The Developing Economies, XXIV-4 (December 1986)

JAPANESE STUDIES ON TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES: A SURVEY

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I. STRUCTURAL CHANGES OF WORLD ECONOMY AFFECTING TECHNOLOGY TRANSFER

STUDIES on North-South technology transfer, initiated globally in 1961 under a U.N. resolution proposed jointly by Brazil and Colombia, were begun in Japan only toward the end of the 1960s. Their promotion in Japan was associated with the phenomenal increases in Japan's direct overseas investment in the years 1967–73 due to (a) a more positive attitude on the part of other Asian countries toward foreign investment in consonance with their switch-over to export-oriented industrialization, (b) Japan's liberalization of capital movements, and (c) rising wage costs in Japan. Indeed, Japan was then emerging as a significant technology-exporting country, especially to the developing Asian countries, as symbolized by a turn to the black in Japan's technology trade balance in terms of new contracts in 1972.

Despite the general recognition of the importance of technology transfer in the economic development of the less developed countries, the actual process has been characterized by unevenness both country-to-country and industry-to-industry, thereby spurring hopes or bringing disappointment to the nominal beneficiaries. Japan's increased direct investment and technology export also gave rise to anxieties as well as optimism among various Asian countries. This, too, was a factor prompting Japanese studies of the issues involved.

Recent changes in world economic conditions have heightened the need for such research. Stagnation of the Japanese economy in the aftermath of the oil crisis, necessitating industrial readjustments, highlighted the need to analyze the influences that technology export might have upon the readjustment process and also the possibility of it inducing so-called boomerang effects. Unlike the industrialized countries such as Japan, NICs managed to avoid declining economic growth rates in the 1970s and, at a time when the industrialized countries' markets were slack, continued to be important buyers of industrial goods. Then, with the advent of the 1980s, the NICs, now on higher technological levels, began to seek capital goods embodying more advanced technologies, and durable consumer goods, in place of the non-durable goods and steel and other materials which they had been after a decade or so earlier. For example, the Republic of Korea in 1983 asked the Japanese government for fifty items embodying the "most advanced" technology. Requests like this have caused numerous frictions between Japan and the NICs.

Thus changes in the world economic environment as well as in Japan's position in it called for studies of the international transfer of technology and also affected the course that such studies have taken. In the following sections, the evolution of Japanese research on international technology transfer will be surveyed in relation to the changes sketched out above.

II. THE ROOTING OF TECHNOLOGY AS A FOCUS

A. *Needs-Resources (N-R) Relation Hypothesis*

Japanese studies on international technology transfer were initiated by Masaru Saitō. Presently still playing a leading role in the field, since the middle of the 1960s this pioneer has made a comprehensive analysis of various issues of technology transfer such as markets, channels, and policies [27]. Saitō proposes what he calls an "N-R relation hypothesis" as a central tool for analysis. According to him, technology transfer is oriented and conditioned by the relationship between technological *needs* of both the giver and the recipient (enterprises or countries), on the one hand, and the *resources* available to meet them—such as technology, capital, labor force, and raw materials—on the other. Bottlenecks of one kind or another growing out of the relationship call for innovation and international technology transfer. Needless to say, needs and resources are thought by Saitō to vary from enterprise to enterprise and country to country and also in accordance with different stages of economic development.

The transfer of technology has been seen by E. M. Rogers and others as two processes: adoption and diffusion. The *adoption process* begins when a recipient enterprise (or country) becomes aware of the availability of a technology and continues till it finally adopts it, while the *diffusion process* involves the spread of technology among a number of enterprises (or countries). Saitō mainly concerns himself with the former, which he tries to elucidate by the N-R relation hypothesis.

The reviewer thinks it correct to see technology transfer as being conditioned by the relationship between needs and resources, and Saitō himself has gone on to conduct comprehensive studies on the international transfer of technology by relating the dimentions and directions of given cases of technology transfer to the varied needs of the enterprises or countries concerned at different stages of economic development as well as to the availability of resources [27] [28].

Yet, in spite of the basic assumption of the Saitō hypothesis that technology transfer takes place when needs are met by resources, actual cases of transfer have not always satisfied developing countries. Hence there is a need for detailed analysis of factors that make for successful transfers. This leads to the question of the rooting of technology in foreign soils.

B. *Rooting of Technology*

If we look back over the history of technical assistance and technology transfer, we quickly recognize that even after the introduction of technology in its hardware form, the introducers have found themselves severely limited in their ability to

repair, improve, and develop the introduced technology. This recurrent problem called for closer examination of the essence of technology transfer, the phases it must go through, and particularly the stages of technology transfer that particular countries are at. Hence the need to discuss the question of "the rooting of technology."

In the first place, it needs to be noted that while goods or materials may be transferred in their entirety at a certain point in time, the flow of technology per se is a gradual one, its constituent elements being transferred one after another. Again, according to how widely or narrowly one views "technology," the understanding of technology transfer will vary. To put it another way, the transfer of the mere ability to operate a machine is different in substance from the transfer of the ability to repair it, not to mention of the capability to further develop it. Thus comes the recognition that technology transfer in the full sense of the term must be nothing less than the transfer of the capacity to understand and develop the introduced technology. One may say that this idea is an extension of Rogers's "adoption process." If the "adoption process" is one of the flow of a technology from one economic unit to another, the rooting of technology denotes a process of technology transfer over a longer time span and in the broader sense.

In Saitō's view, for example, the rooting of technology is "the state of affairs where a technology introduced into a country is understood, mastered, and used for a long period of time by the people there" [27]. Mikoto Usui, another Japanese student of technology transfer, understanding it even more broadly, sees it as not only the process of acquiring a machine-operating technique at the factory level, but also as a process of technological "capacitation," i.e., the formation of the relevant technological base as well as of an institutional capacity on the industry level [34]. Studies by Takeshi Hayashi [3], Pak U-Hui and Masanori Moritani [24], and others also deal with this subject. Based on the Japanese experience, Hayashi sums up the stages to be passed through as follows: (1) the mastering of machine-operating technique; (2) the acquiring of maintenance capabilities; (3) the mastering of repairing technique, including the ability to make minor improvements; (4) attainment of the ability to undertake unaided technological design; and (5) the beginnings of autonomous home production and the development of new technology. Pak and Moritani divides the process into seven stages instead of five, but the content is not much different from Hayashi's scheme.

While views on the rooting of technology and the stages it passes through are quite similar, the discussions have led to the significant recognition of the need to elucidate the conditions which facilitate such rooting. What is called for are analyses of existing channels of technology transfer, of the technology market, and of the character of the technology to be transferred. Thus the discussion of the rooting of technology seems to serve as the focus or axis for analysis. As for studies on technology transfer outside Japan, they may be said to have begun with analyses of the technology market. The joint Brazil-Colombia U.N. resolution on technology transfer, drafted in 1961, included an indictment of the imperfections of the technology market at the time. Analyses of such imperfections have led to studies of technology transfer by the multinational enterprises which rule

the technology market. In Japan, discussions have centered on the particular characteristics of Japanese-type multinational enterprises and their role in technology transfer. These discussions will be surveyed in the next section.

III. EVALUATION OF TECHNOLOGY TRANSFER BY MULTINATIONAL ENTERPRISES

A. *Direct Investment: American Type and Japanese Type*

Since the 1961 U.N. resolution, studies on technology transfer from North to South conducted by UNCTAD and other organizations as well as by individual scholars, have made it clear that the world technology market, dominated by the industrialized nations, has tended to be imperfect, thus hampering the introduction of technology into the developing countries, and that technology transfer to these countries has been taking place mainly through the multinational enterprises (in other words, the technology market has been internalized by such enterprises). Therefore, the question as to how the intra-firm technology transfer of those enterprises relates to the economic development of the developing countries has become an important issue. As for Japan, from around 1967, direct overseas investment has increased phenomenally for the reasons stated earlier. From that time, Japanese studies of technology transfer have paid much attention to the characteristics of Japanese direct investment. The first to raise the matter was Kiyoshi Kojima.

Since he differentiated two types of direct investment, i.e., American and Japanese, in an article in 1971 Kojima has continued to present a unique view of direct overseas investment [12]. In a book published in 1985 [13] which seems to have rounded out his views on the subject, Kojima makes the following argument: Generally, industrialized countries export to developing countries manufactured goods of capital-intensive industries or those employing advanced technology, while importing from them products of labor-intensive industries, and through this a harmonious international division of labor can be established and an effective global distribution of resources realized. However, United States' direct investment in developing countries as often as not goes to those industries which could be operated with comparative advantage at home—high technology industries, oligopolistic industries, etc. This makes it very difficult, if not impossible, for goods of the domestic advanced-technology industries to be exported from the United States. In other words, American overseas investment is export-substitutive, or contrary to a trade orientation. Moreover, under such conditions, the developing countries in which American capital is invested lose a part of the opportunity to foster the labor-intensive and raw materials industries suited to their factor endowment. Japanese direct investment in developing countries, on the other hand, takes place in those industries suffering a comparative disadvantage in the home market—industries which should indeed ultimately be left in the hands of the developing countries, namely, those some labor-intensive and natural resource industries. Such a form of direct investment

may be said to be trade-oriented, for it is advantageous for, not detrimental to, an expanded Japanese export of goods of capital-intensive and advanced-technology industries to the developing countries and the increased import from these countries of goods of industries suited to their factor endowment. In the final analysis, the American type of direct overseas investment, even if it serves the interests of specific investors in maximizing their profits, will only play a negative role in overall global welfare. For its part, Japanese-type investment contributes to an effective global distribution of resources as well as to a higher production efficiency in the world as a whole.

Kojima holds that the industrialized nations should see to it that their direct investment in the developing countries goes into industries which are at comparative disadvantage at home and that after they have served as a tutor and as these industries and technologies take root in the developing countries concerned, the investors should leave the scene so that a harmonious international division of labor based on trade, and not on continued overseas direct investment by the industrialized nations, may be realized.

B. *Appraisals of the Kojima Model*

Kojima's views, as outlined above, which have come to be known as "the Kojima model" both inside and outside Japan, have contributed much to clarifying differences in approach to direct overseas investment and problems of international technology transfer. Moreover, the discussion of investment as being helpful or detrimental to an expanded international trade has provided a valuable theoretical basis for grasping technology transfer in its macro, as opposed to micro, dimentions—i.e., in light of the formation and transformation of international division of labor patterns—and for formulating the international division of labor approach which will be treated in Section VI.

The contributions of the Kojima model, however, do not preclude the necessity to subject it to further theoretical and empirical examinations. The factual question of whether the technologies transferred from Japan to developing countries are indeed labor-intensive and standardized will be touched on in later sections. Here the reviewer would like to raise one or two theoretical questions concerning the Kojima model.

According to Kojima, overseas investment by an enterprise takes place because of comparative profit rates that reflect comparative costs. He holds that investment on such a basis paves the way for the maximization of global welfare. However, it is hard to overlook the fact that in the present-day world, where productive capacities have grown enormously, where capitals have become ever more internationalized and big, oligopolistic corporations dominate the market, enterprises can only hope to grow by pushing their way into the world market so as to enlarge their market shares. Direct overseas investment is an imperative in this context. This being the case, it is questionable whether the profit rate is the only thing which counts in prompting an enterprise to invest overseas. The question as to the time span within which the profit rate is to be calculated is also a matter for argument. Again, it remains to be examined whether the notion

of maximization of global welfare explicit in the comparative costs model and which presupposes perfect competition and a truly free trade can legitimately be said to apply to present-day trade and investment activities which are under the domination of oligopolies. One may add, also, that as the "free-trade imperialism" argument would have it, a free trade based on comparative costs tends to perpetuate, if not advance, the rule of the stronger over the weaker.

Apart from these general reservations about the Kojima model, one should not minimize its significance as a matter for policy discussion, viz., the discussion of a harmonious international division of labor between North and South, or "international division of labor by mutual agreement."

It has been a generally accepted historical fact since the 1960s that the technology market is under the sway of the multinational corporations of the industrialized countries, and it is widely recognized that these corporations are the major channel through which technology is transferred to developing countries. The view which came to be established that technology transfer through direct investment contributes to the enhancing of the technological levels of the developing countries and facilitates their catching up with the industrialized nations (a view as represented by, for example, Yōko Waki [36]) is supported by the historical facts. However, as Kojima himself admits, the argument that the transferred technology will eventually spill over the benefit local industries generally and will necessarily take root there is open to question. What, in fact, are the effects of direct foreign investment and intra-firm technology transfer upon the economic development of the developing country concerned, with its particular indigenous enterprises? As is well known, roughly speaking there are two opposing views to the factors determining technology transfer (or intra-firm technology transfer) accompanying direct investment. D. J. Teece, for instance, emphasizes the lack of ability on the part of developing countries to assimilate new technologies [30] while S. P. Magee [17] and A. M. Rugman [26] believe the real problem is that multinational corporations are uncompromising about keeping their technologies to themselves. Generally, a positive effect of direct investment on economic development of the developing countries may be inferred from the former viewpoint and a negative effect from the latter.

Attempts at analyzing the concrete effects of multinational enterprises upon economic development of developing countries from the point of view of technology transfer have been few. Still fewer studies are available on the particular characteristics of Japanese multinational enterprises similar to that attempted by Kojima. Therefore, the writer will review here some of the studies of a more general character.

Takafumi Hayashi holds that multinational enterprises are keeping developing countries under their control technologically through their exclusive possession of up-to-date technologies [2]. In a similar vein, Minoru Sekishita believes that multinational enterprises, when pressured to transfer some of their technologies to local subcontractors, turn over only those connected with labor-intensive processes. As a result, he points out, a full set of relevant technologies will never diffuse to developing countries. Sporadic transfer of discrete technologies, there-

fore, while perhaps contributing to a limping industrialization of these countries, will not foster real growth of their national economies [29]. Katsukuni Ōnishi, on the other hand, considers that no conclusive evidence can be found to clearly identify multinational enterprises with either positive or negative influence on the economies of the developing countries [22].

Appraisals of technology transfer by multinational enterprises thus vary to a great degree. Terutomo Ozawa, discussing the potential comparative merits, from the standpoint of technology transfer to a developing country of fully-owned subsidiaries of foreign concerns with the joint venture alternative, states that the latter provides more opportunities for transfer than the former [23]. Kenji Akiyama is even more positive about the role of the joint venture as a channel for technology transfer, as opposed to mere licensing agreements or technology transfers to subsidiaries [1]. Akiyama's view is widely shared by Japanese students of technology transfer. It is also generally recognized that overseas investment by Japanese multinational enterprises in many cases takes the form of joint venture.

IV. CHANNELS FOR TECHNOLOGY TRANSFER AND LOCAL ABILITY TO ASSIMILATE THE TRANSFERRED TECHNOLOGIES

A. *Personal Contacts as a Channel for Technology Transfer*

The 1961 joint Brazilian-Colombian proposal was highly critical of the existing patent system, which was held to be unfavorable to developing countries. Since then, fact-finding studies have been undertaken by UNCTAD and other agencies and individuals concerning various restrictive commercial practices embodies in agreements on technological licensing, capital goods transactions, and so on. In the course of these surveys, as was stated earlier in this paper, it became clear that the major channel for technology transfer was the multinational enterprise. Further studies gradually came to focus on the question of the appropriate conditions for an effective transfer of technology to developing countries—whether such transfer take the form of transfer to a subsidiary or the granting of a technological license to a local enterprise. These studies have evolved into a general discussion of channels, which may be broadly classified into (a) documents (patents, specifications, etc.), (b) machinery and equipment ("hardware"), and (c) human or personal contacts.

Increasingly, in such studies, the tendency has been to attach more importance to human contacts (factory inspections, study tours, on-the-job training, scholarly interchanges, etc.) as a necessary condition for the transfer and eventual rooting of technology. For example, Eiji Ogawa, on the basis of his surveys and analyses of the transfer of textile technology from Japan to Thailand, stresses that transfer can really take place only through human contacts [21]. A similar view is expressed by Kōnosuke Odaka, who emphasizes that a fundamental aspect of any technical assistance to a foreign country ought to be human contacts. He

stresses that Japan should be more active in receiving foreign trainees and students as well as in sending Japanese experts for extended terms abroad and that, in conducting aid projects, one and the same person should be assigned to take care of a project from beginning to end [19]. All in all, it is generally accepted today that success in technology transfer is vitally dependent on the closeness and efficiency of human contacts (this point is emphasized in the Hattori article included in the present volume).

While the importance of human contacts in technology transfer may be generally accepted in all countries, the reason why it is singled out for special attention by Japanese students of the subject is because Japanese technology transfer is closely wedded to particular Japanese managerial skills and know-how that can only be transferred through close contact. Hikoji Katano, for instance, also on the basis of a study of the transfer of textile technology to Thailand, points to the importance of the transfer not only of production technology but also of managerial skills in the rooting of new technologies in the local society [10]. The managerial skills aspect is particularly important in the case of Japanese technology transfer.

As the demand for a new world economic order came to be increasingly voiced by developing countries in the 1970s while at the same time emphasis was being put on their own efforts at self-reliance, the necessity of fostering a domestic capacity for technological development also came to be recognized. This in turn led to a keen sense of the need to establish an international organization for collecting and distributing technological information as well as of the need to create effective international bodies for education and training. Hence, for instance, Ōnishi refers to the need for an international pooling of technological information, coupled with the developing countries' own efforts to develop human resources and initiate unaided R & D activities.

B. *Technological Linkage*

Another important theoretical approach to the problems of technology transfer (besides the discussion of the channels for transfer and the recipient's capacity to assimilate the transferred technology) came in the form of studies of "technological linkage," that is, of the relationships between division of labor and cooperation, and between the upper and lower streams of the production process. According to Takeshi Hayashi, the diffusion and rooting of technology can hardly be effective without stronger and closer technological linkage, because it is the existence of allied industries with close ties among them that allows for the effective transfer of technology and increases the capacity of the part of the recipient to assimilate, transform, and develop it [3]. As is well known, A. O. Hirschman in his discussion of the economic development of the less developed countries used the terms "forward linkage effect" and "backward linkage effect." Approaches like his have been accorded importance, particularly in recent years, a fact which seems to reflect the introduction by developing countries in the 1980s of higher technologies, such as those connected with processing, assembling, and capital goods industries, rather than those connected with the more traditional type of industries

which they had introduced in earlier years. Industries based on higher technologies can function only when supported by allied industries manufacturing the necessary parts and materials, and thus they presuppose close technological linkages.

That the lack of such linkages forms a constraint in technology transfer to developing countries has been pointed out by many scholars. For example, Nobuo Maruyama, while not using the term "linkage," states that in China the lack or insufficient development of allied technologies tends to render newly introduced technologies inefficient [18].

V. THE NATURE OF THE TECHNOLOGY BEING TRANSFERRED

A. *Appropriate Technology*

As it came to be more widely understood that the rooting of transferred technologies in developing countries is hampered not merely by imperfections in the technology market but also by inadequate capacity to assimilate them, the question of the "appropriateness" of the technologies to be introduced also came to the fore. In other words, it became clear that technologies not suited to the economic, social, and/or cultural conditions of the developing countries concerned could not hope to take root in their soil.

For example, the Pearson Committee Report in 1969, criticizing the "trickle down" argument that the economic development of the less developed countries could be promoted simply by introducing many of the capital-intensive technologies of the industrialized nations, pointed to the necessity to transfer to those countries technologies more suited to local conditions. In the 1970s it became widely accepted that advanced technologies are not always appropriate from the standpoint of developing countries. Moreover, as calls for the reexamination of the nature of technology itself became louder, appropriate technology arguments acquired political and cultural legitimacy within the establishment [8, p. 169]. As it is now generally understood, the appropriateness of a technology should be determined through consideration of various factors such as the level of economic development, productive factor endowment, and even ecological, cultural, and social factors. Obviously, then, determination of what technology is "appropriate" to a given society is no easy matter.

Yoshirō Hoshino, for example, points to the risks that developing countries may have to bear if they insist on introducing big and advanced technologies from industrial nations without adequate consideration [4]. Ichirō Inukai, on the other hand, while emphasizing the importance of the selection of technologies appropriate to the African countries, takes a multi-pronged approach to the issue, maintaining that many technologies of the industrialized nations may well be suitable to the developing countries [7]. Nor does he accept the view that the introduction of advanced, capital-intensive technologies by these countries can only result in a dual structure in relation to the traditional industries. Referring to the case of Indonesia, Inukai holds that between the formal and the informal

sectors there is an intermediate "mixed sector" that can play an important role in technology transfer to a developing country and can serve as the basis for its dynamic economic development [6]. However, it seems that there is much yet to be studied on the question of the appropriateness of technologies for a given society, and it may even be said that it is one of the most important issues in the general problem of technology transfer.

Generally speaking, the countries of the so-called North and South have different notions as to what technologies are appropriate. For example, the industrialized nations, standing for an "outward" industrialization of the developing countries, have criticized the UNCTAD report on the third U.N. Development Decade [31] for its overemphasis on their "inward" development [32]. Part of difference in approaches may be accounted for by the fact that the developing countries recognize the wide gap between technologies which are presently optimal for them and the advanced technologies of the industrial nations, on the one hand, while the latter nations hold that that gap can be quickly bridged, on the other. Thus, the former tend to regard the intra-South division of labor as more important than the North-South division of labor while the latter hold the contrary view. Further studies on appropriate technologies, therefore, need to be carried out with an eye to the international division of labor question dealt with in Section VI of this paper.

B. *Japan's Technology Transfer to Developing Countries*

Lastly, there is the question as to whether technologies transferred from Japan to developing countries are appropriate to the latter countries. As indicated earlier, Kojima states that Japanese technologies transferred to these countries are generally appropriate because they are standardized and labor-intensive technologies which are easy to assimilate and have a great employment creation effect. Ozawa draws similar conclusions after analyzing the process through which Japanese enterprises have grown to be multinational [23].

Usui is critical of these views [11]. While recognizing that some of the countries which themselves introduced technologies from the more advanced industrial nations like the United States may adapt them for reexport to developing countries (what he calls a "two-stage international technology transfer"), Usui sees little possibility that enterprises of a country like Japan, with a big domestic market, will bother to develop technologies to suit the developing countries whose national economies are of small scale.

Another critic of the Kojima-Ozawa views is Kiichi Kageyama [9]. According to Kageyama, in the industrial nations of North America and Europe, R & D has largely centered on basic technologies which are not easy to develop, and this has weakened their competitive power in the technology market. On the other hand, the technologies Japan obtained in the 1970s are what Kageyama calls "nonstandard" or peripheral technologies that are still in the process of standardization, and these are difficult to transfer to developing countries. He holds, therefore, that the advanced industrial nations, including Japan, should be endeavoring to transfer the nonstandard technologies to the developing countries

while making a continued effort to develop new technologies and industrialize them, so that a harmonious North-South international division of labor may be realized.

As Japanese technological levels were further raised and made it possible to catch up with those of the industrial nations of the West in the 1970s and 1980s, and also as the industrial technologies transferred to developing countries became more advanced and refined, the differences between the two lines of view have become sharper. This confrontation has forced those on both sides of the controversy to deepen their studies. Worth noting in this context is the research by Kikuji Yoneyama who, based on close case studies on steel technology transfer, discusses the relationship between the conditions enabling the creation of appropriate technologies and the Japanese style of managerial system [37].

VI. THE INTERNATIONAL DIVISION OF LABOR APPROACH AND NEEDED ANALYSIS OF THE TECHNOLOGY MARKET

A. *The Boomerang Effect and Technology Transfer Models*

As was stated earlier, the world-wide study of technology transfer was touched off by questions concerning the imperfect nature of the technology market. Later, the emphasis came to be placed on the recipients' capacity to assimilate technology and on the nature of the technologies to be transferred. As for the technology market, analysis focused on intra-firm technology transfers of multinational enterprises because they served as the major channel for technology transfer. Changes in world economic structure, however, have now raised technology market analyses to a higher plane.

Reeitsu Kojima, based on his analysis of the history of China's postwar introduction of foreign technologies, holds that technology transfer was accelerated globally with the breakdown of the United States' technological monopoly in the 1960s, or, to put it another way, by the fact that new technology suppliers emerged in addition to the United States, namely, the West European countries and Japan with their now higher technological levels [14]. In a word, the technology market became competitive. One OECD report has also pointed to this phenomenon, and has been cited in arguments for the necessity and inevitability of a more active transfer of technology to the developing countries and for industrial adjustments in the industrial countries [20]. And Usui points out that the emergence of consulting engineering enterprises in industrial fields where technologies have attained a great measure of sophistication has served to quicken technology transfer to developing countries [34].

Recognition of the inevitability of technology transfer to the less developed countries as well as of its subsequent boomerang effect, coupled with stagnant economic conditions in the industrial nations since the oil crisis, has led to analysis of the relationships between technology transfer and the international division of labor and the required industrial adjustments in the industrialized nations. Underlying the arguments for a "positive adjustment policy," actively put forward by

the OECD and others since the end of the 1970s, for example, was not merely the recognition of the need to establish a harmonious North-South international division of labor, but also a realization of the structural stagnancy of the industrial nation's economies with their relatively overgrown productive capacities and, hence, of the need to create new foundations for capital accumulation globally.

In one sense, these questions had already been dealt with by Kiyoshi Kojima, for his model encompasses dynamic comparative advantage and the dynamic international division of labor. Indeed, the real motive of Ricardo's theory of trade, which first formulated the idea of comparative costs, was to raise domestic profit rates through importation of cheap grains from overseas and thereby overcome the obstacles in the way of domestic capital formation. The dynamism of foreign trade and the international division of labor, as Ricardo would have it, cannot be fully understood without relating it to the process of capital accumulation and qualitative as well as quantitative development of productive capacity, including business cycles and the conversion of industries. The Kojima model, insofar as it argues the dynamics of comparative advantages and the international division of labor, can be said to embody the Ricardo heritage. Since, however, the model's main concern is to link direct overseas investments and international technology transfers to international gaps in profit rates and comparative costs, it naturally leaves some things unelucidated in the area of such present-day aspects of the question as how the factors producing business cycles and industry conversions as well as the quantitative and qualitative development of productive capacity (including the eventual internationalization of capitals with its concomitant deepened relations in the sphere of the international division of labor), are related to direct overseas investment and international technology transfers.

Again, while it may be true that there is a pattern for a harmonious international division of labor in which expanded industrial exports by the Asian countries produce positive, rather than negative, effects of Japan's export of capital goods to these countries, the basis of the economic development Asian NICs has shifted from the textile and materials industries which were so important in the years around 1970 (when the Kojima model was worked out) to the processing and assembly, and durable consumer goods and capital goods industries since the latter half of the 1970s. In other words, the pattern of the division of labor between Japan and those countries has become increasingly horizontal. Such a situation seems to place both the accuracy and adequacy of the Kojima model in question, on the one hand, while making one recognize its significance as a policy argument for the need to establish a harmonious international division of labor, on the other. For their part, Pak and Moritani see little possibility of the spontaneous formation of a harmonious division of labor between Japan and Korea as the two national economies have many similarities, and especially as the latter is close on the former's heels technologically. They point out, therefore, that Japan should be more ready to give way to that a true horizontal international division of labor might be established between the two nations on the basis of comparative advantage, particularly in the electronics and machinery industries [24].

The issue of a higher-level international division of labor—or even a horizontal division of labor—between Japan and other Asian countries is inseparably connected to the important question of its boomerang effect on Japan. In other words, any new division of labor is not necessarily going to be harmonious. Hence the keenly-felt need for a new technology transfer model to replace the Kojima model. Working toward such a model, Usui, for example takes up the innovation and industrial conversions in industrial nations in connection with the pace of expansion of trade and technology transfer to the developing countries [34]. Basing himself heavily on P. Krugman [16], Usui examines the dynamics of the international division of labor as a relationship between the rate of technological progress in the industrialized nations and the pace of their technology transfer to the developing countries. According to him, the division of labor will move toward harmony if the former rate is higher than the latter; contrarily, if the latter outpaces the former, the confrontation between North and South will intensify. While Usui's reasoning concerning international technology transfer is based primarily on the product cycle argument to be touched on later, he seems to combine it with comparative costs theory by bringing in international wage differences and other elements as explanatory variables.

B. *Analyses of the Technology Market*

If the treatment of the technology market and the international division of labor approach is to be successful, deeper analyses of the structure and logic of the technology market will be necessary. One such attempt at deeper analysis involves the introduction of the technological life cycles argument.

European and American studies concerning the technology diffusion process after E. M. Rogers have made it clear that the process can be grasped through logistic curves (E. Mansfield and others). It is also now known that the process is closely related to the life cycles of products or technologies. For example, while W. Abbernathy and others have shown that a technology in its early stages is of necessity fluid and not readily resolvable into a standard type, N. Rosenberg refers to this fluidity as one of the reasons why transfer of a technology in the earliest days of its life cycle is not common. Kageyama makes the notable observation that a technology's life cycle is not merely the simple succession of the three phases *initial, growth,* and *standardization,* but that the last of these can be followed by another phase in which the technology becomes nonstandard again. Nonstandard technology, as Kageyama broadly defines it, covers not only production technology per se, but also efforts to reduce costs, rationalization of the production processes, and the fostering and improvement of subcontract systems, parts making industries, and so on. He holds that because of this broad scope, nonstandard technologies are difficult to transfer to developing countries, where allied industries have not sufficiently grown and supportive technologies are poorly developed [9].

The logistic curves idea and the technological life cycle theory have also been treated by the present author on a theoretical level. Based on the Rogers and Mansfield models which explain the technology diffusion process by the use of

logistic curves, I elucidate the process by further connecting them with arguments concerning the life cycles of products and technologies, thereby trying to clarify the logic of technology market. I believe, for example, that diffusion of a technology in the initial phase of its life cycle tends to be limited, but in its growth phase and after diffusion will be accelerated and the scale will grow.

In my view, the diffusion of technology between enterprises can be classified into market and nonmarket types of transfer, while the former can be further broken down into a competitive market type and imperfect market type. The reason technologies in the initial phase of their life cycles are not readily transferable is because the enterprises to which the technologies belong try to keep them secret and appropriate them for their exclusive use. The reason they become readily transferable after their growth phase is because a greater number of enterprises comes to hold the same sort of technologies, making secrecy and control difficult, and thus these enterprises are led to compete among themselves to gain income through licensing (a "bandwagon effect"), and also because recipient enterprises find themselves under greater pressures of competition in the market for their products. Hence the diffusion of technologies after the growth phase of their life cycles is labelled a competitive market type transfer. On the other hand, the introduction of technologies in the initial phase of their life cycles, when it is impossible to secure a license on the technology market, has to rely on the copying of the technologies concerned, by such means as reverse engineering. This is the nonmarket type transfer. However, in countries where a protectionist trade policy makes it impossible for enterprises to maintain secrecy and proprietary rights to their technologies, they may be forced to give licenses to applicants even in the initial phase of their technologies' life cycles. This is what I call technology transfer of the imperfect market type [15].

The analyses by Reeitsu Kojima, Usui, myself, and others seem to indicate that with structural changes in the world economy, such as the diversification of sources of technology supply due to Japan and the West European countries having succeeded in catching up with the United States in technological development, and with some developing countries introducing higher-level technologies commensurate with their technological development, technology market analysis has come to assume a renewed, if somewhat different, significance. The main object of such analysis now is not the imperfect nature of the technology market; the new focus is on clarification of the logic of the technology market itself, as well as of the factors promoting or obstructing technology transfer—international frictions over the transfer of advanced technologies in the initial phase of their life cycles being one of the sub-issues.

To sum up, Japanese studies on technology transfer have witnessed an evolution on such matters as the factors conditioning the rooting of transferred technologies and those restricting it. As Japan has succeeded in attaining its high level of national economic development and its advanced industrial structures on the bases both of introduced foreign technologies as well as technological exports, and as it is certain to continue on that basis for some time to come, this type of research needs to be further developed and deepened. In particular, studies on

the conditions necessary for the rooting of technologies, such as the appropriate channels for technology transfer, the nature of multinational enterprises of the Japanese type, and the nature of the technologies to be transferred, as well as macro analyses of the technology market and studies based on the international division of labor approach should be conducted in a comprehensive way.

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