THE TRANSFER OF TECHNOLOGY AND THE TECHNOLOGICAL GAP BETWEEN DEVELOPED AND LESS DEVELOPED COUNTRIES

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ABSTRACT

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The Transfer of Technology and the Technological Gap Between Developed Countries and Less Developed Countries

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The problem that will be discussed in this study is that the process of transferring technology from developed countries to less developed countries is so inefficient that it tends to widen the existing tachnological gap between them.

An attempt is made by the writer to examine the process of transferring technology from developed countries to less developed countries, in order to see whether such transfer will narrow the technological gap between them or not.

The result obtained from this study is that technology transfer is a very important condition for the industrial development in less developed countries. However, technology transfer from developed countries to less developed countries has been accompanied by many restrictions and limitations. Such action will never result in an increase of technological capabilities of less developed countries and will keep the technological gap continually wide between them and the developed

countries.

The main sources of information were the United Nations Documents on Transfer of Technology. Many books, journals and periodicals were also used as references.

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INTRODUCTION

The transfer of technology from developed to less developed countries is one way of accelerating the rate of economic growth of the latter while also bringing about rapid improvement of their social and economic structure. In recent years, there has been increasing concern by less developed countries (LDCs) that the process of the transfer of technology is very inefficient and has been left to the prevailing market forces. This tends to accentuate rather than alleviate some aspects of underdevelopment.

The less developed countries argue that they do not share fairly modern technology with developed countries (DCs). Thus, the technological level in LDCs has been deteriorating while it continues to improve in developed countries. At the same time, DCs have acquired a monopoly over research and development (R&D).

Multinational corporations (MNCs) are the primary vehicle for transferring technology to poor countries. Such firms, some 500 to 700 in total, mainly American, now account for the bulk of the direct investment, production, trade, finance and technology of the non-socialist world.

About 250 to 300 MNCs account for over 70 percent of total U.S. foreign investment, about 165 for 80 percent of that of the United Kingdom, and 82 for over 70 percent

of West Germany.[1] LDCs argue that MNCs have already set in motion a process of industrialization highly similar to that found in the advanced nations of the West. This industrialization is not only similar in terms of the output of industry (caputal goods and private consumption goods), but also in terms of the mechanical technology and human technical skills needed for its implementations.[2] LDCs consider this process of transferring technology as so inefficient that it tends to widen the existing technological gap between them and DCs. This argument is based on real experiences of LDCs. The technology transferred to LDCs has been accompanied by many restrictions and high prices. LDCs took those issues to the United Nations seeking solutions. The United Nations Conference on Trade and Development (UNCTAD) is moving in a positive direction toward resolving some of the obstacles surrounding that problem.

Purpose of This Thesis

This thesis proposes to examine the validity of LDCs accusation against DCs. This accusation states that, the less developed countries have not been given much access to the modern technology of DCs mainly because of the restrictive business practices that are associated with the transfer of

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[1]Sanjaya Lall, "Multinationals and Development: A New Look," Westminister Bank Quarterly Review (February 1975), p. 57.

[2]Charles K. Wilber, Ed., The Political Economy of Development and Underdevelopments: MNCs and the Underdevelopment of Third World, R. Muler (New York: Random House, 1978), p. 153.

technology to LDCs. As a result, LDCs have not been able to establish the technological capability that will enable them to solve many of their development problems.

Assuming that these accusations by LDCs are valid, then we may ask whether such restrictive practices are coincidental or the intended policies of DCs. If these policies are not coincidental, then what is the gain to DCs and what are their motives for undertaking such restrictive practices? Are there other practices by DCs that contribute to the widening of the technological gap between DCs and LDCs? These are the questions that will be addressed in this study.

The study is divided into four chapters. The first chapter attempts to explain the technological gap that exists between DCs and LDCs in terms of the technological endowment available to the two sides. It also emphasizes the role of technology in trade and development. The second chapter examines closely the restrictive practices of DCs in the area of transferring technology to LDCs and the unfavorable terms that are associated with such transfer. The third chapter is concerned with the phenomenon of "reverse transfer of technology" or "brain drain" and its impact on the industrial development in LDCs. The fourth chapter attempts to confirm the LDCs allegation against DCs in the area of technology transfer through the Neo-technology Hypothesis of the Pattern of International trade, and the model of the product-cycle.

CHAPTER 1

THE ROLE OF TECHNOLOGY IN TRADE AND DEVELOPMENT

R&D and Trade

It is a fact that technology can help promote economic and social growth in the LDCs. It is also a fact that technology has been the instrument for economic growth in the DCs. The economic growth of industrialized countries has depended to a great extent on technological innovation backed by R&D and capital investment. In LDCs, R&D has played a much smaller role. This is mainly due to lack of money, knowledge, and almost non-availability of scientific research facilities. Also, the opportunities for industrial or agricultural improvement is not enough to ensure economic progress.

Table 1 shows that in 1976 the expenditure on R&D in some of the DCs was 1.2 percent of GNP. LDCs, on the other hand, had a much lower expenditure on R&D. Asia had 0.3 percent and Latin America 0.2 percent of their expenditure on R&D. The number of technicians engaged in R&D per 10,000 population was much lower in LDCs. It was 8.2 in some DCs while Africa had 0.4 percent, Asia 0.6 percent and Latin America 1.4 percent.

The R&D expenditure is also reflected in the trade balance of manufactured goods. The more the country spends on

TABLE 1

TECHNOLOGICAL DEPENDENCE: SELECTED SOCIO-ECONOMIC INDICATORS (Averages expressed as medians for 1976 or latest year available)

		Developed market economy countries[a/]	Developing countries and territories		
			Africa[b/]	Asia[c/]	Latin America[d/]
I.	SCIENCE AND TECHNOLOGY				
(i)	Ratio of total stock of scientists and engineers per 10,000 pop.	112	5.8	22.0	69
(ii)	Ratio of technicians per 10,000	142.3	8.3	23.4	72.2
(iii)	Scientists and engineers engaged in R & D per 10,000 pop.	10.4	0.35	1.6	1.15
(iv)	Technicians engaged in R & D per 10,000 pop.	8.2	0.4	0.6	1.4
(v)	Expenditures on R & D as percentage of GNP	1.2	0.6	0.3	0.2
II.	HIGH LEVEL MANPOWER				
(vi)	Professionals and technicians as percentage of economically active pop.	11.1	...	2.7	5.7
(vii)	Percentage of the economically active population employed in manufacturing sector	25.4	3.5	10.5	14.1
(viii)	Literacy rates (percent)	96[e/]	High[r/] 20	Low[f/] 15 32	77
(ix)	Ratio of primary and secondary enrollment to school age population	92[e/]	32	56	78

Sources: (1) - (iv): UNESCO, Statistical Yearbook, 1973, table 8.3; and United Nations, Statistical Yearbook, 1974, table 199.

(iv) and (vv): ILO, Yearbook of Statistics, 1974, tables 2A and 2B.

(viii) and (ix): Handbook of International Trade and Development Statistics, supplement for 1973, table 6.8.

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

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

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

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

e/ Includes Greece and Turkey.

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

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

R&D, the better the trade balance on manufactured goods will be. For example, in the period of 1963-1969, the U.S.A. had a significant and positive relationship between its exports performance and the intensity of R&D in its industries. This positive relationship has been noticed by Mr. Thomas C. Lowinger within his empirical work.[3] He sets a framework for multiple regression analysis to test the effect of the technology factor (R&D) on the commodity composition of U.S. trade

[3]Thomas C. Lowinger, "The Technology Factor and Export Performance of U.S. Manufacturing Industries," Economic Inquiry 13 (2) (June 1975):221-236.

in five major industries.[4] His general regression equation is $X = B + RD_a + W + TF + ES$.

This regression employs two measures of U.S. export performance.

a) X_1 - U.S. industries export shares in "world" market during a recent time period (1963-1969); see table 2.

b) X_2 - changes in U.S. industries relative export shares over time (1963-1969); see table 3.

RDa - Scientists and engineers engaged in research and development as a percentage of industry's total employment 1967-1969.

ES - Economics of scale variable; it relates productivity changes to increases in the size of establishment.

W - Ratio of wages and salaries of all employees industry's value added, 1967-69.

TF - Export weighted average of foreign tariff rate on the industry's products.

Tables 1 and 2 show the results of the multiple regressions. It turns out that there is a positive relationship between the U.S. export performance (X_1,X_2) and RDa. On the whole, the technological intensity variable (RDa) turns out to be the single most potent explanatory variable of U.S. industries revealed comparative advantage.

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[4]The industries covered in his study were aircraft, chemicals, electrical equipment, communication instrument, and machinery.

TABLE 2

REGRESSION EQUATIONS USING RD_A AS PRINCIPAL EXPLANATORY VARIABLE OF U. S. EXPORT PERFORMANCE (X_1)

Eq.	Dependent Variable	Independent Variables Coefficients					Summary Statistics		
		Const.	RD_A	W	T_F	E_S	R^2	S.E.	D.W.
1	X_1 =	.078 (2.975)**	.054 (6.463)**				.731	.069	1.8485
2	X_1 =	-.070 (1.073)**	.055 (7.538)**	.329 (2.417)*			.800	.059	2.0103
3	X_1 =	-.037 (.536)	.054 (8.861)**	.436 (3.308)**	-.009 (2.563)*		.871	.049	2.3468
4	X_1 =	.230 (5.650)**	.058 (10.188)**		-.010 (2.841)**		.891	.045	2.1209
5	X_1 =	-.012 (.166)	.041 (3.625)**	.212 (1.402)		.495 (1.519)+	.818	.057	2.0799

Definition of variables for Tables 1, 2, and 3.

X_1 = U.S. industries export shares of "world" trade, 1968-70

X_2 = Changes in the relative export share of U.S. industries, 1960-62 to 1968-70.

RD_A = Scientists and Engineers engaged in R&D as a percentage of total employment, 1967-69.

W = Ratio of wages and salaries of all employees in industry value added, 1967-69.

E_S = Economies of scale variable taken from Huffauer (1970, pp. 212-20).

T_F = Export weighted averages of foreign tariff rate on the industry products.

Notes: Numbers in parentheses are "t" coefficients. + — indicates 90 percent level of significance. * — indicates 95 percent level of significance. ** — indicates 99 percent level of significance.

TABLE 3

REGRESSION EQUATIONS USING RD_A AS PRINCIPAL EXPLANATORY VARIABLE OF U.S. EXPORT PERFORMANCE (X_2)[a]

Eq. No.	Dependent Variable	Const.	RD_A	W	NW	T_F	E_S	Summary Statistics R^2	S.E.	D.W.
1	X_2 =	.435 (2.114)*	.262 (3.996)*					.500	.543	2.1119
2	X_2 =	-.718 (1.395)*	.264 (4.658)**	2.553 (2.388)*				.625	.470	2.2499
3	X_2 =	-.260 (.500)	.251 (5.647)**	3.240 (3.331)**		-.091 (3.170)**		.783	.364	2.1912
4	X_2 =	1.734 (5.852)**	.291 (6.935)**		-.055 (3.988)**	-.092 (3.553)**		.822	.330	1.7037
5	X_2 =	-.174 (.315)	.137 (.617)+	1.456 (1.280)			4.631 (1.887)*	.687	.429	2.3358

[a]For definitions of variables see TABLE 1. Sources for table 2,1: Trade: OECD, Trade by Commodities. Series B (various years). Tariffs: The weighted average foreign tariff rates were obtained from Treasury Department study. The foreign countries included were the Group-of-Ten. The average foreign protection was computed from post-Kennedy round tariffs. Cline and Hays (1973, Data Appendix). Research and Development: R&D is defined as "Basic and applied research in the Sciences and Engineering, and the design and development of prototypes and processes." National Science Foundation, Research and Development in Industry, 1970, Washington, D.C., 1972. Other Characteristics: U.S. Department of Commerce, Annual Survey of Manufacturers, 1970, Washington, D.C., U.S. Bureau of the Census, Census of Manufactures 1967, Vol. 1. Washington, D.C., 1971.

Source: Thomas C. Lowinger, "The Technology Factor and the Export Performance of U.S. Manufacturing Industries," Economic Inquiry (June 1975):230-231.

The coefficient of determination (R^2) ranges from .731-.891 in table 2, and .5-822 in table 3.

The combined trade surplus of U.S. five technology intensive industries rose from $7.7 billion to $11.1 billion during the period 1963-69.[5] At the same period of time, the trade deficit of all other manufacturing industries grew from $1.0 billion to $7.5 billion (see figure 1).

Let us now see the LDCs R&D capability in terms of numbers of scientists and engineers compared to DCs. In 1976, the number of scientists and engineers engaged in R&D was 10.4 per 10,000 population in DCs while in LDCs the number was only 3.7 per 10,000 population (see table 1). As a result the composition of LDCs world trade looked like this; the LDCs are the main supplier of raw and semi-raw materials to DCs, and they imported almost all of their manufactured goods. Table 4 analyzes the exports and imports of DCs and LDCs for 1976, dividing them by categories of goods. In 1976 LDCs exports consisted of 81.2 percent of raw or semi-raw materials. Their export of manufactured goods amounted to 18.5 percent. The import of manufactured good was estimated to 65.9 percent.

The thesis of Gruber, Mehta, and Vernon, (G-M-V) is that, "All roads lead to a link between export performance and R&D." The supportive evidence of this thesis derives from an

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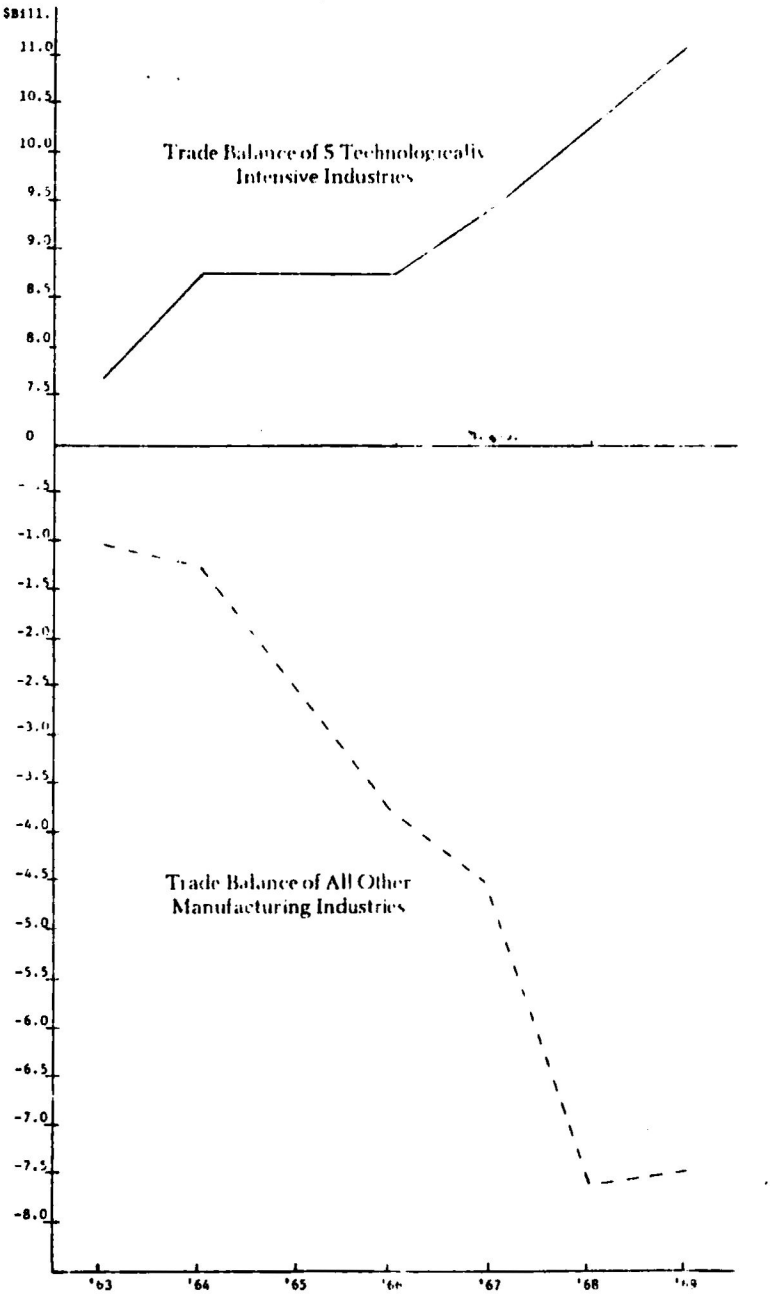
[5] Ibid., p. 221.

[6] W. Gruber, D. Mehta, and R. Vernon, The R&D Factor in International Trade and International Investment of United States Industries," Journal of Political Economy (February 1967).

Figure 1

Figure 1. Trade Balance of Five Technologically Intensive Industries* and All Other Manufacturing Industries' Trade Balance, 1963-69



*Includes: Aircraft (SIC 372); Chemicals (SIC 28); Electrical equipment and communication (SIC 36); Instruments (SIC 38) and Machinery (SIC 35).

Source: U.S., Department of Commerce, *U.S. Commodity Exports and Imports as Related to Output*, Washington, D.C. (various years).

TABLE 4

COMPOSITION OF WORLD EXPORTS AND IMPORTS, BY GROUPS OF COUNTRIES, 1976 (percentages)

	Developed Market Economies	Developing Market Economies	Centrally Market Economies	World
		E X P O R T S		
Primary Products	22.9	81.2	37.0	39.2
Food, beverages and toabcco	10.8	13.5	9.4	11.3
Crude materials (excluding fuels), oils and fats	7.1	8.7	8.8	7.7
Mineral fuels and related materials	5.0	59.0	18.8	20.2
Manufactured Products	75.7	18.5	56.5	59.2
Chemicals	9.4	1.4	4.8	6.9
Machinery and transport equipment	37.7	3.7	29.3	28.2
Other manufactured goods	28.6	13.4	22.4	24.1
Miscellaneous	1.4	0.3	6.5	1.6
Total	100.0	100.0	100.0	100.0
		I M P O R T S		
Primary Products	42.3	31.0	30.6	39.2
Food, beverages, and tobacco	11.3	10.4	13.5	11.3
Crude materials (excluding fuels); oils and fats	8.5	4.7	7.8	7.7
Mineral fuels and related materials	22.5	15.9	9.3	20.2
Manufactured Products	56.3	65.9	66.3	59.2
Chemicals	6.8	7.4	6.5	6.9
Machinery and transport equipment	24.5	37.0	34.1	28.2
Other manufactured goods	25.0	21.5	25.7	24.1
Miscellaneous	1.4	3.1	3.1	1.6
Total	100.0	100.0	100.0	100.0

World import figures include certain imports, which, because their regions of destination could not be determined, are not otherwise included in the import figures in this table.

NOTE: Data do not include trade among the centrally planned economies of Asis, the export of Rhodesia, or the trade between the Federal Republic of Germany and the German Democratic Republic.

Source: Based on data from United Nations, Monthly Bulletin of Statistics, vol. 32, no. 6 (June 1978), Special Table F.

examination of the 1962 trade performance of nineteen United States industries. In summarizing their results, the authors observe, "In sum, one derives an evidence of high research effort being correlated with industries that experience a great trade surplus.... It is in these industries that the U.S. trade advantage lies.[7]

Keesing's thesis is similar to that of G-M-V, "This article tests the hypothesis that R&D activity is associated with American competitive ability in manufacturing industries ...."[8] There turns out to be a powerful relation between the intensity of R&D activity in U.S. industries and their export performance. This finding is consistent with a view that the world economic role of the U.S. involved the systematic export of new products.[9]

Primary Commodities and LDCs

There is tremendous price fluctuation for primary commodities as opposed to that of manufacturing commodities which leads to the unfavorable terms of trade for LDCs. One reason for the declining price of primary commodities is that DCs and LDCs have competitive interests in the grain production. The increasing technology in grain production (rice, wheat and oil seed) by the U.S., Canada and Australia could be cited as a

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[7]Ibid., p. 30.

[8]D. B. Keesing, "The Impact of Research and Development on United States Trade," Journal of Political Economy (February 1967).

[9]Ibid., p. 39.

TABLE 5

RESEARCH INTENSITY AND WORLD TRADE PERFORMANCE BY UNITED STATES' INDUSTRIES, 1962
(Spearman Rank Correlation Coefficient for Indicated Cell)

Export Performance Measure	R_1	R_2
Total Trade of U.S. Industries		
E_1	0.69	0.74
E_2	0.79	0.69
Trade of U.S. Industries with Europe		
E_1	0.63	0.65
E_2	0.35*	0.48
Trade of U.S. Industries with Non-Europe		
E_1	0.73	0.74
E_2	0.78	0.67
U.S. World Exports in 1962 as a Percentage of World Exports of:		
OECD countries	0.68	0.64
U.K.	0.28*	0.37
West Germany	0.08*	0.24*
France	0.60	0.59

Source: G-M-V, op. cit., Table 3, Table 5.

E_1: Exports as a percentage of sales, 1962.
E_2: Excess of exports over imports as a percentage of sales, 1962.

R_1: Total R&D expenditures as a percentage of sales, 1962.
R_2: Scientists and engineers in R&D as a percentage of total industry employment, 1962.

*: These coefficients are not significant at the 5 percent probability level.

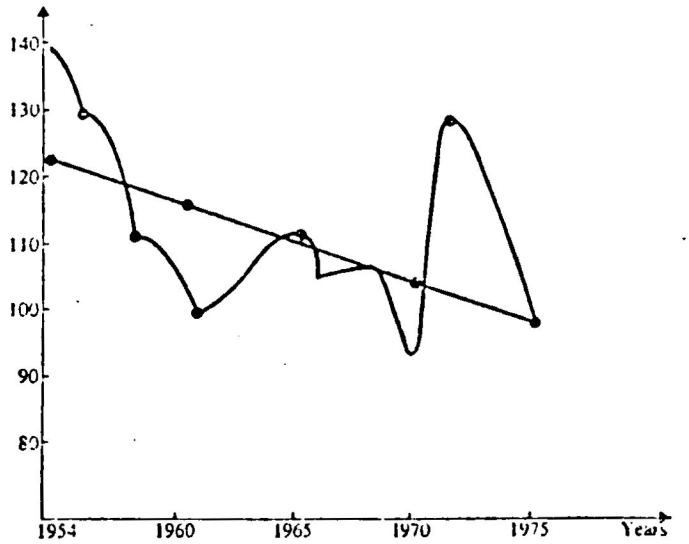
major reason.

Table 6 shows the prices of fifteen major primary commodity exports of developing market economies for the period 1973-1977 (annual and quarterly). It also demonstrates the fluctuation in these prices. For example, the prices of sugar in 1973 was 13 cents/lb., by 1974 it had increased to 34 cents/lb., by 1973 it had declined to 20 cents/lb., in 1976 it had declined to 12 cents/lb., then by 1977 it had declined also to 8 cents/lb. That is just one example.

Figure 2 shows the terms of trade for primary commodities of LDCs for 1954-1975 and the fluctuation that is associated with it. The price fluctuation has a direct effect on

FIGURE 2

World Bank Index of the Terms of Trade of Primary Commodities, 1954-1975



Source: Jere R. Behrnan, Development, the International Economic Order, and Commodity Agreements (Reading: Addison-Wesley Company), 1978, p. 48.

TABLE 6

PRICES OF FIFTEEN MAJOR PRIMARY COMMODITY EXPORTS OF DEVELOPING MARKET ECONOMIES, 1973-1977 (annual and quarterly)

Fifteen Major Exports	1973	1974	1975	1976	1977	1976 (iii)	1976 (iv)	1977 (i)	1977 (ii)	1977 (iii)	1977 (iv)
Petroleum[2] ($/barrel)	2.7	9.8	10.7	11.5	12.4	11.5	11.5	12.1	12.1	12.7	12.7
Sugar[3] (cents/lb.)	13	34	20	12	8	11	8	9	7	9	7
Coffee[4] (cents/lb.)	63	68	71	140	243	159	189	254	297	217	203
Copper[5] (cents/lb.)	81	93	56	64	59	70	58	66	62	55	55
Timber[6] (logs) ($/m^3)	81	83	74	99	112	104	111	115	114	110	107
Cotton[7] (cents/lb.)	59	63	54	76	70	83	83	80	78	63	59
Natural Rubber[8] (cents/lb.)	33	36	28	38	39	38	40	39	38	39	41
Iron Ore[9] ($ met. ton)	17	20	23	22	22	22	22	22	22	21	22
Cocoa[10] (cents/lb.)	65	98	75	110	220	117	149	192	120	248	229
Phosphate Rock[11] ($/met. ton)	14	55	67	36	31	35	35	34	31	29	29
Tin[12] (cents/lb.)	220	375	318	354	503	381	381	644	454	512	582
Maize[13] ($ met. ton)	99	132	120	112	95	118	103	110	100	80	91
Rice[14] ($ met. ton)	350	542	363	254	272	250	262	259	258	274	298
Beef[15] (cents/lb.)	n/a	n/a	28	33	35	n/a	33	37	35	32	35
Tea[16] (cents/lb.)	48	64	63	70	122	76	77	120	163	108	97

[1] Ranked by average value of exports in 1973-1975 period.
[2] Saudia Arabia
[3] World
[4] Average of Angola, Brazil, Colombia and Guatemala for 1973-1976; average of Colombia and Guatemalia for 1977.
[5] London Metal Exchange.
[6] Average of Ivory Coast and Philipines
[7] Average of United States and Mexico
[8] Average of United States and Singapore.
[9] Europe
[10] Ghana
[11] Morocco
[12] Average of Malaysia, United Kingdom, and U.S.
[13] United States
[14] Thailand
[15] Average of Argentina and Australia
[16] Average price at London auctions

Source: Annual figures for 1973 and 1974 based on data from World Bank, Economic Analysis and Projections Department, "Commodity Price Data." February 18, 1976, and October 20, 1976; all other figures are based on data from "Commodity Price Data," December 16, 1977, and October 16, 1978.

the revenues of Third World countries. On the other hand, the price of manufactured export goods by DCs is not subject to such price fluctuation. In fact, the movement in price has been positive. Table 7 shows that movement.

The fluctuation in the prices of primary commodities and the increasing prices of manufactured goods, together gives some indications of the growth rate of the total value of export in LDCs and the purchasing power of their export revenue (see figures 3 and 4).

Figure 3 shows that the growth rate of total value of export in DCs is relatively higher than in LDCs for the period 1953-1973, except for the period 1957-1958. Figure 4 shows that the purchasing power of exports of DCs is relatively higher than in LDCs for the period 1938-1972. Therefore, Third World countries have to sell a greater volume of primary products in exchange for manufactured goods.

Tables 8 and 9 show the net trade balance of LDCs and the industrial countries. By comparing the net trade balance of the two groups we see that LDCs face a chronic balance of trade deficit as compared to the industrial countries. For example, the net imports as a percentage of imports in the industrial countries for the period 1973-76 ranged from 1.4-7.5 percent, while in LDCs it ranged from 15.1-32 percent during the same period.

It seems obvious that the rapid adoption of R&D in LDCs is important in order to alleviate their financial problems which is the major cause of the slow growth and

TABLE 7

MANUFACTURED GOODS EXPORTS

Indices 1970=100 — Value in Billion U.S.$

	1960	1965	1973	1974	1975	1976	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III
					Unit value index[5] - indice de valeur unitaire[5]								
Total	84	89	133	162	182	183	178	179	185	191	196	198	201
America	82	84	113	137	156	166	163	166	167	170	171	172	176
Canada	87	83	112	134	142	156	155	158	157	153	161	159	...
United States	81	84	113	137	159	170	166	168	170	175	175	176	181
Europe	84	91	139	168	193	191	186	186	192	200	204	207	211
E.E.C.[1]	85	91	139	165	190	187	183	183	289	195	201	204	209
Belgium—Luxumbourg[2]	87	89	137	171	185	184	177	180	183	194	...	...	195
Denmark	89	94	146	176	205	208	199	205	210	220	225	224	...
France	87	93	143	162	197	...	...	...	...	...	...	...	...
Germany, Federal Rep. of	82	89	147	172	195	195	187	190	196	206	208	210	215
Italy[2]	93	92	126	154	180	169	161	161	176	179	191	...	...
Netherlands[2]	87	98	139	178	195	194	186	189	194	208	208	212	...
United Kingdom	82	92	127	153	177	176	178	172	178	176	192	196	203
E.F.T.A.[3]	81	89	144	180	214	216	208	210	218	227	230	229	230
Austria	102	104	137	172	199	193	189	180	194	208	207	211	...
Finland	83	93	139	204	244	236	229	231	237	249	...	...	...
Norway	80	91	132	177	219	210	200	201	219	220	224	...	...
Sweden	78	84	143	173	210	219	209	214	218	234	240	...	...
Switzerland[2]	76	87	154	185	220	224	218	224	225	230	229	230	230
Other Dev'd Man. Econ.[4]	93	88	139	179	178	177	167	173	179	188	194	198	200
Japan	97	88	141	181	178	178	167	173	180	190	197	201	203

Footnotes: [1]Including Ireland.
[2]Deri ed from sub-indexes using current weights.
[3]Including Iceland and Portugal.
[4]Comprises Australia, Israel, Japan, New and South Africa
[5]Unit value indexes in national currencies, for selected countries .

Source: U.N. Monthly Bulletin of Statistics "December 1977), p. xxiv.

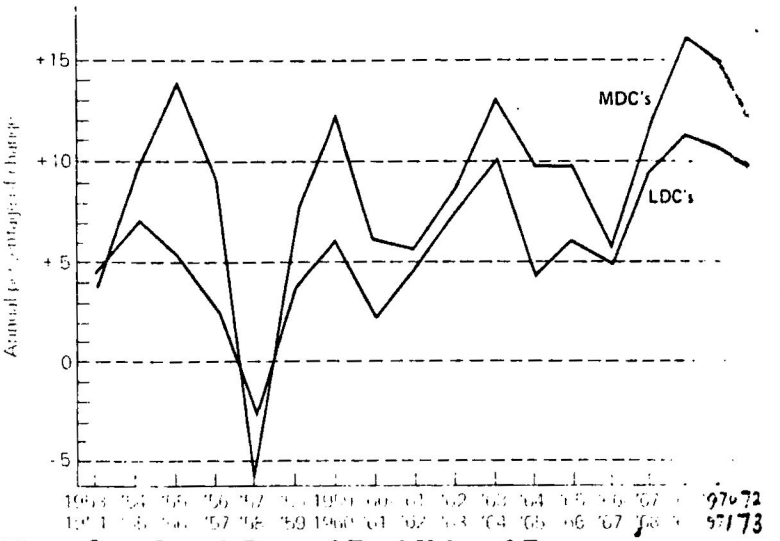


Figure 3 Growth Rates of Total Value of Exports
(Source: World Bank, *Trends in Developing Countries*, 1973, Table 3.3)

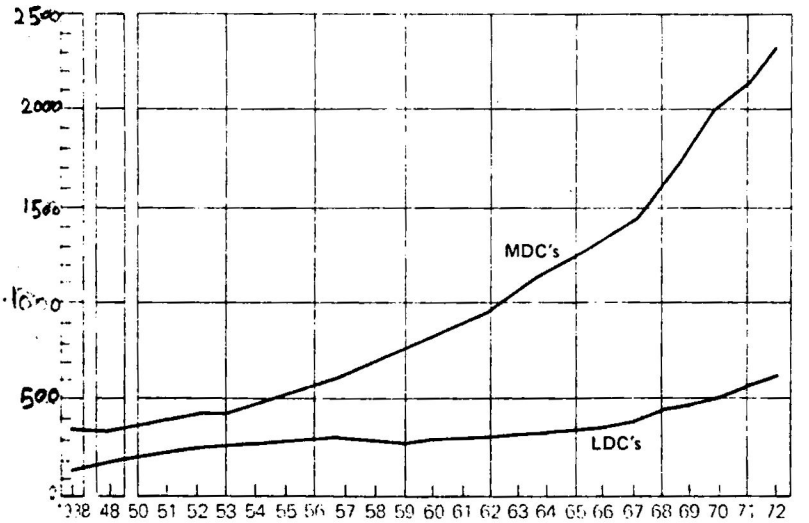


Figure 4 Income Terms of Trade (purchasing power of exports)
(Source: U.N. *Monthly Bulletin of Statistics*, August 1973, p. 111; U.N. *Yearbook of International Trade Statistics*, 1958, 1969.)

TABLE 8

NET TRADE BALANCE OF INDUSTRIAL COUNTRIES, 1973-76 (U.S. $ billions)

	1973	1974	1975	1976
Export	376.390	503.610	537.310	596.950
Import	386.150	544.630	545.480	632.630
Net Import	9.760	41.020	8.170	35.680
Net Import as % of Import	2.5%	7.5%	1.4%	5.6%

Computed from: IMF, International Finance Statistics, 1977.

TABLE 9

NET TRADE BALANCE OF LDCs OTHER THAN OPEC COUNTRIES (U.S. $ billions)

	1973	1974	1975	1976
Export	67.380	98.100	93.700	113.830
Import	79.370	130.670	137.890	142.970
Net Import	11.990	32.570	44.190	29.140
Net Import as % of Import	15.1%	24.9%	32%	20.3%

Computed from: IMF, International Financial Statistics, 1977.

development in LDCs. This is the dream of LDCs, but the role of DCs in the field of technology transfer is not encouraging. This will be the topic of discussion in the next chapter.

CHAPTER 2

THE TECHNOLOGY TRANSFER TO LDCs AND THE UNFAVORABLE TERMS THAT ARE ASSOCIATED WITH IT

This chapter examines the role of DCs in transferring technology to LDCs. It also attempts to show the inefficiency that is associated with the transfer of technology to LDCs. In doing so, four important topics are discussed.

1) The world patents system and its distribution.
2) The contractural agreements on the transfer of technology between LDCs and DCs, and the restrictions that are associated with it.
3) Factors influencing the selection of particular technology in LDCs.
4) The price of technology transfer to LDCs.

The World Patent System and Its Distribution

Technology can be transferred from DCs to LDCs by means of patents, licenses, technical and managerial know-how and trademarks. In 1975 the U.N.. Department of Economics and Social Affairs published their findings on the main characteristics of national and international patents. Also included in the report were the abuses of patent monopolies and the impact of the patent system on LDCs.

One of the characteristics that the survey points out is

that the participation of LDCs in shaping as well as in the operation of international patent system remained minimal. For example, only 6 percent (roughly 200,000) of the 3.5 million in existence are owned by LDCs.[10] Of the patents granted by developing countries, about 84 percent or some 170,000 are owned by foreigners. Most of them are held by large corporations of five developed market economy countries such as the U.S.A., the Federal Republic of Germany, the United Kingdom, Switzerland, and France.

The patents held by foreigners in the LDCs are extremely underutilized. Only about 5-10 percent of the 170,000 patents have been used in the production processes in LDCs up to 1972, according to the U.N. report (see table 10). From a sample of 4,872 patents granted between 1960 and 1970 in major industrial sectors in Peru, only fifty-four were reported to have been exploited. In Argentina, patent utilization by the affiliates of foreign did not exceed 5 percent throughout the period 1957-1970. An examination of 3,513 patent processes or products for Colombia showed that 2,534 of them belonged to the textile and chemical industries. Only 10 percent of the total were actually used in the production process in the country up to 1970.[11]

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[10] U.N. Department of Economic and Social Affairs, The Role of Patent System in the Transfer of Technology to Developing Countries (New York: U.N. Publications, 1975), p. 41.

[11] U.N. Department of Economic and Social Affairs. The Role of the Patent System in the Transfer of Technology to Developing Countries (New York: U.N. Publications, 1975), p. 40.

TABLE 10

PATENT HOLDINGS IN DEVELOPING COUNTRIES BY OWNERSHIP AND USE, 1972

Item	Number of patents held (in thousands)	Percentage distribution
World distribution:		
Developed countries	3,300	94
Developing countries	200	6
Total	3,500	100
Distribution in developing countries:		
Held by nationals	30	16
Held by foreigners, of which:	170	84
used	10-20	5-10
not used	150-160	90-95

Source: U.N. Department of Economic and Social Affairs, The Role of the Patent System in the Transfer of Technology to Developing Countries (New York: U.N. Publications, 1975), p. 41.

Table 11 shows the unequal participation of LDCs in the patents of such modern sector as electrical equipment. The share of LDCs in this particular sector was 5.7 percetn, compared with 12.4 percent for DCs. The former have been granted a relatively large proportion (about 34.4 percent) of patents in agricultural production as compared to 19.7 percent for DCs.

Tables 10 and 11 demonstrate to a great extent the excessive monopoly of DCs over LDCs in regards to patents. The high portion of patents granted by DCs to nationals of DCs reflects the unequal economic and technological strengths of DCs and LDCs. At the

TABLE 11

DISTRIBUTION OF PATENT GRANTS BY SECTORS

IN 1971 (in percentages)

Sectors	Developed market-economy countries	Socialist countries of Eastern Europe	Developing countries
Chemistry	19.7	15.5	34.4
Agriculture; foodstuffs and tobacco; personal and domestic articles; health and amusement	9.6	7.3	20.0
Separating and mixing; shaping; printing; transporting	9.2	25.0	13.8
Textiles and flexible materials not otherwise provided for; paper; building; and mining	11.7	9.1	8.2
Engines and pumps; engineering in general; lighting and heating; and weapons and blastings	11.5	18.5	5.9
Instruments and nucleonics	12.4	12.6	5.7
Electricity	2.4	3.7	3.0
Metallurgy	--	--	0.5
Others			

Source: U.N. Department of Economic and Social Affairs. The Role of the Patent System in the Transfer of Technology to Developing Countries (New York: U.N. Publications, 1975), p. 41.

same time, LDCs remain, to a considerable extent, technologically dependent on DCs.[12]

[12]Edith Penrose, "International Patenting and the Less Developed Countries," The Economic Journal, vol. 83, no. 331 (September 1973):768.

The Contractual Agreements Between DCs and LDCs for the Transfer of Technology and the Restrictions that are Associated with It

Between the period of 1961-1970 over 2,000 contractual agreements on the transfer of technology were made between five of the industrial countries of the LDCs. The contracts show the nature of restriction, especially on exports (see table 12). The data in this table shows a wide variation in the nature of the restrictions imposed on LDCs. These restrictions

TABLE 12

CONTRACTS CONTAINING RESTRICTIVE EXPORT CLAUSES, ACCORDING TO THE NATURE OF THE RESTRICTION

Country*	Total number of contracts	Contracts with restrictive clauses		Total prohibition or prior approval	Permitted to certain destinations only	Other specific restrictions
		Number	% of total	Percentage of total number of restrictive contracts		
Peru	100	99	99	90	10	
Mexico	109	106	99	62	4	34
Chile	125	162	99	38		
Bolivia	35	29	83	93	7	
Colombia	117	92	79	98	2	
Ecuador	12	9	75	100		
India	1051	455	48	40	53	7
Philippines	254	82	32	81	6	13
Argentina	60	17	28	53	47	
Israel						
1961-1963	144	16	11	100		
1964-1965	150	9	6	100		

Source: UNCTAD, Major Issues Arising from the Transfer of Technology to Developing Countries (New York, 1975), p. 20.

have been into three major categories:

1) Total prohibition of exports or requirement of prior approval.

2) Export permitted to certain countries and prohibited to others.

3) Other forms of restriction.

The countries in table 12 are listed in descending order of the proportion of agreements containing such restrictive clauses. These proportions vary from as much as 99 percent in Peru, 93 percent in Chile to as little as 6 percent in Israel. India and the Philippines are in an intermediate position.

Table 13 shows the contractual agreements containing the restrictive export clauses, classified by industry. For example, it seems that there is a high proportion of contracts containing restrictive exports clauses in the pharmaceutical industry in Peru, Bolivia, Colombia, and the Philippines. In India and the Philippines, the proportion is also very high for the electrical goods and the machinery sector.

The Restriction of Competition

Technology suppliers have been very anxious to protect their market interests in LDCs, and have employed several methods to eliminate competition. Therefore, some agreements oblige the enterprise not to engage in the manufacture and sale of products other than those covered by the license or to diversify or expand into other lines. In India only 65 out of 1051 effective contracts were approved have non-restriction up to 1964. In the Philippines 5 out of 254 agreements in 1970 had such restrictive

TABLE 13

CONTRACTUAL AGREEMENTS CONTAINING RESTRICTIVE CLAUSES, CLASSIFIED BY INDUSTRY (Percentage of total agreements in the industry specified)

Industry	India	Philippines	Argentina	Colombia	Bolivia	Peru
Food		16				
Tobacco	100	29				
Beverages		11		92	35	
Textiles	25	60				
Building materials	50	30				
Metal products	39					
Chemicals	25	35	29	61		
Pharmaceuticals	29	52		81	80	100
Machinery and tools	52	43				
Electrical goods and machinery	55	45	40			
Transport equipment	53	14	40			
Other	43	31	39		92	93
Total	48	32				

Source: UNCTAD, Major Issues Arising from the Transfer of Technology to Developing Countries (New York, 1975), p. 20.

conditions, while in Mexico 19 out of 109 agreements in 1969 also had such conditions.[13]

Let us now show a specific instance of restrictive practices by DCs to eliminate competition. A good example of this is the technological search carried out in Mexico for Caprolactama to manufacture a fibre called "Nylon G." The local investor did not have access to large financial resources and wished to produce on a relatively small scale to meet the demand from his own

[13]UNCTAD, Major Issues Arising from the Transfer of Technology to Developing Countries (New York: United Nations Publication, 1975), p. 22.

textile factory. As often happens, the investor contacted the main producer of this fibre in the world, a United States enterprise, which refused him the technology owing to the reduced scale of his plant.[14]

The recent contractual agreements between Saudi Arabia and the U.S. petrochemical companies, that would produce 3.2 million metric tons in net basic petrochemical production between 1983 and 1985, shows some unfavorable terms and restrictive clauses. These clauses would restrict Saudi Arabia from competing in the world market of petrochemicals.

Forbes Magazine, in its 33rd annual report on American industry (January 5, 1981), reported that the American petrochemical producers have little to worry about from upcoming Middle East competition. A look at the agreements between Shell and Saudi Arabian government, as it was demonstrated in Forbes Magazine,[15] will underline the unfavorable terms that associated with this agreement, for example:

1) Saudi Arabia, in 1985, will receive rights to market only 50 percent of the final product even though it is providing 70 percent or 2.1 billion for financing the complex. Shell will receive the right to the remaining 50 percent. Add to that, Shell will probably get on the order of 200,000 barrels of crude a day, which it can use as a source for its petrochemical plants

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[14] UNCTAD, Handbook on the Acquisition of Technology by Developing Countries (New York: UNCTAD Publication, 1978), p. 14.

[15] Jane Carmichael, "Chemicals," Forbes, 33rd Annual Report on American Industry (January 5, 1981), pp. 198-199.

at home.

All of this is considered to be the price tag for Shell's technology and marketing training.

2) The 1.6 million metric tons a year of ethylene, ethylenedichloride, styrene are just basic petrochemicals used as building blocks for more complex products as polystyrene and vinycloride monomer (a product of plastic). Shell plans to bring most of the primary chemical products back to its own plants in the U.S. to be refined into higher products.

3) Saudi Arabia will have only 4 percent of the world market of petrochemical. But, American producers are still worried; they think that even 4 percent or 5 percent, if it comes during a period of oversupply, could disrupt world prices of petrochemical for a short time. Forbes Magazine, on the same report, quoted Mr. J. E. Mitchell of Dow Chemical, who as director of corporate planning has been following negotiations for Dow's joint venture with the Saudis. He emphasize his attitude toward the upcoming Saudi competition by saying:

> If all plants came in the same year, there's no question but there would be some disruption, but I don't think the earliest plant will be in until 1985, and the rest will spread out between 1985 and 1990.

Again, it seems here that even though the petrochemical industry in the Middle East is on its first step, the industrial countries are still worried from that upcoming competition. This is just another example of what the industrial development faces in the LDCs.

Factors Influencing the Selection of Particular Technology In LDCs

Multinational corporations (MNCs) are the best channels for transferring technology to poor countries because of their global organizational skills. Their ability mobolize resources quickly, and their massive investment in R&D.[16] It is well known that the central characteristic of MNCs is that it seeks to maximize the profits not of its individual subsidiaries, but rather of the center parent company.[17] The only way for MNCs to maximize their profits is to minimize the cost of production. If this does not happen within their original bases, they shift the production out where there is cheap labor. This action will maximize profit and keep MNCs competitive along the lines. This attitude no doubt affects the quality of technology LDCs are receiving from DCs.

In 1974, the U.N. (Department of Economic and Social Affairs) issued a report concerning MNCs and their affiliates in LDCs. This report examines the factor that influences the selection of a particular technology by a particular kind of enterprise in LDCs.[18] A number of these studies in the report are concerned explicitly with the behavior of the MNCs

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[16]Denis Goulet, The Uncertain Promice: Value Conflicts in Technology Transfer (New York: I.O.D.C., 1977), p. 84.

[17]Ronald Muller, "The Multinational Corporation and the Underdevelopment of the Third World," in The Political Economy of Development and Underdevelopment, ed. Charles K. Wilber (New York: The Random House, 1978), p. 151.

[18]U.N. Department of Economic and Social Affairs, The Acquisition of Technology from Multinational Corporations (New York: U.N. Publications, 1974), p. 9.

enterprise that are based in the U.S.A. and its affiliates in LDCs.

The study has found that the price elasticity of demand for the firm's product and the degree of competition facing the MNCs, are the major indicators for the selection of the particular technology in LDCs. Therefore, the more elastic the demand for a particular product, the more the technology selected in LDCs differed from that used by the firm in the U.S.A. In other words, the more elastic the demand for the particular product, the more labour intensive technology will be used to produce that product. In this case, the technology used in LDCs will differ from that used by the firm in the U.S.A. This was the finding of the U.N. Department of Economic and Social Affairs.

It seems here that the transfer of technology from DCs to LDCs takes place in order for MNCs (the suppliers of technology) to have access to cheap low level labor (see table 14), which results in cost minimizing or profit maximizing for MNCs. The actual contribution to skill formation that is needed in LDCs is limited.

Table 14 shows the average hourly earnings of works processing or assembling U.S. materials overseas and in the U.S.A. It also shows the enormous differences in labour cost of which advantage can be taken by an international firm. For example, the average hourly earning of a Korean worker how processing or assembling U.S. materials (office machine plants) in Korea is $0.28. On the other hand, the average

TABLE 14

AVERAGE HOURLY EARNINGS OF WORKERS PROCESSING OR ASSEMBLING U.S. MATERIALS OVERSEAS AND IN THE UNITED STATES

	Average hourly earnings abroad* (dollars)	Average hourly+ U.S. earnings (dollars)	Ratio of U.S. earnings to earnings abroad
Consumer electronic products			
Hong Kong	0.27	3.13	11.8
Mexico	0.53	2.31	4.4
Taiwan	0.14	2.56	18.2
Office machine parts			
Hong Kong	0.30	2.92	9.7
Mexico	0.48	2.97	6.2
Korea	0.28	2.78	10.1
Singapore	0.29	3.36	11.6
Taiwan	0.38	3.67	9.8
Semiconductors			
Hong Kong	0.28	2.84	10.3
Jamaica	0.30	2.23	7.4
Mexico	0.61	2.56	4.2
Netherlands Antilles	0.72	3.33	4.6
Korea	0.33	3.32	10.2
Singapore	0.29	3.36	11.6
Wearing Apparel			
British Honduras	0.28	2.11	7.5
Costa Rica	0.34	2.28	6.7
Honduras	0.45	2.27	5.0
Mexico	0.53	2.29	4.3
Trinidad	0.40	2.49	6.3

Notes:

*Including supplementary compensation.
+Including supplementary compensation. Estimates by firms of earning for comparable job.

SOURCE: United States Tariff Commission, Economic Factors Affecting the Use of Items 807.00 and 506.30 of the Tariff Schedule of the United States (Washington, 1970).

hourly earnings of an American worker in the U.S.A., doing the same job is $2.78.

Therefore, it can be argued that there is a need for coherent policy in this area, a policy that will ensure that LDCs receive the maximum benefits possible from transferring technology.

The Price of Technology Transfer to Less Developing Countries

An estimate by UNCTAD of the direct cost of technology transfer to LDCs, covering payment, licensing, trademark, and consultancy services, shows that by the end of the 1960s the costs had reached as much as $1500 million. These payments could well have grown six-fold, about $9 billion by 1980 (see table 15).

These direct costs at (table$_{16}$) were about 8 percent of LDCs' imports of machinery, equipment and chemicals. They were as much as 37 percent of public debt service payments and 56 percent of the annual flow of direct foreign investment.

This expensive commodity places indeed a heavy load on the external public debt of LDCs. The World Bank estimated that the external public debt of ninety-six LDCs increased by $51 billion or about 25 percent in 1978 to a total of $235 billion.[19]

Table 16 shows in detail, the payments by LDCs for the transfer of technology and their relationship to GDP and

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[19]World Bank, 1979 Annual Report, p. 14.

TABLE 15

DIRECT COSTS OF TRANSFER OF TECHNOLOGY IN COMPARISON WITH OTHER RELEVANT FOREIGN EXCHANGE FLOWS OF DEVELOPING COUNTRIES, 1968

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

Source: UNCTAD, Major Issues Arising from the Transfer of Technology to Developing Countries (New York: U.N. Publications, 1975), p. 26.

TABLE 16

Payments[a] by developing countries for the transfer of technology and their relationship to GDP and exports

Country and region	Most recent year available	Payments for transfer of technology for: Patents, licences, know-how and trademarks (1)	Payments for transfer of technology for: Management and other technical services (2)	Total (3)	GDP (4)	Exports (5)	Payments for transfer of technology as proportion of: GDP (6)	Payments for transfer of technology as proportion of: Exports (7)
		(Millions of dollars)			(Billions of dollars)		(Per cent)	
Latin America:								
Argentina	1970	70.5	45.3	115.8	23.4[b]	1.8	0.49	6.5
Brazil	1970	..	..	104.0	35.3	2.7	0.29	3.8
Chile	1969	8.2	..	(8.2)	6.1	1.1	0.13	0.8
Colombia	1966	..	..	26.7	5.4	0.5	0.49	5.3
Mexico	1968	..	..	200.0	27.1	1.3	0.74	15.9
Peru	1971	9.9	1.1	11.0	5.8[b]	0.9	0.19	1.2
Venezuela	1966	14.8	..	(14.8)	8.8	2.7	0.17	0.5
Sub-total		..	..	(480.5)	111.9	10.9	0.43	4.4
Africa:								
Nigeria	1965	19.0	14.8	33.8	4.7	0.8	0.72	4.5
Asia:								
India	1969	6.4	43.2	49.6	49.1	1.8	0.1	2.7
Indonesia	1968	25.0	..	(25.0)	11.0	0.7	0.23	3.6
Iran	1970	1.7	1.6	3.3	11.2	2.4	0.03	0.1
Israel	1961-1965[c]	1.6	2.3	3.9	2.6	0.3	0.15	1.2
Republic of Korea	1970	2.1	..	(2.1)	8.1	0.8	0.03	0.3
Pakistan	1965-1970[c]	2.1	(100)	(102.1)	14.5	0.6	0.7	15.7
Sri Lanka	1970	0.1	9.2	9.3	2.2	0.3	0.42	2.7
Sub-total		39.0	(156.3)	(195.3)	98.7	7.0	0.2	2.8
Southern Europe:								
Greece	1966	..	..	2.6	6.4	0.4	0.04	0.6
Spain	1970	81.6	52.2	133.8	32.4	2.4	0.41	5.6
Turkey	1968	..	..	49.1	12.6	0.5	0.39	9.9
Yugoslavia	1970	5.4	..	(5.4)	12.3	1.7	0.04	0.3
Sub-total		..	..	(190.9)	63.7	5.0	0.3	3.8
TOTAL, excluding Southern Europe		..	..	709.6	215.3	18.7	0.33	3.8
TOTAL, including Southern Europe		..	..	900.5	279.0	23.7	0.32	3.8

Sources: Replies to the UNCTAD secretariat's questionnaire and other sources shown in the annex to document TD/106, *loc. cit.* (cf. foot-note 4 above). For Venezuela: Oficina Central de Coordinación y Planificiación (CORDIPLAN), Departamento Industrial, *II Encuesta Industrial: Documento Básico* (Caracas, November 1968).

NOTE. Parentheses indicate that the information available is incomplete.

[a] In most cases payments refer to the foreign exchange cost (i dollars, at current prices) of the transfer. For further details, see th annex to document TD/106, *loc. cit.* (cf. foot-note 4 above).

[b] UNCTAD secretariat estimate.

[c] Annual average.

Sources: UNCTAD, Major Issues Arising From the Transfer of Technology to Developing Countries (New York: U.N. Publication, 1975), p. 26.

exports for selected countries. For example, Pakistan, during the period of 1965-1970 paid a total of $102.1 million, its GDP was $14.5 billions, its exports was $0.6 billion. The payment for transfer of technology as proportion of GDP was 0.7 percent, and 15.7 percent as proportion of its exports, which is considerable high in comparison to Greece, Spain, or Israel. In Spain, the payments for transfer of technology as proportion of its exports is 5.6 percent, in Greece it is 0.6 percent, in Israel it is 1.2 percent.

Let us now look at the relationship between the annual average growth rate of payments for transfer of technology (PTT) and the annual average growth rate of manufacturing output (MO) in select countries for the period of 1953-1970 (see table 17). In Nigeria $(\frac{PTT}{MO})$ or $(\frac{55.5}{9.3})$ is equal to 6.0; this means 6 PTT for each 1 MO. In Argentina the ratio is 5.4, Sri Lanka 4.2, India 2.6. Those ratios seem to be significant compared to 1.2 in Spain, for example. Table 17 tends to indicate that the more advanced is the level of development of the LDC, the lower will be the ratio of PTT to MO and vice versa.

It seems here that the annual average growth rate of manufacturing output in LDCs is not catching up with the annual average growth rate of payments for transfer of technology. In other words, their payments on the purchase of technology is higher than their income from its sale.

TABLE 17

Relationship between increase in payments for transfer of technology, manufacturing output and GDP for selected countries

Country	Period	Payments for transfer of technology		Annual average growth rate of			Relationship of growth rates of	
		Initial year	End year	payments for transfer of technology (PTT)	manufacturing output (MO)	real GDP	PTT / MO (i.e. column 3 divided by column 4)	PTT / GDP (i.e. column 3 divided by column 5)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Millions of dollars		Per cent per year			Ratios	
Developing countries								
Nigeria	1963-1965	13.8	33.8	55.5	9.3[a]	4.0	6.0	13.9
Korea (Republic of)	1967-1970	0.7	2.1	43.0	24.2	12.5[b]	1.8	3.4
Sri Lanka	1965-1970	2.0	9.2	36.0	8.6[a,c]	3.9	4.2	9.2
Argentina	1965-1970	35.1	115.8	26.9	5.0	3.9[c]	5.4	6.9
Brazil	1965-1969	42.5	91.0	20.9	9.7[d]	6.2	2.1	3.4
India	1959-1969	12.0	49.6	15.2	5.8	9.2[e]	2.6	1.7
Mexico	1953-1968	14.7[f]	120.0[f]	15.0	8.5	6.7[g]	1.8	2.2
Iran	1965-1970	1.1	1.7	10.1	11.8	10.4[c]	0.9	1.0
Other technology-receiving countries								
Turkey	1964-1968	6.2	49.1	65.5	10.5[a]	6.6	6.2	9.9
Yugoslavia	1965-1970	0.6	5.4	50.5	6.3	5.3[c]	8.0	9.5
Ireland	1963-1969	0.2	2.2	49.0	6.6	4.3	7.4	11.4
Greece	1959-1966	0.7	2.6	19.8	8.6[h]	9.4[h]	2.3	2.1
Spain	1965-1969	79.9	133.0	13.6	11.0	6.5	1.2	2.1
Developed market-economy countries		Receipts from developing countries for the transfer of technology						
France[i]	1967-1969	23.2	32.2	17.8				
Germany (Federal Republic of)[j]	1963-1969	50.3	105.4	13.1				
Belgium	1966-1970	5.6	8.8	11.6				
United States of America	1960-1969	175.6	442.3	10.8				
United Kingdom[k]	1965-1969	19.6	29.3	10.6				
Sweden	1965-1970	0.2	0.2	1.9				
Japan[l]	1968-1969	12.4	11.3	–				

Sources: As for table 17, p. 29.

NOTE. Countries in each group have been arranged in descending order of their annual growth rates of payments for the transfer of technology.

[a] Real GDP in manufacturing.

[b] 1966-1969.

[c] 1965-1969.

[d] 1965-1968.

[e] 1960-1968.

[f] In contrast to table 10, these figures have not been adjusted for their limited coverage.

[g] 1953-1967.

[h] 1960-1966.

[i] Excluding $36.4 million in lump-sum receipts in the petroleum sector from the Algerian Government.

[j] Receipts from developed and developing countries.

[k] Excluding receipts by petroleum companies, including receipts from Southern European countries.

[l] For the period 1963-1968 Japan's receipts from all countries, developed and developing, rose from $9.1 to $34 million for an annual growth rate of 30 per cent, according to figures shown by T. Ozawa, *Transfer of Technology from Japan to Developing Countries*, UNITAR Research Report No. 7 (New York, 1971).

CHAPTER 3

THE LESS DEVELOPED COUNTRIES AND THE REVERSE TRANSFER OF TECHNOLOGY

This chapter is concerned with the problem of the migration of skilled personnel from LDCs to DCs. In the last two chapters we have shown the importance of technology in trade and development. Also, we have shown the existent number of engineers and scientists engaging in research and development; they were 10.4 per 10,000 in the developed market economy, 0.35 in Africa, 1.6 in Asia, 1.15 in Latin America.[20] That by itself reflects an enormous weakness in the technological infrastructure in LDCs. The phenomenon of "reverse transfer of technology" or "brain drain" makes it harder for LDCs to build a strong base for their industrial development. The concern of UNCTAD with the "reverse transfer of technology" dates back to the third session of the conference in Santiago de Chile in May 1972, in resolution 39 (III) the conference requested UNCTAD to contribute to the studies being carried out on the outflow on trained personnel from LDCs which constitutes a reverse transfer of technology.[21]

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[20] See table 1.

[21] UNCTAD, The Reverse Transfer of Technology: A Survey of Its Main Features, Causes and Policy Implication (New York: United Nations Publication, 1979), p. 1.

Magnitude of Skill Flows from LDCs to DCs

The immigration policies in the United States and Canada referred to in the UNCTAD study as discrimination in favour of professionals over other immigrants and as having selectively reduced barriers to entry applying to professional immigrants from the developing countries.[22]

Estimates made earlier by the UNCTAD secretariat show that between 1960 and 1972 skilled migration from the developing countries (consisting of engineers, scientists, surgeons and physicians and technical and kindred workers) to the United States, Canada and the United Kingdom, reached about 230,000 persons. If one adds to this a flow of about 29,000 to the United States during 1973-1975 and 25,000 to Canada during 1973-1976, this makes a total figure of nearly 285,000 (see table 18). The developing countries provided the United States 77-80 percent of the skilled migrants between 1973-1974.

Table 19 gives a detailed examination of the occupational composition of skilled migration. For example, physicians and surgeons have been the most significant category of developing country immigrants into the United States, Canada and the United Kingdom constituting 60 percent of the overall immigration in this category to these three countries (72 percent in the United States, 49 percent in the United Kingdom and 37 percent in Canada). Engineers and scientists have been the second most important category, representing 43 percent of overall

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[22] UNCTAD, The Reverse Transfer of Technology (New York: United Nations Publication, 1979), p. 4.

TABLE 18

TRENDS IN SKILLED MIGRATION FROM DEVELOPING COUNTRIES TO THE UNITED STATES OF AMERICA, CANADA AND THE UNITED KINGDOM, 1961-1976

Year(s)	Number of skilled migrants from devleoping countries[a]				Share of developing countries in total skilled migration (percentage)		
	United States of America (1)	Canada (2)	United Kingdom (3)	Total (4)	United States of America (5)	Canada (6)	United Kingdom (7)
1961-1965	14,514	(6,147)[b]	(20,411)[c]	(41,072)	37	20	26
1966	7,635	5,930	10,812	24,277	49	23	26
1967	8,239	8,614	8,156	25,009	52	25	21
1968	8,052	7,489	9,418	24,959	50	24	23
1969	8,419	8,286	9,932	26,637	64	28	22
1970	11,412	6,867	8,635	26,914	69	27	19
1971	16,098	6,195	7,843	30,136	85	31	18
1972	15,822	7,070	8,833	31,725	86	36	19
1973	10,602	6,180		(16,782)[d]	77	25	15
1974	8,725	7,631		(16,356)[d]	80	27	15
1975	9,298	6,362		(15,660)[d]	72	25	14
1976	..	4,842		(4,842)[e]	..	24	..
Cumulative total	118,816	(81,613)	(84,040)	(284,469)	61	26	22

Sources: TD/B/C6/7, table 1; for the United States: unpublished data supplied by the National Science Foundation, Washington, D.C.; for Canada: Department of Manpower and Immigration, Immigration Statistics.

[a]The concept of skilled migration used is wider for Canada and the United Kingdom than for the United States. The United States figures invlude only the "professional" categories (i.e., engineers, natural and social scientists and doctors) whereas figures for the United Kingdom and Canada include "professional, technical and kindred workers."

[b]Total for 1963-1965 only.

[c]Total for 1964-1965 only.

[d]Total for the United States and Canada only.

[e]Total for Canada only.

TABLE 19

SHARE OF DEVELOPING COUNTRIES IN TOTAL SKILLED MIGRATION INTO THE UNITED STATES OF AMERICA, CANADA AND THE UNITED KINGDOM, TOTAL 1961-1976

Occupation and country of destination	Number of skilled migrants[a] from: Developing countries (1)	All countries (2)	Column (1) as a percentage of column (2) (3)
United States of America[b]	118,816	190,813	62
Physicians and surgeons	40,876	56,447	72
Engineers and scientists	77,279	133,478	58
All others[c]	661	888	74
Canada[d]	81,613	297,211	27
Physicians, surgeons and scientists	4,850	13,023	37
Engineers and scientists	13,601	42,711	32
All others	63,162	241,477	26
United Kingdom[e]	84,040	380,751	22
Physicians, surgeons and dentists	15,655	32.065	49
Engineers and scientists	9,225	54,705	17
All others	59,160	293,981	20
Total	284,469	868,775	33
Physicians, surgeons and dentists	61,381	101,535	60
Engineers and scientists	100,105	230,894	43
All others	122,983	536,346	23

Sources: TD/B/C6/7, table 3; for the United States: unpublished data supplied by the National Science Foundation, Washington, D.C.; for Canada: Department of Manpower and Immigration, Immigration Statistics.

[a]The concept of skilled migration used is wider for Canada and the United Kingdom than for the United States (See note a to table 1 above).

[b]For years 1961-1972.

[c]Computer specialists.

[d]For years 1963-1972.

[e]For years 1964-1972.

immigration in this category into developed countries (58 percent in the United States, 32 percent in Canada and 17 percent in the United Kingdom). In terms of absolute flows, nearly 61,000 physicians and surgeons, over 100,000 engineers and scientists and 123,000 technical and kindred workers migrated from developing countries to the developed countries between 1961 and 1976.

Let us now measure in terms of dollars the capital value of skill flow from developing countries to the United States of America, Canada and the United Kingdom between 1961-1972 (see table 20). Column 1 shows the total numbers of developing country skilled migrants in the United States, Canada and the United Kingdom, broken down by skill categories. Column 2 gives estimates of imputed capital value on a per migrant basis. Column 3 multiplies the per migrant figures by the total migration flows. The flows to the United States amounting to over $28 billion, to Canada about $10 billion, and to the United Kingdom about $5 billion. The combined imputed capital value of skill transfer in the three countries was about $42 billion (1961-1972), or in annual average terms about $3.5 billion per year.

Table 21 shows the contribution to the U.S. net income gain by LDCs from skilled immigration into the U.S. The income from work and services of highly skilled personnel who migrated to the U.S. from LDCs reached about $3.7 billion in 1970. This figure accounts for over 0.3 percent of U.S. GDP, about 14 percent of the total U.S. expenditures on research and

TABLE 20

MEASURES OF IMPUTED CAPITAL VALUE OF SKILL FLOWS FROM DEVELOPING COUNTRIES TO THE UNITED STATES OF AMERICA, CANADA AND THE UNITED KINGDOM, 1961-1972

Country of immigration and occupational category	Number of skilled immigration (1)	Imputed capital value per migrants[a] (thousands of dollars) (2)	Total imputed capital value (1) x (2) (millions of dollars) (3)
United States of America (1961-1972)	90,191	313	28,233
Engineers	43,626	227	9,889
Scientists[b]	29,464	198	3,850
Doctors[c]	27,100	535[b]	14,494
Canada (1963-1972)	56,598	169	9,556
Engineers	6,377	213	1,358
Scientists[e]	3,394	214	728
Doctors	4,049	385	1,560
Others[f]	42,778	138	5,910
United Kingdom (1964-1972)	84,040	55	4,603
Engineers	6,735	63	425
Scientists	2,490	64	160
Doctors	15,655	68	1,073
Others[g]	59,160	50	2,945
Grant total	230,829	184	42,392
Annual average	19,236	184	3,533

Source: TD/B/C.6/7: for figures in columb 1, tables A-5, A-9 and A-12, for figures in columb 2, the Y_p rows in tables 9, 10, and 11.

[a]Average values weighted by migration flows in each category, each year.
[b]Social and natural scientists.
[c]Physicians and surgeons.
[d]Averages for physicians, surgeons and dentists.
[e]Natural scientists and biologists and agricultural professionals.
[f]Professors and principals, teachers, nurses, medical technicians and managerial and other professionals.
[g]Teachers, nurses, medical technicians, and managerial and other professionals.

TABLE 21

CONTRIBUTIONS TO THE UNITED STATES NET INCOME GAIN BY DEVELOPING COUNTRIES FROM SKILLED IMMIGRATION INTO THE UNITED STATES OF AMERICA IN 1970 ("MEDIAN"ASSUMPTION)

Country	Total Number of Immigrants (1)	Scientists and Engineers (2)	Physicians and Surgeons (3)	Total (4)
			(Millions of dollars)	
Asia	8.993	1,809.1	1,092.4	2,091.5
India	3,141	718.2	156.3	874.5
Philippines	2,318	383.8	496.8	880.6
Korea (Republic of)	541	77.5	147.3	224.8
Hong Kong	262	54.8	26.5	81.3
Other	1,797	400.6	116.3	516.9
Near and Middle East	934	174.2	149.2	323.4
Africa	1,212	252.2	121.4	373.6
Latin America	1,031	172.4	214.5	386.9
Cuba	114	15.3	33.6	48.9
Columbia	114	19.2	23.3	42.5
Mexico	92	15.5	18.7	34.2
Argentina	72	10.1	20.7	30.8
Brazil	70	15.5	4.5	20.0
Peru	41	6.9	8.4	15.3
Venezuela	42	7.6	7.1	14.7
Chile	33	5.4	7.1	12.5
Ecuador	32	4.4	9.0	13.4
Bolivia	24	2.2	9.7	11.9
Other	396	70.0	72.4	142.4
Developing Countries Total	11,236	2,233.7	1,428.3	3,662.0

SOURCE: Figures in column (1) obtained from Table B-1 of Scientists, Engineers and Physicians from Abroad: Trends Through Fiscal Year, 1970, National Scientist Foundation (Washington, D. C.: June 1972), publication NSF 72-312.

NOTE: Figures in columns (2) and (3) were estimated by multiplying number of immigrants into the United States from each developing country by the net income gained per immigrant presented in column (3) of Table 2 above.

development and about 39 percent of U.S. current expenditures on higher education.[23]

The Causes of Migration

Studies relating to the question of the causes of brain drain have been compiled or commissioned by the secretariats of the United Nations and other international agencies, including ILO and WHO. The causes of the voluntary migrant can be most clearly elaborated within the context of three broad categories of motivation.[24]

1. Income differentials between LDCs and DCs and other related economic consideration have been most often as a main cause of the brain drain.

2. Working conditions and professional opportunities may also have some affect on migration decisions. Lack of infrastructure in the form of equipment, instruments, libraries, etc. in home countries is one of the reasons why developing countries professinals have wanted to pursue their research interests in developed country institutions.

3. The effect of social conditions could include anything from the stability of the political and social environment to the availability of particular consumer goods.

Some Policy Issues for Action

It was clearly recognized by the group of government experts on reverse transfer of technology that concerted efforts were needed to assist the developing countries in

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[23]UNCTAD, Reverse Transfer of Technology: Economic Effects of the Brain Drain (New York: UNCTAD Publications, 1975), p. 2.

[24]UNCTAD, The Reverse Transfer of Technology: A Survey of Its Main Features, Causes and Policy Implication (New York: U.N. Publication, 1979), p. 9.

finding solutions to the problem of reverse transfer of technology (brain drain). A good deal of the responsibilities with the industrialized countries, however, they prefer to use high-level manpower from less developed countries because of the lower cost involved and fewer difficulties encountered if employment has to be terminated in the event of decrease in demand or financial austerity.[25] Several alternative proposals have been advanced in recent years and they fall into two main groups:[26]

(i) Proposal requiring action by the LDCs.

(ii) Proposal requiring action by the DCs.

A. Action by the Developing Countries

Measures to be taken by developing countries can be separated into three main categories: (i) "insensitive policies" to encourage professionals to stay in their home countries or to return from abroad, (ii) "restrictive policies" aimed at discouraging professionals from leaving their country; and (iii) "delinking policies" intended to "indigenize" the educational system in developing countries so as to minimize the need or desire of professionals to go abroad.

B. Action by the Developed Countries

Traditionally, the measure most commonly adopted by developed countries has been to limit the entry of developing country professionals and to control the composition of migraton through the application of immigration quotas on a selective basis. Several other useful suggestions have been made where action by developed countries could prove of value:

(a) The developed countries could reorient aid or technical assistance programs to strengthen educational institutions

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[25]F. J. Van Hoek, The Migration of High Level Manpower from Developing to Developed Countries (Paris: Mouton, 1970), p. 39.

[26]UNCTAD, The Reverse Transfer of Technology, p. 18.

in LDCs and to encourage the absorption of trained personnel within these countries;

(b) As a related measure, they could set up and support funds which promote the undertaking of research and training activities in the institution of developing countries and encourage greater use of skilled professionals and consultants of developing countries in programmes or projects funded by DCs sources.

The previous review of the concern of UNCTAD with reverse transfer of technology shows the importance that is being attached to this problem and the extent of the work needed to be accomplished in this area.

CHAPTER 4

THE NEO-TECHNOLOGY HYPOTHESIS OF THE PATTERN OF INTERNATIONAL TRADE AND THE TECHNOLOGY TRANSFER FROM DCs TO LDCs

In this chapter we shall focus on the neo-technology hypothesis of the pattern of international trade with regard to the restrictive practices by DCs in the area of technology transfer to LDCs and the phenomena of "brain drain."

The neo-technology hypothesis attempts to explain the pattern of international trade on the basis of comparative advantage that originates in technological progress. The main proponents of this hypothesis are: Posner (1961), Hufbauer (1966), Johnson (1968), and Vernon (1966).[27]

The so-called "product-cycle" theory was formulated by Vernon in 1966.[28] It was the first fully articulated statement concerning the neo-technology hypothesis in international trade. The hypothesis deals primarily with the invention and innovation of new products and it states clearly that foreign

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[27]Jitendralal Bokakti, "Some Welfare Implication of the Neo-technology Hypothesis of the Pattern of International Trade," Oxford Economic Paper, vol. 23, no. 3 (November 1975):383.

[28]R. Vernon, "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics (1966):190-207.

investment is the main route for transmitting technology.[29]

In the first half of the chapter, an attempt will be made to explain the theory of the product cycle in detail, with special attention to its implications on the existing technological gap between DCs and LDCs. The second half of the chapter will show some of the efforts on the part of LDCs to narrow the technological gap between them and the developed countries.

The Theory of the Product Cycle

The purpose of this chapter is to take a new look at the product cycle model of international trade as developed by Raymond Vernon. This theory employs the technological differential between the countries to explain the trade patterns, particularly where new goods are being introduced such as those embodied in scientists and engineers (computers, electronics, nuclear energy, space equipment, and aircraft).

The country that has a technological lead will maintain a comparative advantage in its exports, but after a period of time, this export advantage disappears when the technological lead is lost or narrows. For example, it has been found that U.S. exports have had a high technological component and that many of these exports diminish or disappear when the technological lead of the United States narrows or is lost.[30]

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[29]Jitendralal Brokakti, "Some Welfare Implications of the Neo-technology Hypothesis of the Pattern of International Trade," Oxford Economic Paper, vol. 23, no. 3 (November 1975): 385.

[30]Kindleberger and Lindert, International Economics (Homewood, Illinois: Irwin, 1978), p. 76.

Trade in this case seems to be based to a great extent on a technological gap created by the invention and marketing of new products. The basic premise upon which Vernon's model is founded is that as the product cycle (life cycle) of any new commodity unfolds, its production passes through successive stages of standardization, and associated with it will be dynamic shifts in comparative advantage of predictable direction.[31] The product is first new, then matures as it goes to other industrialized countries, and finally is standardized. Computers are at one end of the line today, and leather goods, rubber products, paper and textiles are at the other end.

The trade pattern over the life cycle of a new product is illustrated in Figure 5. In the first stage of development, with time measured along the horizontal axis, the new product starts in, say the United States, at time t_o. After a while, at t_1, the United States begins to export some of the new product to other industrial countries. Then after a period of time, these countries develop their own ability to produce the new good by a successful imitation. The increasing imitation by other industrial countries makes them net exporters of the products at time t_3 in figure 5. As the technology in this product line ages and becomes increasingly standardized, the United States loses its comparative advantage and becomes a net importer of this good at t_4. It is also possible in this

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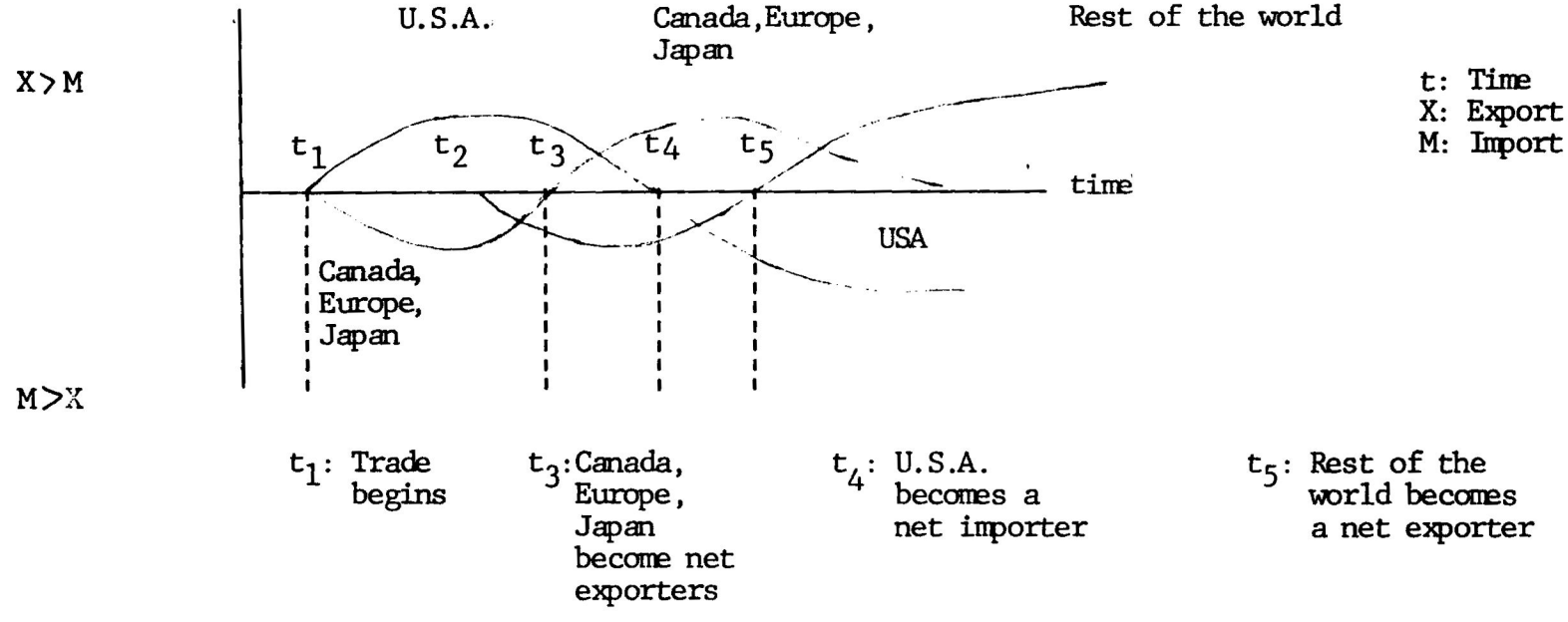
[31]Michael P. Claudon, International Trade and Technology (Washington, D.C.: University Press of America, 1977), p. 3.

FIGURE 5

How Trade Balances Might Evolve Over "Product Cycle" of a New Good



Source: Kindleberger and Lindert, International Economics (Richard D. Irwin, Inc., 1978), p. 77.

case to expect that the rest of the world, including the LDCs, can also catch up in time with the technological knowledge of Europe, Canada, and Japan in this aging product line. At t_5, the product cycle enters its final phase as far as trade is concerned, with the product being exported from the rest of the world (for example, from less developed countries) to the U.S.A. and other higher-income countries. What makes the mature product settle in less developed countries is their wage-rate advantage.[32] In other words, the wage rate advantage makes this product line a comparative advantage export item for less developed countries.[33] As long as the leader in this case, the U.S.A., keeps coming up with new goods to introduce into world trade, and as long as it maintains a monopoly of the knowledge needed to make the new product for longer periods, it can then retain its comparative advantage for longer periods of time.

Figure 5 shows that LDCs are the last to get the new technology. That indeed confirms the LDCs allegation against DCs in the area of technology transfer. The theory of the product cycle by itself requires the existence of a technological gap between countries in order for trade to circulate between them.

Chapters 2 and 3 of the study has shown conclusively that DCs have done many things to keep the technological gap

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[32]See table 14.

[33]Kindleberger and Lindert, International Economics (Homewood, Illinois: Irwin, 1978), pp. 77-78.

continually wide between them and LDCs. The restrictive practices that are associated with the transfer of technology, the high price of technology and finally the encouraging of the brain drain are but few examples. Mr. J. Fred Bucy, President of Texas Instruments, says:

> Today our toughest competition is coming from foreign companies whose ability to compete with us rests in part on their acquisition of U.S. technology .... The time has come to stop selling our latest technologies, which are the most valuable things we've got.[34]

Mr. Bucy's words indeed shed light on the unfair relationship between DCs and LDCs in the area of technology transfer and proves DCs' attempts to maintain the technological gap in their favor.

It seems clear now that the theory of the product cycle does not only show the pattern of trade between countries, but also explains the reasons behind DCs restrictive technology transfer policy.

LDCs Efforts to Narrow the Technological Gap

The inequities in the present international economic system was what led the "group of 77" to launch an official campaign for a new international economic order in 1974. The group of 77 came into being within the framework of UNCTAD I in 1964. The official call for a NIEO is manifested in four United Nations resolutions passed since May 1974.[35]

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[34] *Fortune* (May 22, 1978), p. 106.

[35] U.N. General Assembly, Resolutions 3201 (S-VI) and 3202 (S-VII), May 1, 1974, and Resolutions 3281 (XXIX), December 12, 1974, and Resolutions 3262 (S-VIII), September 16, 1975.

(i) The "Declaration on the Establishment of a New International Economic Order," adopted May 16, 1974.

(ii) The "Programme of Action on the Establishment of a New International Economic Order," adopted May 16, 1974.

(iii) The "Charter of Economic Rights and Duties of States," adopted December 12, 1974.

(iv) Resolution on "Development and International Economic Co-operation," adopted September 16, 1975.

The less developed countries have offered eight major proposals to correct the inequality in the present international economic system. These eight major proposals are included in the "Programme of Action on the Establishment of New International Economic Order." One of these proposals addresses the question of the technology transfer between DCs and LDCs.

The NIEO Proposal on the Transfer of Technology

The NIEO proposal on the "transfer of technology" states that:

All efforts should be made:

(a) To formulate an international Code of Conduct for the transfer of technology corresponding to needs and condition, prevalent in developing countries;

(b) To give access on improved terms to modern technology and to adopt that technology, as appropriate, to specific economic, social and ecological conditions and varying stages of development in developing countries;

(c) To expand significantly the assistance from developed to developing countries in research and development programmes and in the creation of suitable indigenous technology;

(d) To adopt commercial practices governing transfer of technology to the requirements of the developing countries and to prevent abuse of the rights of sellers;

(e) To promote international co-operation in research and development in exploration and exploitation, conservation and the legitimate utilization of natural resources and all sources of energy.

UNCTAD at its fourth session, held in Nairobi in 1976, decided in resolution 87 (IV), that an Advisory Service on the Transfer of Technology (ASST) should be established.

Major Areas of Activity of UNCTAD's Advisory Service and Example of Activities Already Undertaken

The Advisory Service co-operates with and assists the developing countries in:[36]

(a) The preparation of national technology policies and plans and their implementation in co-ordination with other relevant economic policies and plans;

(b) The establishment of national centers for the transfer and development of technology, and their links with other national bodies concerned in the process, as well as the productive system, public and private;

(c) The establishment of subregional and regional centers on transfer and development of technology, and of appropriate linkages among them, taking into account the various sectors of particular interest to developing countries;

(d) Dealing with the techno-economic, legal, commercial and developmental aspects of technology arrangement;

(e) The evaluation of the economic and developmental aspects of technological information, including

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[36] UNCTAD, Handbook on the Acquisition of Technology by Developing Countries (New York: UNCTAD Publication, 1978), p. 57.

patents and other forms of industrial property;

(f) The establishment of co-ordinated training programmes at the national, subregional, regional and interregional levels, seminars and exchanges of government officials, dealing with transfer and development of technology;

Examples of activities already undertaken at the request of government are given below.

(1) Establishment of Intitution and Formulation of Policies at the National Level.

(2) Formulation of Policies and Establishment of Initutional Machinery in Specific Sectors of Critical Significance;

(3) Training Programmes, In-house Training Fellowships;

(4) Contribution to the preparatory process for the United Nations Conference on Science and Technology for Development (UNCSTD).

Another effort that has been made to narrow the technological gap between DCs and LDCs is the conference that was held at Buenos Aires, Argentina in 1978 by United Nation Conference on Technical Co-operation Among Developing Countries. The following are some of the recommendations:[37]

1) National programming for technical cooperation among developing countries;

2) Adoption of policies and regulations favorable to technical co-operation among developing countries;

3) The strengthening of national information system for technical co-operation among developing countries;

4) The improvement of existing institutions;

5) Promotion of national research and training

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[37]United Nations Conference on Technical Co-operation Among Developing Countries, Report of the United Nations Conference on Technical Co-operation Among Developing Countries (Buenos Aires, 1978), p. 20.

centers with multinational scope;

6) The promotion of greater technological self-reliance in economic and social spheres;

7) Technical co-operation among developing countries in the cultural spheres;

8) Control of the "brain drain" from developing countries;

Collective self-reliance among developing countries has become one of the more widely discussed notions in the recent debate on international development strategies. Several pronouncements made recently at the international level have either put forward, or supported, proposals for co-operative skill exchange among developing countries. Thus, addressing the International Labour Conference in June 1975, the then Prime Minister of Srilanka noted that there were several developing countries that had

> .... adequate financial resources to be invested in development. However, a lack of skilled manpower seems to be inhibiting the speedy take-off of development projects. On the other hand, there are countries ... where, though they have the human resources, they lack the capital for investment in industry. In this context, it may be possible for trained manpower resources from countries where these are available to countries where their services are required. This would promote regional co-operation of a new type.[38]

More recently, in its resolution 32/192, of 19 December 1977, on reverse transfer of technology, the United Nations General Assembly in paragraph 3 urged:

> ... the developing countries to give immediate consideration to the modalities for promoting collective self-

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[38]International Labour Conference, Sixtieth Session, Record of Proceedings (Geneva, ILO, 1975), Tenth (special) Sitting (10 June 1975), p. 190.

> reliance among themselves with a view to using and developing their human resources on the basis of mutual advantage within the broader framework of co-operation in the fields of trade, technology and capital.[39]

There is also some empirical evidence which provides examples of and supports the case for greater inter-developing country co-operation in this area. For example, the four country case studies submitted by the UNCTAD secretariat, on India, Pakistan, Philippines and Srilanka, bring out a number of interesting facts in this regard. They show, for example, that there has, in recent years, been an increasing trend in favor of migration from certain skill-surplus to skill-deficit developing countries, and that several of the countries studied seem to be actively encouraging inter-developing country migration in selected skills. In Sri Lanka, for example, the study indicates that more than 35 percent of doctors, engineers, teachers and accountants (who migrated abroad over the period 1971-1974) went to ther developing countries. In the case of Pakistan, of the total number of nationals (both skilled and unskilled) employed abroad at the end of 1977, nearly 45 percent were working in other developing countries. In the case of India and the Philippines, the UNCTAD studies indicate that a significant amount of skilled manpower flows to the Middle East.[40]

The previous efforts and proposals by LDCs to narrow

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[39] UNCTAD, Co-operative Exchange of Skills Among Developing Countries (New York: UNCTAD Publications, 1979), p. 3.

[40] Ibid., p. 4.

the technological gap are very encouraging signals. However, those proposals remain to be explored in depth. Much research work needs to be done in this field in order to achieve viable policies.

The Question of Appropriate Technology for LDCs

The logic that the transfer of appropriate technology to LDCs will foster industrialization, increase employment, and stimulate trade has become a dominant theme in international development circles.

The NIEO proposal on technology transfer states that such transfer must take into account the social and economic conditions in less developed countries.

The economic conditions in developing nations differ in a number of respects from those of the industrialized nations. Typically, developing nations have rather large ratios of unskilled to skilled labor relative to those of developed nations. Most developing nations also have low rates of capital formation, so that they are characteristically capital-poor when compared with industrialized nations. Thus, unit labor costs in these nations are generally lower than those in the industrialized nations. These conditions have led many to consider the need to develop and use labor-intensive and/or capital saving technologies in developing countries. Such technologies are sometimes referred to as "appropriate" technologies. This usage can be misleading; for example, if a

nation's overriding goal is creating jobs over maximizing national income, more labor-intensive technologies might be chosen. On the other hand, it is hard to imagine a simplified, labor-intensive process to manufacture petrochemicals. Therefore, it can be argued that highly labor-intensive technologies are not appropriate for all industrial sectors even in developing countries.[43]

In this context, there is a tendency to blame unemployment in LDCs on the transfer of "inappropriate" technologies, in the sense that they use too little labor and too much capital.

The term "intermediate technology"[44] has been used to describe "appropriate technology." Presently, "there are no widely accepted definitions of what constitute an appropriate, low cost or intermediate technology."[45] So the question of how to develop technologies that are "appropriate" to the goals of developing nations is the subject of wide controversy. Because "appropriate technology" in this context means technology that is optimal for a particular situation in a particular developing nation, given that nation's economic and social conditions and goals.

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[43]Department of State. U.S. Science and Technology for Development: A Contribution to the 1979 U.N. Conference, p. 49.

[44]E. F. Schumacher, Small is Beautiful: Economics as if People Mattered (New York: Harper and Row, Publishers, 1973).

[45]Nicholas Jequier, ed., Appropriate Technology: Problems and Promises (Paris: December 10, 1976), p. 17.

any new product.

In the opinion of the writer, based upon the research undertaken, LDCs must continue their effort to narrow the technological gap between them and DCs. The co-operative exchange of skill among themselves is the first step toward improving their technological infrastructure in order to enable them to absorb the new technology that fits their needs. The responsibility does not only lie with LDCs, but with DCs also. They must stop restrictive practices in technology transfer, and implement policies to lessen the "brain drain." There is a code of conduct on transfer of technology that was drawn up by the Group of 77.[46] DCs need to give strong consideration to adopting this code. If this code[47] is adopted by DCs, it will go a long way towards minimizing some of the problems associated with the transfer of technology from DCs to LDCs.

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[46] UNCTAD, An International Code of Conduct on Transfer of Technology (New York, 1975).

[47] The main objectives of the Code would have to deal with the following problem areas:

a) To control and regulate the costs of technology, especially those arising from transfer pricing and accounting;

b) To eliminate the many restrictions associated with the transfer of technology to LDCs;

c) To give LDCs access to unpackaged technology;

d) To establish international rules that will act as safeguard to national laws and policies on transfer of technology.

CONCLUSION

At the beginning of the thesis, it was explained that technology is the main instrument for economic growth. The more the country spends on R&D the better its trade balance on manufactured commodities will be. This has been the case for DCs. On the other hand, the technological endowment needed for R&D in LDCs is very insignificant compared to DCs. This fact makes it impossible for LDCs to enter the world market of manufactured commodities and compete as well with DCs. The fluctuation in the prices of primary commodities and the increasing prices of manufactured commodities are causing a chronic balance of trade deficit in LDCs. The best way to alleviate this deficit which is the major cuase of underdevelopment in LDCs is the rapid adaption of R&D. But unfortunately, the technologies that have been transferred to LDCs have been accompanied by many restrictive practices, thereby undermining the R&D capabilities in LDCs. The study also showed that, the phenomenon of "brain drain" in LDCs discourage the development of local skills, thereby undermining the possibilities of self-reliance in development. The theory of the "Product Cycle" was used to show the location of LDCs in the world technology market. The results show that LDCs were at the end of the cycle. They were the last to receive new technologies for producing

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