AN ANALYSIS ON MUTUAL BENEFITS AND REQUIREMENTS OF TECHNOLOGY TRANSFER IN DEVELOPING COUNTRIES

KANG SUK-HOO*

I. Introduction

Technology is one of the most important contributors to economic development. Many developing countries have made economic plans to achieve the goals of a self-sufficient economy in which technology has played an important role. Developing countries are usually interested in agricultural technology for self-sufficiency of food and manufacturing technloogy to substitute for importing products. But most developing countries do not have the capabilities to develop the needed technology by themselves. They have frequently depended on technology transfer from advanced countries that has a very important influence on the patterns of world trade, rates of economic growth and standards of living.

There have been many criticisms of technology flows not only from developing countries but also from advanced countries. One of the most important and continuous criticisms from the developing side is that the advanced countries have tightly controlled technology exportation. The advanced side, however, argues that developing countries have not made much effort to meet the requirements for successful technology transfer and adaptation. The argument of the advanced countries raises the question of what grounds they have.

This paper attempts to evaluate the argument of the advanced group. This starts with an identification of the factors that influence successfull technology transfer and adaptation. In order to examine these efforts, seven important factors that are believed to have a strong influence on the requirements are chosen and the selected factors of twelve developing countries for which data are available will be compared with those of the twelve members of the Organization for Economic Cooperation and Development (OECD). The indices to measure those factors are constructed. These indices will provide a concrete understanding and evaluation of the requirements for technology transfer. The analysis of the argument

* Hanyang University.

is not conclusive since the developing countries are divided into two groups—one group meets the requirements of technology transfer to some degree and the other group does not sufficiently meet the requirements.

Major purposes of this paper are to identify the channels of technology transfer, to evaluate mutual benfits from technology transfer and preconditions for the successful technology transfer by developing countries, and to discuss issues related to technology transfer.

II. Channels of Technology Transfer

Technology consists of ideas about how to make goods, production facilities required to manufacture those goods, or managerial skills. The sources of those ideas for new technology are scientific research and corporate or individual invention that most developing countries can hardly conduct by themselves because of a lack of highly trained people. The developing countries have, thus, heavily depended on the importation of technology from advanced countries.

The package of technology imported consists of the tranfer of patents or trademarks, the ability to do something well, good product design, and special application techniques. It also includes anything that is sufficiently distinctive to permit the technology importer to be a strong competitor in a particular market.

The package of technology transfer can be accomplished through many channels. The mobility of personnel, which refers to students educated abroad and the emigration of engineers and skilled workers, accounts for much of technology transfer. Another important channel takes the form of an international trade in goods and services. This type of technology transfer has rapidly increased among the advanced countries (Norris and Vaizey 1973, p. 125). Technologies also transfered through official aid programs of both bilateral and multilateral aid agencies.

It is multinational companies (MNCs) that play the most important role in transferring technology internationally. Technology transfer through the MNCs takes the form of licensing agreements, joint ventures, and direct investiments, whereby the MNCs establish and manage overseas branches and subsidiaries. MNCs not only train people as operatives and managers for successful technology transfer and adaptation, but also stimulate suppliers to upgrade their technology.

III. Benefits and Criticisms of Technology Transfer

This section focuses on evaluating the arguments of the developing countries that advanced countries have not been generous in technology transfer with them. Their arguments are briefly analyzed by discussing the benefits and criticisms of technology transfer based on past studies in this matter.

International exchange of technology is necessary and beneficial for both givers and receivers. Technology exchange would help solve the major problems facing humanity—overpopulation, air pollution, water pollution, and starvation. A free flow of technology contributes in important ways to a rising standard of living in the world. Technology exchange has also provided an abundance of goods and a continuous flow of new experiences of modernization in the developing countries.

Technology transfer has not only brought benefits to the developing countries but also to MNCs of the advanced countries. Technology transfer which has been accomplished through manufacturing licenses and joint ventures could provide the opportunities to access foreign markets to the technology providing country because the exploitation of know-how can leap across oceans and surmount tariff barriers, quotas, labor costs, differentials, and other restrictions to foreign trade development.

From a licensing relationship, MNCs can expect royalties or technical fees which are generated by the use of their technology. The MNCs can expect technical and product feedback. Continuing interchange with an overseas partner will give the MNCs the partner's ideas for adapting know-how and experience to market environment and industrial standards. Through partner's ideas, the MNCs could improve product design, come out with new products, manufacture products more economically, find new markets, improve application engineering, and establish the scope of product acceptance, which every manufacturer throughout the world is facing.

The MNCs can also increase the sale of their products by offering technology abroad, because their partners in overseas markets become new customers for their products such as manufacturing equipment, components, or certain models or designs necessary for the overseas partners. Technology transfer is not only feasible but can provide most MNCs with tremendous incentives for long-term profit and growth. A Danish economist, professor Erik Hoffmeyer, noted that many MNCs in the United States "tend to specialize in research-intensive goods and, as a result, the exports of these companies had increased twenty times in the period between World War I and the mid-fifties, while exports of traditional goods merely trebled (Fiatemi and Williams 1957, p. 118). Dr. Michael Boretsky emphasized in his studies that progress and expansion of United States trade depended largley on the export of higher-technology products (Fiatemi and Williams 1957, p. 119). These two studies support the claim that the high technology of the United States has contributed to the increase of its exports. Because technology has mobility, it enables a manufacturer to gain permanent penetration of overseas markets without diverting capital, mangement talent or engineering talent (Lang 1973, p. 62).

Some MNCs have been concerned that if they expose their intimate knowledge to a foreign company, the company could use it to compete in their own market. This problem is not really valid for a number of reasons. First, know-how can be dealt with as a property value; the laws in most countries protect it. Second, there are contractual techniques for limiting the use of know-how by others. Third, those who are concerned about revealing their know-how are often deluding themselves; any competitor, given enough time, money, and talent, could acquire this know-how. Fourth, know-how is a wasting asset; it becomes obsolete as technology advances and markets change.

Imported technologies have not always brought benefits to the developing countries. Mexico, for example, has had some problems (Said and Simmons 1975, p. 84). This Mexican case shows one important criticism made by the developing countries on technologies transferred from the advanced countries. The machinery and equipment used by foreign subsidiaries in Mexico are frequently obsolete. Sometimes there is interference in the production, marketing, and administration of the technology-importing company. Often contract specifications enable the supplier to fix prices and either limit or prevent research by the recipient company. The supplier bans the use of alternate technology and sets itself up as the sole purchaser of the goods produced.

Because of this type of restriction, the Mexican government has regulated technology transfer by a new law. Under this law, contracts or agreements for the import of technology will not be approved when they prohibit or limit the export of goods or services produced by the technology imported in a way contrary to the interests of the country.

The developing countries continue to make other criticisms of technology transfer by MNCs. These are that MNCs arrange licensing agreements even with their own subsidiaries which result in excessive fees and perhaps no transfer of new technology and MNCs do not provide enough training (Mason 1973, p. 5).

Professor Mason noted that these criticisms are not true. He tested twenty eight firms in Mexico and the Philippines. When he compared licensing fees in Mexico and the Philippines with the fees in Europe, he found they were not excessive. He stated that "without the licensing arrangement it would be virtually impossible to continue production and that the licensing fee was a real bargain." Information regarding licensing fees is presented in TABLE 1.

In regard to the second criticism, failure to provide training, professor Mason found that there were a small number of expatriates in highly technical positions for which nationals were not yet qualified. His study showed that the local firms in his sample of the Philippines and Mexico had a total employment of 11,873 with 50 expatriates among them, while the 14 firms of the United States in both countries had a total employment of 10,354 with 76 expatriates. When one considers that the local firms

TABLE 1 Royalties and Fees as a Percentage of Assets—All Industries

	1957	1964	1968	1969
All Areas	0.95	1.70	1.92	1.93
Canada	0.69	1.17	1.34	1.27
Latin America	0.94	1.66	1.73	1.73
Europe	1.40	2.54	2.63	2.79
Others	1.03	2.23	1.92	1.92

Source: *California Management Review,* (Summer 1973), p.6.

produced products with a somewhat lower level of technical refinement, the extra 0.03 percent of the expatriates of the United States would not seem to be an extraordinary demand.

Professor Mason's survey showed that MNCs trained more local personnel than similar locally-owned firms, and the subsidiaries of the United States trained in a broader spectrum of skills, particularly at the higher technical, professional, and managerial levels. The criticisms made by the developing countries are, therefore, groundless.

IV. Requirements for Technology Transfer

The success of technology transfer and adaptation depends critically on human factors. According to the MNC's experience, a major obstacle to the technology flow was a lack of the right people for successful technology transfer in developing countries (Bairoch 1975, p. 135; Ramaer 1977, p. 236; Hayami and Ruttan 1971, p. 170). In order to digest incoming technology, there should be trained personnel on the receiving side of the developing countries who can communicate with foreign partners and know enough to ask the right questions. It raises the question of how a developing country can overcome the major obstacles to the technology inflows. How can people in developing countries, in other words, become capable of learning foreign technology?

People's capabilities to utilize incoming technology basically come from education which plays a major role in economic life. Most people learn basic and advanced knowledge through formal education. Education is the most important factor to eliminate the major obstacle of technology transfer. Therefore, it can be stated that the abilities to elarn foreign technology have a functional relation with education.

It can be stated that factors related to education determine the level of the preconditions for successful technology transfer and adaptation. These factors which influence successful technology transfer probably include the level of people's education, public expenditure on education, public expenditure on research and development, legal restrictions on technology transfer, government desire for economic development, availability of raw materials, and the market situation of both transferring and receiving countries.

In order to evaluate the efforts of developing countries to meet the requirements of the technology inflow, more important factors among the above are chosen. The seven factors selected are literacy rates, the primary school enrolement rates, secondary school enrolment rates, numbers of scientists and engineers, numbers of technicians engaged in research and development, expenditure for research and development and public expenditure on education. There would be some correlation among these seven factors. The level of the requirements for technology transfer can be a function of the seven variables above. The level of requirements will change as the seven factors change. Thus, it is possible that the seven factors may be treated as independent variables and the level of the preconditions as a dependent variable.

It is also true that the independent variables are related to each other. The five independent variables such as the literacy rates, primary school enrolement rates, secondary school enrolment rates, numbers of scientists and engineers and the number of technicians will be affected by a change in expenditure on education. Both the number of scientists and engineers and the number of technicians engaged in research and development have a functional relation with expenditure for research and development. This means that the number of research persons is influenced by expenditure on education and expenditure for research and development. These relationships among the variables imply that if a country emphasizes expenditure on education and research and development, its future is probably promising for technology inflow and, thus, for economic development even though it has a low literacy rate, a poor school enrolment rate, and a small number of research persons at the present time.

The effect of the seven variables combined determine the level of the requirements for technology transfer. But the measures of the seven variables of a country may not be enough to indicate a degree to meet the preconditions of successful technology transfer. However, a comparison of the levels of these seven factors in a developing country with those of the OECD group could provide a fair indication in the evaluation of the level of the requirements to meet technology transfer. It could be possible to develop indices by computing the ratio of the level of each factor of the developing country to the level of the corresponding factor of the OECD members. The indices can explain to what extent a developing country meets the preconditions for the technology inflow.

An assumption for index construction is made that a certain level of meeting the requirements for technology transfer should exist, that is, a country may not have any obstacle to technology importation if it reaches this level. The level may be an average of the twelve OECD countries for each factor since we may assume that the OECD countries have no obstacle to the requirements of the technology inflow.

Table 2, 3 and 4 present the levels of the seven factors which influence technology transfer in both the developing and OECD countries. The factors related to determinant of educational level are listed in Table 2. The factors related to research and development and public expenditure on education are shown in Tables 3 and 4, respectively. Table 5 provides the index of each factor for each developing country.

Table 2 presents the three factors of literacy rates, primary and secondary school enrolment rates for both twelve developing and twelve OECD countries. There are important differences in literacy rates between the two groups. The literacy rates of the developing group are in a range between 14.7 percent and 87.6 percent. Korea is the country with the highest literacy rate of 97 percent among the developing group while Sudan is the country with the lowest rate of 14.7 percent. Meanwhile, the literacy rates of all OECD countries are more than 97 percent. Even Korea with the highest rate does not come up France with the lowest rate among the OECD countries. The average rate of the twelve developing countries is 55.3 percent which is only a little over half of the average for the OECD group.

It is interesting to note that there are substantial differences in the male and female literacy rates of the developing countries. Women's literacy rates in the most developing countries are lower than that for men by 20 percent. Women's lower rates imply that the developing countries are not utilizing women labor. The lower literacy rates of women may be related to slow progress in technology in the developing countries and to a delayed diffusion of technology.

The primary school enrolment rates of the developing countries are widely scattered, ranging between 39 and 110. Peru has the highest rate of 110 while Sudan has the lowest rate of 39 among the developing countries. The developing countries are distinctly divided into two groups: one with higher primary school enrolment rates and the other with the lower rates. The higher group has rates above 100 and the lower group below 100 (The calculation method of school enrolment rates are based on the *UNESCO Statistical Yearbook* 1982, pp. III-81; The higher the rate, the better the school enrolment rate is). The higher group consists of seven countries such as Ecuador, Korea, Mauritius, Peru, Philippines, and Turkey of which the average rate is 105.5, higher than the OECD average of 104.4. Thus, the higher group's future is promising for technology inflow. Indonesia has the highest rate of 82 among the lower developing group.

There are large differences in the secondary school enrolment rates between the developing and the OECD countries. Korea has the highest rate of 63 while Malawi has the lowest rate of 5. The average rate of 35.2 for the developing countries is much lower than the average rate of 81 for the OECD group. But the rates of the three developing countries of Korea,

TABLE 2 Literacy Rate and School Enrolment Rates

OECD Countries	Literacy Rate (%)* Year	Literacy Rate (%)* Total	Primary School Enrolment Rate**	Secondary School Enrolment Rate**	Developing Countries	Literacy Rate (%) *** Year	Literacy Rate (%) *** Total	Literacy Rate (%) *** Male	Literacy Rate (%) *** Female	Primary School Enrolment Rate**	Secondary School Enrolment Rate**
Austria	1970	99	102	77	Ecuador	1974	74.2	78.2	70.4	102	42
Denmark	1970	99	103	77	Guatemala	1973	46	53.6	38.5	69***	16***
France	1970	97	108	85	India	1971	34.1	47.7	19.4	79	28
West Germany	1971	99	129	66	Indonesia	1971	56.6	69.5	44.6	82	20
Iceland	1970	99.9	101	79	Korea	1970	87.6	94.4	81	109	63
Japan	1972	98	101	92	Malawi	1977	22.1	3.7	12.3	56	5
Netherlands	1972	98	101	93	Mauritius	1980	79	86	72.3	103	45
New Zealand	1970	98	111	92	Nigeria	1980	34	45.6	23	49	56
Norway	1973	100	102	89	Peru	1972	72.5	83.3	61.8	110	49
Sweden	1982	99	96	70	Philippines	1970	82.6	84.3	80.9	105	56
Switzerland	1980	99	90	52	Sudan	1966	14.7	25.3	3.7	39	13
U.S.A.	1971	99	109	100	Turkey	1975	60.2	77.2	43.1	104	29
Average		1.23	104.4	81			55.3	64.9	45.9	83.9	35.2

Source: **Background Notes*, United States Department of State, Bureau of Public Affairs.
**Alan A. Tait and Peter S. Heller, *International Comparisons of Government Expenditure* (Washington, D.C.: International Monetary Fund, April, 1982): Data are in 1977 or latest available year.
***UNESCO, *Statistical Yearbook*, 1982.

Nigeria, and the Philippines exceed Switzerland, one of the OECD countries in which the rate of 52 is the lowest among the OECD countries.

The factors in Table 2 may lead to the conclusion that the developing countries are classified into two groups and the group with the higher levels for the three factors may not have much difficulty in importing relatively simple technology. But the lower group should make efforts to raise the level of educaton.

Table 3 shows the three factors to represent the research and development potential of each country and the per capita income. The numbers of

TABLE 3 HUMAN AND FINANCIAL RESOURCES FOR RESEARCH AND DEVELOPMENT (R&D)

OECD Countries	Personel Engaged in R&D* (Per Million Population)			Expenditures for R&D as percentage of GNP*	Income per Capita**	
	Year	Scientists & Engineers	Technicians		Year	USS
Austria	1975	716	657	0.9	1979	9.114
Denmark	1980	1,174	1,809	1.0	1980	12,956
France	1979	1,363	2,952	1.8	1977	7,210*
West Germany	1979	1,989	1,883	2.4	1981	11,142
Iceland	1979	1,309	935	0.8	1979	9,000
Japan	1980	3,808	748	2.1	1980	8,460
Netherlands	1979	1,857	1,979	1.9	1981	9,749
New Zealand	1976	1,192	1,031	0.9	1981	7,363
Norway	1980	1,818	1,855	1.3	1980	12,432
Sweden	1979	1,781	2,614	1.9	1980	14,821
Switzerland	1979	2,592	2,502	2.3	1981	15,698
U.S.A.	1980	2,800	——	2.4	1977	8,431*
Average		1,867	1,724	1.64		10,531
Developing Countries						
Ecuador	1979	185	178	0.3	1980	1,050
Guatemala	1978	83	65	0.2	1980	1,083
India	1977	46	42	0.5	1981	245
Indonesia	1976	57	39	0.2	1980	415
Korea	1981	483	194	0.6	1980	1,403
Malawi	1977	34	44	0.2	1979	220
Mauritius	1979	163	132	0.4	1981	1,052
Nigeria	1977	31	19	0.3	1977	551
Peru	1976	247	140	0.3	1981	1,102
Philippines	1975	87	61	0.2	1980	779
Sudan	1978	188	188	0.2	1982	370
Turkey	1979	221	96	0.6	1978	1,140
Average		152	100	0.33		793

Source: * *UNESCO Statistical Yearbook* 1982.

** *Background Notes*, United States Department of State, Bureau of Public Affairs.

** Alen A. Tait and Peter S. Heller, *International Comparisons of Government Expenditure* (Washington, D. C.: International Monetary Fund) April, 1982).

scientists and engineers per million population are in the range between 31 for Malawi and 483 for Korea. The average number of about 152 persons in the developing countries are below one tenth of the average number of the OECD countries. The average OECD country has 17 times more technicians engaged in research and development than the average developing country does.

There are also considerable differences in expeditures for research and development as percentage of gross national products between the two groups. All developing countries spend far less than one percent while most OECD countries spend far more than one percent for research and development. No developing country reaches the level of the OECD countries in this factor. The low levels of this factor imply that the developing countries do not have enough capability for developing sophisticated technology by themselves. Most developing countries in this case may not meet the requirements of the technology inflow.

The factors which represent research and development potential are probably the most important factors to speed up the technology inflow and to accelerate economic development. It is worth noting that the Japan's higher levels for these factors than most OECD countries have probably contributed much to their outstanding achievement in electronic and optical technology. A relatively larger number of scientists and engineers and more expenditure for research and development have made possible the recent economic success in Japan.

The level of expenditure on education is correlated which the six factors discussed earlier. The expenditure on education also indicates a government's commitment to educate its people. A country could improve its literacy rate, school enrolment rate, and increase the numbers of scientists, engineers and technicians as it increases investment in education. Thus, the expenditure on education is a fundamental factor in improving the preconditions for technology inflows.

Education expenditure as percentage of total expenditure and as a percentage of government domestic product (GDP) is shown in Table 4. It is to be expected that the developing countries spend more on education than the OECD countries since many developing countries have emphasized economic development to catch up with the advanced countries; yet this expectation is not realized. The developing group spends an average total expenditure of 12.6 percent for education which is lower than the OECD countries' average rate of 13.6 percent, making a difference of 1.0 percent. The difference in public expenditure on education as percentage of GDP between the two groups becomes 2.2 percent. Although the difference in the rate is not large, it would be substantial in the actual amount since the GDP for the OECD countries is much greater than that for the developing countries. In addition, the private sector's contribution should also be considered since the private sectors in the

TABLE 4 Public Expenditures on Education in 1971

OECD Countries	Education as Percentage of Total Expenditure	Education as Percentage of GDP	Developing Countries	Education as Percentage of Total Expenditure	Education as Percentage of GDP
Austria	10.1	3.7	Ecuador	25.7	3.5
Denmark	9.9	3.6	Guatemala	11.8	1.4
France	15.1	5.8	India	1.7	0.3
West Germany	12.1	4.7	Indonesia	——	2.8*
Iceland	11.6	3.7	Korea	14.3	2.7
Japan	19.0	4.2	Malawi	10.4	2.2
Netherlands	14.9	7.9	Mauritius	13.3	4.8
New Zealand	13.6	5.1	Nigeria	7.7	2.4
Norway	18.0	7.7	Peru	17.5	3.5
Sweden	14.1	7.7	Philippines	11.9	1.8
Switzerland	3.9	0.8	Sudan	5.1	1.3
U.S.A.	21.4	5.0	Turkey	19.1	4.9
Average	13.6	5.0		12.6	2.6

Source: Alan A. Tait and Peter S. Heller, *International Comparisons of Government Expenditure* (Washington D.C.: International Monetary Fund, April, 1982).
*UNESCO, *Statistical Yearbook*, 1982, p. IV-14.

TABLE 5 INDICES TO REQUIREMENTS OF TECHNOLOGY TRANSFER

	Literacy Rate	Primary School Enrolment Rate	Secondary School Enrolment Rate	Scientists and Engineers	Technicians	R & D Expenditure	Education Expenditure*
Average of OECD countries	100% (99.74)	100% (104.4)	100% (81)	100% (1,867)	100% (1,724)	100% (1.64)	100% (13.64)
Ecuador	79.5	97.7	51.9	9.9	10.3	18.3	188.4
Guatemala	57.1	66.1	19.8	4.4	3.8	12.2	86.5
India	47.7	75.7	34.6	2.5	2.4	30.5	12.5
Indonesia	65.6	78.5	24.7	3.1	2.3	12.2	——
Korea	90.2	104.4	77.8	25.9	11.3	36.6	104.8
Malawi	38.2	53.7	6.2	1.8	2.6	12.2	76.2
Mauritius	83.3	98.7	55.6	8.7	7.7	24.4	97.5
Nigeria	47.6	46.9	69.1	1.7	1.1	18.3	56.5
Peru	78.2	105.4	60.5	13.2	8.1	18.3	128.3
Philippines	86.2	100.6	69.1	4.7	3.5	12.2	87.2
Sudan	32.3	37.4	16.0	10.1	10.9	12.2	37.4
Turkey	68.4	99.6	35.8	11.8	5.7	30.6	140.0
Average	64.5	80.4	43.4	8.15	5.8	20.3	92.3

* Education expenditure as percentage of total expenditure.

OECD countries usually take some of the government's responsibility for expenditure on education. The addition of the private sector's contribution apparently makes even largert he difference between the educational expenditure of the two groups.

Table 5 shows a comparison index for each factor of each developing country with the corresponding factor for the twelve OECD countries. For the developing countries, the ratio of each corresponding factor to the average factor of the twelve OECD countries is computed and given an index for the purpose of factor comparison. An index of each factor of a developing country indicates as percentage of the average level for the twelve OECD countries.

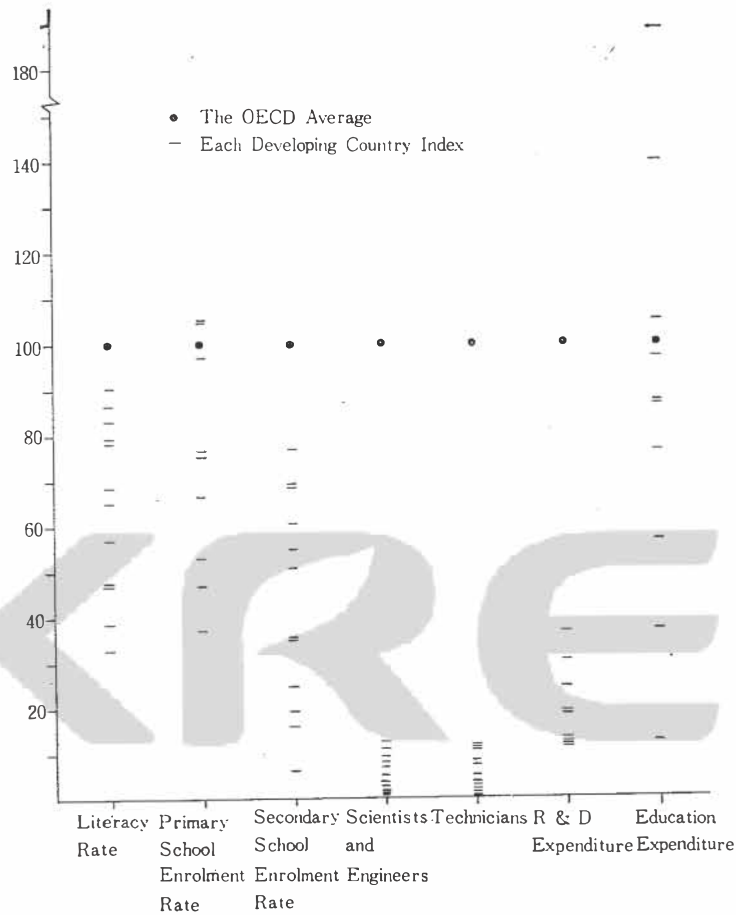
As a result of the index constructed, Figure 1 is obtained. Figure 1 enables quick understanding of a situation in which the developing countries meet the requirements for technology inflow to them. Most developing countries the preconditions such as the primary school enrolment rate and educational expenditure. But they seem to have some obstacles to the advanced technology inflow since they have low indices for the research and development related factors.

This tendency becomes more apparent if an index matrix in Table 6 is deisgned. In Table 6 the seven factors are divided into three groups in accordance with the level of the index, making an index matrix; the high-index-factor group, the middle-index-factor group, and the low-index-factor group. A factor is, for example, classified into the high group if its index is above 66.6 percent, into the middle group if its index is between 33.4 percent and 66.6 percent, or in the low group if its index is below 33.4 percent. The high group consists of two factors; the primary school enrolment rate and the education expenditure as percentage of total expenditure. The middle group includes two factors; the literacy rate and the secondary school enrolment rate. The low group consists of three factors; the number of scientists and engineers, the number of technicians and the R & D expenditure.

The twelve developing countries are also classified into three groups in accordance with the index of each factor for each country; the high-index-country group, the middle-index-country group and the low-index-country group. The criteria index for this country classification is the same as the index factor classification.

The index matrix in Tables 6 and 7 is obtained as a result of the index factor classification and the index country classification. The two index matrixes show the cross sectional evaluation for the preconditions for the technology inflow to the developing countries. The figures in Tables 7 indicate the number of the devloping countries that belong to that cell. Use of the index matrixes leads to the conclusion that most of the twelve developing countries meet the preconditions for some simple technology inflow since they have higher indices for the two factors of

FIGURE 1 INDICES FOR THE REQUIREMENTS OF TECHNOLOGY TRANSFER



the primary school enrolement rates and educational expenditure and moderate indices for literacy rates and secondary school enrolemnt rates. But probably all developing countries, except Korea, the Philippines, and Turkey, may not satisfy the preconditions for highly sophisticated and advanced technology inflow since they have very low indices for the three factors of the numbers of scientists and engineers, the number of technicians and the R & D expenditure.

Korea, the Philippines and Turkey seem not to have many obstacles to technology inflow of some advanced technologies since they meet the OECD levels for most the preconditions except the two requirements of the numbers of scientists and engineers and the number of technicians engaged in research and development. Improvement in the preconditions for the technology inflow could explain the recent economic success in Korea.

TABLE 6 INDEX MATRIX

Index		High		Middle		Low		
		Primary School Enrolment Rate	Educational Expenditure	Literacy Rate	Secondary School Enrolment Rate	Scientists and Engineers	Technicians	R & D Expenditure
High	Korea	H	H	H	H	L	L	M
	Philippines	H	H	H	H	L	L	L
	Turkəy	H	H	H	M	L	L	M
Middle	Ecuador	H	H	H	M	L	L	L
	Mauritius	H	H	H	M	L	L	L
	Peru	H	H	H	M	L	L	L
	Nigeria	M	M	M	H	L	L	L
Low	Guatemala	M	H	M	L	L	L	L
	India	H	L	M	M	L	L	L
	Indonesia	H	—	M	L	L	L	L
	Malawi	M	H	M	L	L	L	L
	Sudan	L	M	L	L	L	L	L

H: High, M: Middle, L: Low

TABLE 7 FACTOR-COUNTRY MATRIX

		Index						
		High		Middle		Low		
		Primary School Enrolment Rate	Educational Expenditure	Literacy Rate	Secondary School Enrolment Rate	Scientists and Engineers	Technicians	R & D Expenditure
Countries	High	8	8	6	3	0	0	0
	Middle	3	2	5	5	0	0	2
	Low	1	1	1	4	12	12	10

V. Conclusion

Both the developing countries and the OECD countries have made criticisms of each other on technology transfer; the developing countries criticize the OECD countries for not being generous in transferring technology while OECD countries criticize that the developing countries have not tried to meet the requirments for technology transfer. This analysis, however, indicates that the arguments of both sides do not have strong supporting evidence.

This study focuses on analysing the arguments of the OECD countries concerning the requirements of technology transfer. The seven factors that are related to education were chosen for this evaluation since the rate of technology transfer and adaptation was strongly related to the educational level of people (Solo and Rogers 1972, p. 105). This evaluation shows that the arguments of the OECD countries are not conclusive since the arguments have had neither firm ground nor strong support. This analysis, however, indicates that all developing countries should make more efforts to produce research personnel and increase expenditure for research and devleopment.

Technology transfer should not be restricted for many reasons: First, the highly advanced industry of the modern world is based on a free exchange of scientific information and the competitive sale or licensing of technology. Second, technology transfer brings benefits for both technology givers and receivers. Successful innovations in advanced countries have relied heavily on inputs of foreign knowledge. It is also essential for the rapid economic development of the developing countries. Technology transfer will help raise the standards of living throughout the world and improve the world allocation of resources.

This analysis has many limitations: First, the data used in this analysis was not collected from the same year which would otherwise, make the indices developed here different. Second, there are many factors which influence the requirements for technology transfer but only these seven factors were evaluated. Third, only twelve developing countries among many were examined. This attempt, however, provides a starting point for the discussion and assessment of the requirements for technology transfer.

REFERENCES

Bairoch, Paul, *The Economic Development of the Third World since 1900*, Trans. Cynthia Posta, Berkeley and Los Angeles: University of California Press, 1975.

Bureau of Public Affairs, U. S. Department of State, *Background Notes*, Washington, D. C.: GPO, 1983.

Fiatemi, Nasrollah S. and Gail W. Williams, *Multinational Corporations: The*

Problems and the Prospects, New York: A. S. Barnes and Company, 1957.

Hayami, Yujiro and Vernon W. Ruttan, *Agricultural Development: An International Perspective,* Baltimore: The Johns Hopkins Press, 1971.

Lang, Eugene M, "Technology Transfer: A Quick Route to Foreign Markets," *Management Review,* November 1973.

Mason, R. Hal, "The Multinational Firm and the Cost of Technology to Developing Countries," *California Management Review,* XV, No. 4, Summer, 1973.

Norris, Keith and John Vaizey, *The Economics of Research and Technology,* London: George Allen & Union Ltd., 1973.

Ramaer, J. C., "The Choice of Appropriate Technology by a Multinational Corporation: A Case Study of Messrs Philips, Eindhoven," In *Appropriate Technologies For Third World Development: Proceedings of a Conference Held by the International Economic Association at Teheran, Iran,* Ed. Austin Robinson, New York: St. Martin's Press, 1977, 239–245.

Said, Abdul A. and Luiz R. Simmons, eds., *The New Sovereigns: Multinational Corporations as World Powers,* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1975.

Solo, Robert A. and Everett M. Rogers, eds., *Inducing Technology Change for Economic Growth and Development,* Michigan State University Press, 1972.

Tait, Alan A. and Peter S. Heller, *International Comparisons of Government Expenditure,* Washington, D. C.: International Monetary Fund, April 1982.

UNESCO, *Statistical Yearbook,* 1982.