from 25 per cent of the value of R & D expenditures of technology-importing firms in the early 1970s to below 10 per cent of their R & D expenditures in 1983 (see Figure 1). During this period, many Japanese firms closed the technology gap between themselves and leading foreign firms. As this occurs, internal R & D becomes an increasingly important part of firm expenditures. On a more limited scale, the same phenomenon is occurring in Canada. Payments for

Figure 1

TECHNOLOGY TRADE OF JAPANESE FIRMS AS PERCENTAGE OF THEIR R & D



Source: OECD, *International Flows of Technology: Trends and Developments*, OECD, Paris, June 1985, draft.

technology by firms performing R & D have dropped from 30 per cent of the value of Canadian business R & D expenditures in the early 1970s to 20 per cent. This is largely attributable to the sharp increase in R & D expenditures in the aircraft, communications and petroleum industries.

The Patterns by Industry

More than 80 per cent of international technology transactions are related to manufacturing industry, and for most countries over 90 per cent are manufacturing-based. Most of these transactions are concentrated in a restricted group of industries: chemicals, electronics and electrical engineering; non-electrical machinery; professional, scientific and industrial instruments and controls; automobiles and transport equipment. These industries are highly internationalised; large firms have networks of foreign subsidiaries, smaller firms have numerous formal and informal international links, and they are highly trade-oriented and research intensive. Beyond manufacturing, technology payments are often linked with the provision of industrial complexes and turn-key plants in developing countries. There are also some agreements between firms in OECD countries involving technology linked to commercial and distribution services.

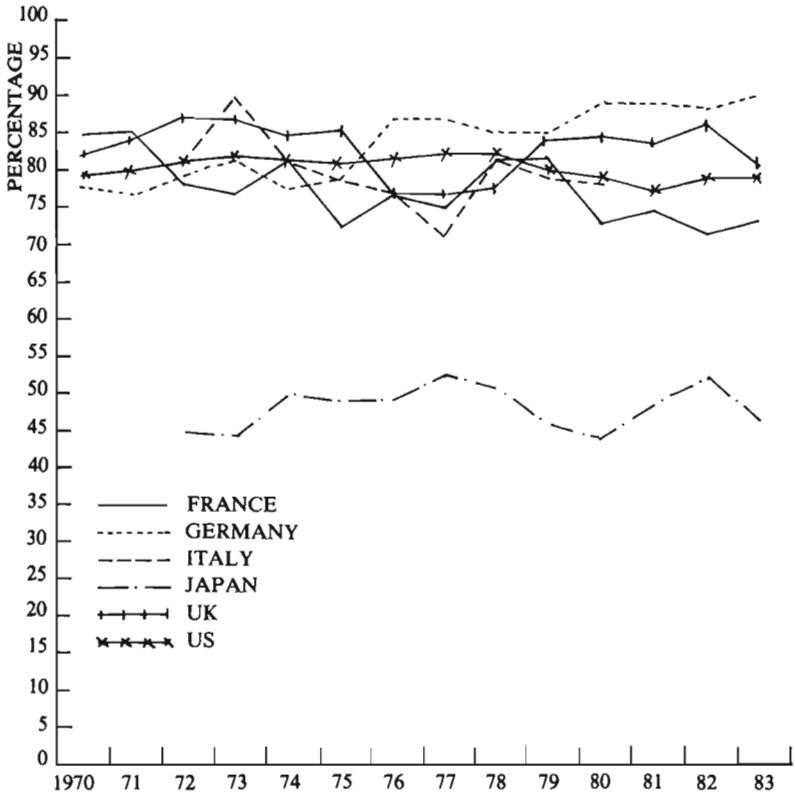
Research-intensive industries — often defined as 'high technology industries' — are involved in a significant share of international technology transactions. For many countries, this share is increasing as electronics, communications, information processing, aerospace and pharmaceutical industries are expanding internationally and have high rates of foreign investment and foreign co-operation. Canada, France, Japan and South Korea have tended to increase their technology transactions in research intensive industries, reflecting a structural shift towards increased purchases and sales of more advanced technologies. In other countries, including Australia, the trends are weaker, but there have been no major shifts toward technology transactions in less research-intensive industries in countries for which detailed data are available.

Geographical Distribution

Technology transactions for the United States, United Kingdom, France, Germany and Italy are mainly with other industrial countries, although there has been a slight downward trend in this share (see Figure 2). Payments by the countries listed in Table 1 decreased from 75 per cent to 70 per cent of their total receipts from 1975 to 1983 as payments from other countries — developing and OPEC — increased in importance. The pattern of technology transactions is similar to the pattern of foreign investment — three quarters of technology transactions is between industrial countries and about three quarters of total investment is in industrial countries. Japan is the exception to the rule. One half of Japan's technology exports goes to developing countries — mainly in Asia — and one half of Japan's foreign investment is also in these countries.

Figure 2

SHARE TOTAL TECHNOLOGY RECEIPTS FROM OECD COUNTRIES



Source: As for Figure 1.

A large share of technical assistance goes to developing countries. OPEC countries took a major share of technical services and assistance during the mid-1970s and after the second oil price rise, but this share has declined with the decline in oil revenues. Countries which have a less developed technological infrastructure also rely on foreign technical services and assistance either generally or selectively. France and Italy separately identify technical assistance as part of technology trade: technical assistance and know-how are imported

from other advanced countries and exported to developing countries. Advanced collaborative projects in aerospace and nuclear engineering are heavily involved in the international exchange of technical assistance and are important sources of international technology payments between industrialised countries.

Technology Transactions and Multinational Firms

Technology transactions are largely between associated firms linked by equity holdings (see Table 2). Payments of fees and royalties to the United States are predominately from affiliates to United States parents. These payments are usually to cover parent expenditures for R & D, organisation, administration and provision of business services. Payments to the United States:

- from Canada in 1982 were 94 per cent to affiliated (parent) firms, in 1983, 95 per cent;
- from Germany in 1982, 78 per cent, in 1983, 87 per cent to affiliated firms;
- from the UK in 1982, 89 per cent, in 1983, 87 per cent to affiliated firms.

Table 2

SHARE OF TOTAL ROYALTIES AND SIMILAR PAYMENTS TO RELATED FIRMS: MANUFACTURING INDUSTRY 1983

(percentages)

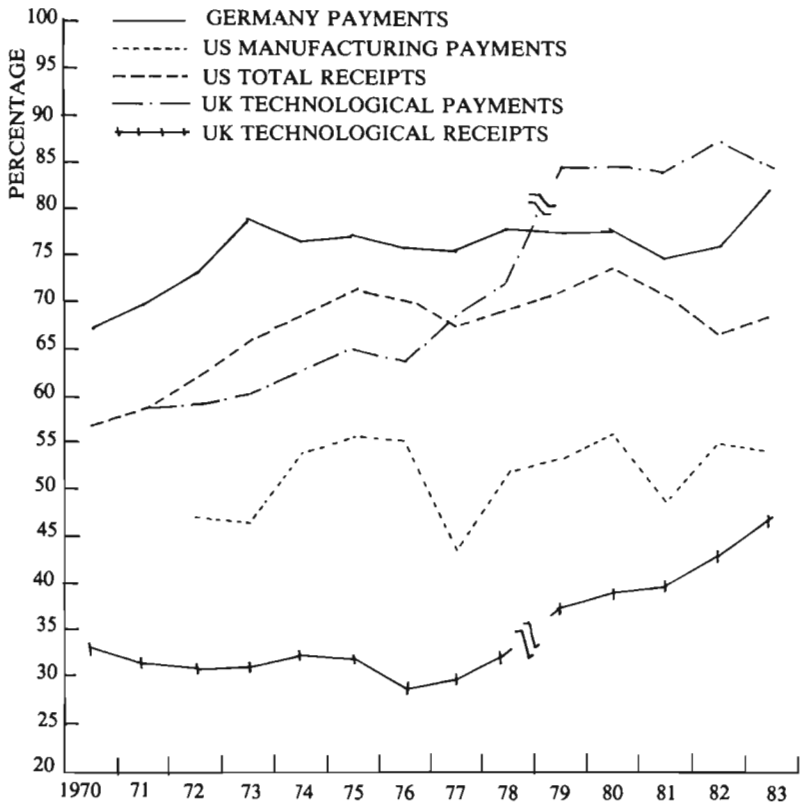
	Germany	UK		US
	Expenditure	Expenditure	Receipts	Receipts[1]
Chemicals and allied industries	69	91	50	82
Ferrous and non-ferrous metal industries	76	72	76	35
Mechanical engineering	38	93[2]	70[2]	93[3]
Transport equipment	25	8	21	76
Electrical engineering	97[3]	96[3]	91[3]	42
Precision instruments	71			
Food, drink, tobacco	94	83	79	
Other manufacturing	83	78	55	75
Total manufacturing	82	89	62	74

Source: Calculated by OECD from national sources.

Notes: 1. Includes management fees.
2. Includes precision instruments.
3. Includes data processing equipment.

Figure 3

ASSOCIATED FIRMS TECHNOLOGY TRADE AS PERCENTAGE OF TOTAL



Source: As for Figure 1.

Payments by United States firms to foreign firms are more evenly split between affiliated and unaffiliated firms, as are receipts of Australian and United Kingdom firms. Foreign payments by Japanese and Swedish firms are less influenced by affiliated transactions, reflecting relatively low levels of foreign direct investment in both countries.

Transactions between related firms are increasing in importance, although they fluctuated during the recessions of the mid-1970s and 1980-83 (see Figure 3). Interpretation of the upward trend in related

payments is not necessarily straightforward. Royalty and licence payments between independent firms are usually based on a fixed percentage of sales of the licensee, and these payments reflect real industrial activity by licensees. Payments between related firms may be sustained or climb when they are used to distribute profits or repatriate capital, or to take advantage of currency movements and taxation law — none of which necessarily reflects real industrial activity. However, the general trend since 1970 across three major countries suggests that equity links are becoming a more important basis for technology trade.

Research-intensive industries, such as electrical engineering, computers and electronics, are the most important source of payments between related firms. Firms usually operate through subsidiaries in research-intensive industries.[4] Despite this generalisation, in the chemical and transport industries the picture is mixed; payments to the United States are largely to parents, and both German and United Kingdom data suggest that independent licensing is important in transport equipment. Technology transactions between associated firms are also important in traditional industries dominated by multinational firms, notably the food, drink, tobacco and rubber products industries. Smaller firms in traditional industries, such as textiles and metal-working, are more likely to license their technology in foreign countries, particularly if the technology does not require extensive adaptation to foreign conditions and is not research-intensive.

Overall, the shift in international technology trade towards more research-intensive industries has favoured the internalisation of technology transactions, within the same firm or within related firms. This shift parallels the growth in international co-operative agreements, often involving joint ventures or minority equity investment.

RESEARCH AND DEVELOPMENT BY FOREIGN FIRMS

R & D performed by foreign firms plays an important role in adapting foreign technology to domestic markets and in contributing to domestic technological activity. R & D activities follow foreign direct investment — but with a lag. Countries which have a large stock of foreign direct investment and a high proportion of business activities controlled by foreign firms have a relatively large share of business R & D performed by foreign-controlled firms. In 1981, Australia, Canada and Ireland had between 40 and 50 per cent of their business enterprise R & D performed by foreign firms (see Table 3). Foreign-controlled R & D activities and adaptation to local conditions of technology developed by parent firms occupy a major share of private

sector research resources. Most other OECD countries have between 10 and 20 per cent of their R & D performed by foreign firms. Sweden and Japan both have a very low share of R & D performed by foreign firms, reflecting relatively low levels of foreign investment.

Table 3

R & D BY FOREIGN FIRMS AS A PERCENTAGE OF TOTAL BUSINESS ENTERPRISE R & D EXPENDITURES: ESTIMATES FOR VARIOUS YEARS

	Business enterprise R & D performed by		
	All foreign firms	US firms	
	1981	1966	1977
Australia	40 (1976-77)		38 (1976-77)
Canada	44	39	32
New Zealand			9
Belgium		13	13
Denmark			2
France	17 (1977)	4	7
Germany		9	6
Ireland	53		47
Italy		5	8
The Netherlands			5
United Kingdom	15	8	10 (1978)
Finland	3		
Norway			8
Sweden			2
Switzerland			5
Japan		0.3	0.5

Source: Foreign firm data: OECD. US firm data for 1966 from *Overseas Research and Development by United States Multinationals, 1966-1975,* The Conference Board, New York, 1976, Table 3-8, as percentage of total business enterprise R & D in 1967 from OECD. US firm data for 1977 from Department of Commerce, *US Direct Investment Abroad, 1977,* Washington DC. 1981, Table III.J7, as percentage of total business enterprise R & D in 1977 from OECD.

United States multinationals are the major performers of foreign-controlled R & D. The limited data available suggest that United States firms contribute at least half of R & D performed by foreign firms (compare the two sets of columns in Table 3). United States firms have also increased their foreign R & D. R & D by US foreign manufacturing affiliates rose from less than 5 per cent of parent R & D in 1966 to over 11 per cent in 1977, and the volume of US affiliate R & D has subsequently increased in real terms, though it declined in US$ terms.

Over half of R & D expenditures of United States affiliates are in France, Germany and the United Kingdom. Germany carries out the

largest share of this R & D. German subsidiaries are paid more for 'technological research and development' for foreign parent firms than all German-controlled firms receive from the sale of patents, inventions and processes. Scattered evidence suggests that R & D performed in the US by foreign firms is also increasing rapidly — particularly in chemicals — as foreign direct investment increases.

However, foreign research activities follow foreign direct investment only slowly. The share of parent firm R & D expenditures and R & D employment outside the home country is considerably lower than the share of sales, expenditures on plant and equipment, or employment. In 1977 US firms investing overseas had the equivalent of over one third of their domestic sales and employment outside the US, but only 10.7 per cent of parent R & D expenditure in manufacturing was spent by affiliates, and only 16.7 per cent of manufacturing R & D employment (R & D scientists and engineers) was outside the US (Table 4). The pattern was the same in all industries. Swedish multinational firms also concentrate their R & D activities and their fixed asset investments at home in Sweden, and investment is much more highly concentrated on marketing activities outside Sweden (Table 5). Parent firms tend to centralise R & D in home countries to capture economies of scale in research and to ensure the integration of research in their strategic development and management planning.

R & D Joint Ventures

There has been an upsurge in co-operative agreements, varying from joint ventures to research contracts, to develop and exploit new technologies. R & D-oriented agreements have been particularly noticeable in chemicals and pharmaceuticals, in the new materials and biotechnology sub-sectors, in electrical and electronic components and equipment, and in communications. These international co-operative agreements — often 'triangular' in that they involve firms from the US and Europe or Japan — are an important new element influencing international technology transfers.

In biotechnology and related areas based on fundamental scientific research, major firms are involved in numerous contract research arrangements with academic and medical research groups and specialised research enterprises. In electronics and communications, agreements are often between leading firms in related but different segments of these industries; they have pooled resources to keep pace with the rapid development of research and the potential for new but increasingly expensive product and system applications. R & D-oriented agreements are usually between United States companies and foreign partners, particularly where the foreign partner is attempting to boost technological performance. These agreements are

Table 4
PRODUCTION, EMPLOYMENT, CAPITAL EXPENDITURE AND R & D BY US FOREIGN AFFILIATES AS A PERCENTAGE OF US PARENT FIRM TOTALS: 1977

	Sales	Employment	Plant and equipment expenditure	R & D Expenditure	R & D Employment[1]
Chemicals	34.4	39.3	26.6	12.1	18.6
Machinery except electrical	37.0	35.3	53.7	5.0	16.3
Electric and electronic	32.6	53.8	26.0	14.0	23.8
Transport	30.0	33.3	21.5	12.4	12.1
Other	21.5	28.6	19.3	10.3	17.6
Manufacturing total	27.8	34.3	26.4	10.7	16.7
Total industry	38.2	30.7	27.7	11.1	15.5

Source: Calculated from Department of Commerce, *US Direct Investment Abroad, 1977,* Washington DC, April 1981.

Note: 1. R & D scientists and engineers.

Table 5
INVESTMENT BY SWEDISH MANUFACTURING GROUPS: 1978

	5 largest groups		37 largest groups	
	All group	Foreign subsidiaries only	All group	Foreign subsidiaries only
R & D	25	10	21	6
Machinery and buildings	45	41	52	42
Marketing	30	49	27	52
Total	100	100	100	100

Source: G. Eliasson, *Information Technology, Capital Structure and the Nature of Technical Change,* Industrial Institute for Economic and Social Research, Working Paper 138, 1985.

positively influenced by market size, national and firm-based technical skills and market access.[5] Agreements involving Japanese companies are often aimed at marketing or gaining market access.

There are few statistics and relatively little research literature on joint ventures and co-operative agreements. Joint ventures can range from loose agreements to co-operate through to the establishment of a new jointly owned enterprise on a permanent basis. Countries that

collect information have different definitions and sectoral coverage. Data that do exist understate the range and significance of the international research and technology-based joint ventures and co-operative agreements that have arisen in the last few years. The evolution and growth of new arrangements between firms places foreign direct investment in a different perspective. Two distinct but inter-related kinds of foreign investment are developing: there is a continuation of traditional methods of international expansion through 100 per cent owned subsidiaries, but this is coupled with the growth of a wide variety of flexible co-operative arrangements (joint ventures, research agreements, minority equity holdings in high technology firms), increasingly with a clear technology orientation or a clear and tightly defined market/sub-contracting relation.

FOREIGN DIRECT INVESTMENT

Foreign direct investment is an extremely important route for transferring developed technology between countries. However, the role of foreign-controlled firms and their contribution to the research and the technological development of host countries is a continuing source of policy debate. Interest in their performance and technological legacy has heightened as foreign investment in research-intensive industries has recently been the most dynamic element in international investment. But many factors will determine the development and transfer of technology by foreign firms — factors in the host country, the industry, and the firm. The level of foreign direct investment is an indication of technology transfer, but not a perfect proxy for it.

The Changing Structure of Investment Flows

The United States has been the most important destination for foreign direct investment flows since the mid-1970s, and the share of total investment going to the US increased dramatically from 1978 (see Table 6). More foreign direct investment went to the United States in the period 1982-84 than to all other OECD countries combined. In the same period, Canada, France, Germany, Japan, the Netherlands and the United Kingdom were each the source of more foreign direct investment than the United States. This is in marked contrast to the situation in the early 1970s when the United States, Germany and the United Kingdom were of equal importance as the major destinations for foreign direct investment, and the United States was by far the largest source. Such a complete change in long-term patterns of foreign direct investment requires explanation.

Direct investment inflows consist of two components:

- foreign investment where a foreign owner acquires or establishes a business in the host country; and
- inflows from established overseas affiliates to their parents, attributable either to dis-investment or movements on inter-company account and borrowing in foreign capital markets.

Both of these have contributed to the strong inflow of investment funds into the US, although inflows from overseas affiliates to parents have been very volatile. For example, in 1983 inter-company debt inflows to US parents from affiliates (mainly, but not entirely, offshore banking subsidiaries) were equivalent to 75 per cent of foreign investment flows into the United States: they were equivalent to only 35 per cent of foreign-owned flows in 1984.

There are three major reasons for the strong inflow of foreign direct investment into the US.

- Many European and Japanese firms have developed strong competitive positions in their industries, based on their technological, production and marketing abilities. They have expanded internationally on the basis of these strengths, particularly in the US. Adoption and assimilation of foreign technologies and techniques (for example, in automobiles, chemicals, steel, and electronics), spurred by strong competition from foreign firms, is helping to transform many US industries.
- Economic growth in the US has been very strong since 1982, improving the outlook for earnings and increasing the attractiveness of direct investment in the US. Corporate restructuring of US firms has in many cases involved the sale of operating units to foreign firms (acquisitions have been consistently higher than new establishments in the US).
- Access to a large, stable homogeneous market is a continuing attraction for foreign investment, as is investment to avoid potential trade restrictions.

Appreciation of the US$ did not markedly slow foreign investment inflows and acquisitions of US businesses. These continued strongly over the period 1980-1984, despite marked increases in the foreign purchase cost of US assets as the weighted value of the dollar rose 44 per cent relative to other currencies. Dollar-financed investment was less affected by currency appreciation and long-term investment is less prone to the effects of what may be only short-term currency fluctuations. Investment financed in foreign currencies has been more affected by currency appreciation. However, the mix of different types of investment has been sufficient to maintain vigorous foreign investment activity, and dollar appreciation did not apparently slow inflows into the US.

Table 6

INFLOWS AND OUTFLOWS OF FOREIGN DIRECT INVESTMENT: SELECTED OECD COUNTRIES

(millions of US $)

		Annual average 1971-1973	1977	1978	1979	1980	1981	1982	1983	1984	Annual average 1982-1984
Australia	Inflow	771	1,153	1,672	1,601	1,795	2,259	2,021	2,854	887	1,921
	Outflow	162	252	234	361	445	669	729	634	1,693	1,019
Austria	Inflow	88	124	158	191	240	318	206	220	117	181
	Outflow	33	85	84	84	101	206	150	186	67	134
Belgium	Inflow	519	1,116	1,295	1,006	1,453	1,352	1,390			1,398[(1)]
	Outflow	167	354	362	1,119	62	30	−77			5[(1)]
Canada	Inflow	791	447	118	640	684	−3,670	−810	162	1,660	337
	Outflow	468	696	2,038	2,178	2,694	5,756	872	2,414	2,934	2,073
Finland	Inflow	24	47	34	27	28	17	−14	16	54	19
	Outflow	45	73	63	125	131	142	234	261	413	303
France	Inflow	765	1,765	2,445	2,722	3,327	2,426	1,563	1,631	2,198	1,797
	Outflow	639	1,198	1,794	1,973	3,138	4,615	3,063	1,841	2,126	2,343
Germany	Inflow	1,682	969	1,728	1,742	424	341	837	1,601	1,164	1,201
	Outflow	1,422	2,206	3,605	4,493	4,081	3,885	2,485	3,167	3,103	2,918
Italy	Inflow	592	1,135	510	361	587	1,146	636	1,190	1,290	1,039
	Outflow	291	551	168	544	754	1,404	1,025	2,126	1,995	1,715

		Annual average 1971-1973	1977	1978	1979	1980	1981	1982	1983	1984	Annual average 1982-1984
Japan	Inflow	112	21	8	239	278	189	439	416	−10	282
	Outflow	996	1,645	2,371	2,898	2,385	4,894	4,540	3,612	5,695	4,616
Netherlands	Inflow	680	357	667	1,287	1,959	482	489	697	159	448
	Outflow	713	1,513	1,747	2,348	3,208	3,290	1,984	1,683	2,609	2,092
Norway	Inflow	141	771	490	400	59	686	424	334	−181	192
	Outflow	27	125	64	44	254	184	316	358	542	405
Spain	Inflow	293	304	606	810	926	918	958	800	917	892
	Outflow	54	142	133	189	257	182	446	183	188	272
Sweden	Inflow	71	81	69	111	249	181	183	55	149	129
	Outflow	245	738	418	606	626	854	916	1,057	1,053	1,009
United Kingdom	Inflow	1,306	2,313	2,419	3,686	5,907	1,969	1,876	3,327	3,261	2,821
	Outflow	2,488	3,288	5,198	6,430	7,853	9,385	3,923	4,849	2,520	3,764
United States	Inflow	1,372	3,728	7,896	11,876	16,892	25,190	13,800	11,960	22,530	16,100
	Outflow	8,906	11,891	16,057	26,223	19,222	9,624	−4,420	5,400	4,500	1,826

Source: OECD.

Note: 1. 1980-82.

'−' sign on inflow is an outflow; '−' on outflow is an inflow.

Overall there has been a rapid increase in the application of foreign technology, techniques of organising production and marketing skills associated with foreign direct investment in the US, modifying the nature of competition and performance in the US domestic market. There has also been a sharp decline in outflows of US direct investment; and in some cases there have been inflows from foreign subsidiaries to US parents. The inflow from US subsidiaries (or decreased outflows to them) is influenced by growth prospects in the US relative to other countries, but relatively high interest rates and appreciation of the dollar are probably equally important in influencing movements on inter-company accounts. By the end of the 1970s, US enterprises had established a worldwide network of foreign operating subsidiaries and financial intermediaries. When interest rates and currency movements favoured the US, the outflow to affiliates declined. High real interest rates in the US from 1980-81 relative to the average in other major investing countries, although not the only factor, coincided with sustained reductions in outflows from US parents to foreign affiliates — and a net inflow from subsidiaries in 1982.

These changes may suggest a relative slowdown in the transfer of US technology to other countries. However, foreign direct investment flows do not necessarily mirror transfer of technology and in many cases other sources of funds (for example, local borrowing) have been used to finance relatively stable levels of investment, research and industrial activity by US firms in foreign countries.

The accumulated stock of foreign investment has adjusted more slowly to changes in the patterns of foreign direct investment flows. The stock of foreign direct investment in the US has increased, while the relative share of US accumulated investment in other countries has declined. The share of United States outward foreign investment stock in the total outward foreign investment stock held by four major countries (Germany, Japan, UK, US) declined from 61 to 55 per cent in the period 1978-1982, while the share of the United States in the total inward investment stock of these four countries rose sharply from 37 to 57 per cent of the total in the same period.

More than three quarters of foreign direct investment goes to industrial countries. Industrial countries are the source of around 90 per cent of investment, and the source of an even larger share of investment in manufacturing. OPEC countries have purchased industrial assets in many OECD countries and are the principle non-OECD investors. Offshore investment centres and international holding companies also affect analysis of origins and destinations of foreign direct investment. Higher shares of investment originate in, and go to, industrial countries, if investment funds passing through offshore investment centres, such as Panama and the Netherlands Antilles, are attributed to their original sources and final destinations.

Foreign direct investment has grown rapidly in the industrialising countries in Asia. They are now the most important destinations of foreign investment in developing countries. There has been a strong inflow (particularly since 1983 in electroncis and related industries) to countries with relatively liberal foreign investment regimes, including Malaysia, Singapore and Taiwan; and into Korea, which has liberalised its treatment of foreign investment. Foreign investment in Latin America has declined sharply, along with aggregate capital formation in Latin America. These economies have deflated domestically, sharply reducing total domestic demand, and have cut imports and boosted exports in response to external indebtedness. Foreign investment in Latin America is generally going through a period of rationalisation and restructuring in response to these pressures. There is also scattered evidence that investment to take advantage of low wages in assembly operations has been particularly mobile — sensitive to relative wage levels, automation of some assembly operations (electronics, for example), and international competition.

Employment in Foreign Affiliates

Foreign affiliates generally maintained or expanded employment and company capital expenditures during the 1980-1983 recession. These data give a better picture of foreign direct investment activity than international flows of foreign investment derived from the balance of payments, particularly in recent years, when international capital flows have been very unstable.

Table 7
EMPLOYMENT IN FOREIGN SUBSIDIARIES
(thousand employees)

	Japan			Germany		
	1973	1983	Growth (%)	1976	1982	Growth (%)
Subsidiaries in:						
Asia	206	413	7.2	75	114	7.2
North America	22	112	17.7	89	373	27.0
Europe	11	59	18.6	628	718	2.3
Rest of world	82	275	12.9	322	570	10.0
World	320	860	10.4	1204	1685	5.8
Share of employment in manufacturing	80%	79%	10.3	77%	74%	5.1

Source: MITI, *White Paper on International Trade; Monthly Report of the Deutsche Bundesbank.*

Employment associated with German and Japanese foreign subsidiaries has risen rapidly. By 1982/1983 their combined foreign employment was over 2.5 million. Three quarters of this employment was in manufacturing (Table 7). However, almost half of Japanese foreign employment was still in Asia, whereas 65 per cent of German foreign employment was in Europe and North America. In both cases the share of employment in North America has increased sharply, and employment in European affiliates of Japanese firms has also increased. Employment in foreign affiliates of US firms was almost 5.5 million in 1977, with almost three quarters in manufacturing. Of total employment in US affiliates, 64 per cent was in Canada and Europe (17 and 47 per cent respectively), and in manufacturing 67 per cent was in Canada and Europe. Swedish industrial firms have around 285,000 employees in foreign countries; this is about 30 per cent of the combined domestic and foreign employment in Swedish firms.

The share of total manufacturing employment in foreign firms is now at least 10 per cent in most OECD countries. In the United States, where employment in foreign firms has been low, it almost doubled from 3.6 per cent of all manufacturing employment in 1977 to 7.0 per cent in 1982; by the end of 1982, almost 2.5 million people were employed by foreign firms, 50 per cent in manufacturing. Employment in foreign firms is particularly high in electronics and data-processing (around 60 per cent of total employment in the manufacture of data-processing equipment in France and Germany), and in the chemicals industry (where it makes up at least one quarter of total employment in France, Germany, Ireland, United Kingdom and the United States) (Table 8).

Foreign direct investment in manufacturing is concentrated in research-intensive manufacturing industries such as electrical and mechanical engineering, chemicals, transport equipment. Chemicals is the most important industry in terms of foreign manufacturing investment. For example, the foreign capacity of the German chemical industry is about three quarters of the total size of domestic capacity, mechanical engineering about 40 per cent, electrical engineering about 25 per cent. Electronics, electrical and mechanical engineering have grown rapidly, particularly in the case of Japanese investment. These industries expanded during the recession, unlike many other industries.

The relative importance of foreign investment in more advanced, research-intensive industries has increased in most OECD countries. Large European, Japanese and United States firms are internationalising and rationalising worldwide operations. In industrialised countries, technology is applied rapidly in subsidiaries, the rate of application has increased, and the rate of diffusion of advanced international production (for example, in electronics) is

Table 8

EMPLOYMENT BY FOREIGN-OWNED ENTERPRISES AS A PERCENTAGE OF NATIONAL EMPLOYMENT IN SELECTED COUNTRIES

France	**1974**	**1982**	**Sweden**	**1983**
Chemicals	34.3	37.5	Food	13.0
Electrical machinery	16.9	24.2	Chemicals	13.7
Precision machinery	22.3	30.7	Non-metallic minerals	12.5
Information processing equipment	68.4	65.3	Engineering	7.8
All industry	16.4	17.0	All manufacturing	7.5
Germany	**1980**	**1983**	**United Kingdom**	**1981**
Chemicals and related[1]	24.8	23.9	Chemicals	30.8
Mechanical engineering	14.2	13.0	Mechanical engineering	19.8
Electrical engineering	18.6	20.3	Office and data processing	38.2
Data processing	49.6	59.4	Electrical and electronic	21.4
Motor vehicles	18.1	18.6	Motor vehicles	36.1
All manufacturing	16.6	16.1	Food, drink, tobacco	11.1
			All manufacturing	14.9
Ireland	**1973**	**1983**	**United States**	**1977** **1982**
Food, drink, tobacco	19.5	18.6	Food and related	4.6 8.1
Chemicals	52.0	65.1	Chemicals[2]	16.9 43.2
Metals and engineering	46.5	57.9	Metals	2.9 4.8
All industry	26.7	36.3	Machinery	2.2 5.7
			Electrical and electronic	4.7 8.0
Japan	**FY 1984**		Transport equipment	0.1 3.9
Manufacturing (excl. petrol)	0.9		All manufacturing	3.6 7.0

Source: Calculated by OECD from national sources.

Notes: 1. Includes oil refining, plastics and rubber products.
2. Excludes petroleum refineries, petroleum and coal products, rubber and plastic products. Data for 1977 incomplete.

extremely rapid.[6] The predominance of foreign investment in research-intensive industries, and in research- and technology-intensive firms within each industry, raises important policy issues. The structure and nature of concentration in high technology industries, and the tendency towards greater informal concentration through networks of international co-operation agreements and minority equity investment, are influential forces modifying technology transfer associated with direct investment.

SUMMARY

This paper has briefly reviewed international technology transfer by examining aggregate statistical data describing three technology

transfer routes: technology trade in patents, licences and technical know-how; R & D by foreign firms; and foreign direct investment. Technology trade in patents, licences and technical know-how has increased steadily in volume, but it is heavily — and increasingly — influenced by transactions between related firms. Nevertheless, manufacturing production under licence by independent firms is probably worth between 7 and 10 per cent of total production by foreign subsidiaries. The shift towards an increasing share of technology trade taking place between related firms is most noticeable in research-intensive industries, which are also taking a greater share of this trade. R & D performed by foreign firms has steadily increased, although it continues to lag behind the share of employment or output of foreign subsidiaries. The pattern of location of research and technological development is also being influenced by the increasing array of international collaboration agreements and joint ventures in research. The importance, durability and effects of these agreements and ventures are not yet clear. Finally, foreign direct investment has continued to expand in most countries, most importantly in chemicals, which is the most highly internationalised broad industry grouping, and in electronics and related industries.

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2. For a good example of this approach, see Farok J. Contractor, *International Technology Licensing,* Lexington Books, Lexington, Mass., 1981.
3. Howard Davies and Neil Rosser, 'International trade in technology: a survey' in Julian Lowe and Nick Crawford (eds.), *Innovation and Technology Transfer for the Growing Firm,* Pergamon, Oxford, 1984, pp. 187-209.
4. Piero Telesio, *Technology Licensing and Multinational Enterprises,* Praeger, New York, 1979. Note, however, that Telesio found that companies which spend a larger percentage of sales on R & D have greater returns to licensing (average returns are higher), and that diversified firms are more likely to license.
5. Karen J. Hladik, *International Joint Ventures,* Lexington Books, Lexington, Mass., 1985. This work found that by 1982 about 20 per cent of newly formed US-foreign joint ventures were involved in some kind of collaborative R & D activity, and that collaborative R & D had risen sharply. Furthermore, electric and electronic equipment accounted for a rising share of all joint ventures (chemicals were the most important) and US-Japan joint ventures were the most common.
6. There is also some evidence that technology is being transferred to foreign subsidiaries more rapidly than in the past. See, for example, Edwin Mansfield *et al.,* 'New findings in technology transfer, productivity and economic policy', *Research Management,* 26, 2, 1983, pp. 11-20.