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Technology and Alliance Strategies for Follower Countries

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Abstract

This paper starts with a simplified model and then modifies it with accelerated innovation process, changing comparative advantages and emerging global strategies to explain the contemporary situations of international trade and industrial transplantation induced by a global innovative product or product class, and the new challenges to follower countries. In order to explore the feasible strategies for the follower countries, this paper assumes the U.S. as a leading innovator, and examines the historical experiences of Japan (a first follower) and Taiwan (a second follower) in their catching-up courses. The preliminary conclusions are as follows:

(1) The follower countries mainly relying on "traditional strategies" will very likely be unfavorably impacted by the new situations.

(2) The concerted national technological cooperative system and international management of foreign bases to accelerate "technological metabolism," as Japan's experience shows, can contribute decisively to a follower country's rapid progress in especially process technology and appropriability of economic benefit from innovation.

(3) The historical priority on process technology as suggested by Japan's successful locus should not be taken for granted by today's follower countries. New emphasis should be placed on product innovation as shown in the case of Taiwan. To implement this strategy, the geographical deployment of innovation functions to and the international alliances with innovative countries are crucial to success.

(4) Aggressive joint efforts by follower countries, as illustrated by the close connection between Japan and Taiwan, can bring about extra benefit to participants and also shorten their lags behind the innovator and forerunners.

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Notes

I. International Product Life Cycle and Follower Countries

A Simplified Model[1]

For simplicity, suppose that a global innovative product which starts a new productive unit[2] or a new product class[3] appears in the U.S., and all the countries are categorized into three aggregate groups:

(1) the innovator (supposing the U.S. in this case),

(2) the other (moderately) advanced countries, and

(3) the developing countries.

In respect to world trade flows and industrial transplantation, the following sequential stages will probably happen:

Stage 1: The U.S. is the only producer. Most of its products are provided initially for domestic market, only a small proportion of which are exported to other advanced countries with somewhat similar industrial and consumption structures.

Stage 2: The export from the U.S. to other advanced countries expands greatly and the export to the developing countries begins to increase significantly.

Stage 3: Other advanced countries start to produce the products by importing the necessary technology, sometimes accompanied by U.S. capital, or by imitating or developing the technology themselves. These countries also begin to compete with the U.S. for the market in developing countries.

Stage 4: Other advanced countries increase the market share in developing countries and start to export the products back to the U.S. Meanwhile, the developing countries also begin to implement import substitution and indigenization strategy by importing or imitating foreign technology. The U.S. thus gradually moves its production bases to these

countries with a view to lowering cost and keeping or acquiring local and international markets. Other advanced countries also follow this track but often fall a little behind the U.S.

Stage 5: After satisfying their domestic needs, the developing countries begin to pursue export expansion strategy, partly for the sake of foreign exchange, and export their products to the U.S. and other advanced countries. Their products have usually been standardized and might be of lower quality than those the U.S. and other advanced countries presently produce, but most of the time these products are better than those previously exported by the U.S.

Figure 1 roughly depicts the development of the international trade of this simplified model.

Insert Figure 1 here.

Accelerated Innovation Process, Changing Comparative Advantages and Emerging Global Strategies

If the product life cycle is long enough, then most countries will sooner or later benefit economically from the innovation. And if the followers can take advantage of the relatively low uncertainty at the later development stages faced by them and concentrate their limited resources on some appropriate strategic fields, their lag behind the forerunners might be effectively reduced over time.

However, if the product life cycle is somehow shortened, then it is likely that before the international trade of the former product evolves to stage 4 or 5 (see Figure 1), another new cycle based on a new product or product class will appear and replace the old one. In this case the

followers will be in an unfavorable situation, either because of the deterred export expansion from which foreign exchange is earned for the import stage of the next cycles, or, more seriously, because of the production is never transplanted to them. Some countries below a certain development level will thus be excluded from the potential economic prosperity brought about by more frequent innovations. Conversely, the innovators or pioneers, if equipped with strong production capability -- including process innovation and productivity -- will enjoy relatively more benefit.

In fact, the recent incorporation of modern information technology into product and process design and the automation of production in many advanced countries have already exerted such a far-reaching impact as just mentioned. This new trend can not only shorten the time needed in R&D and introduction of new products and processes, but also reduce the comparative advantage typified by labor cost in many developing countries.

Another crucial factor lies in the emergence of more comprehensive global strategies adopted by many multi-national corporations. These strategies include the global deployment of the elements of "value chain"[4] across country boundaries from the very beginning or at early stages, therefore making the traditional sequential strategy unnecessary any more. The prevalent "triad alliances" among world class corporations in the U.S., Europe and Japan[5] are just well-known examples. Though their sustainability remains to be seen due to the potential instability rooted in the possibilities of strategic inconvergence, imbalance of appropriability, incompatibility of blending competition and coorperation, and so forth, the global strategies of this kind will no doubt deprive many developing countries of many opportunities.

New Challenge to Follower Countries

After World War Two, the diffusion of many major innovations invested during wartime and their incremental evolution contributed dramatically to the prosperity of the world economy. Many developing countries also greatly improved their originally impoverished situations. The optimism thereby involved for non- and less-oil-producing countries lasted until oil shock. Nevertheless, from the late 1970s many new promising technologies again gave rise to hope. It is expected that the world economy and technology are to undergo some structural change by the end of this century. But the issues as previously described will very probably leave many lagging countries only dismal prospects, if these countries are still passively dependent on the more advanced countries to transfer technologies and industries to them and could not take more active initiatives to cope with the new challenge.

In order to explore the strategies for the follower countries, the next two parts will examine the experiences of Japan and Taiwan.

Japan, once regarded as a follower by many western advanced countries, is now standing out as the world's second largest economic power and threatening technologically even the U.S. -- the most innovative country after World War One. Taiwan, once a developing country, has already been categorized into a special group -- "newly industrialized countries (NICs)." For this reason, the development loci of these two countries may provide some insightful lessons for other follower countries.

For simplicity, in their catching-up courses Japan can be treated as a first follower and Taiwan as a second follower relative to the innovator -- the U.S., which is still leading the world in most pioneering fields.

II. The First Follower's Strategy -- Japan's Case

National Technology Transfer and Cooperative Systems

It is obvious that technology import from advanced countries has long been among the highest priorities in Japan's history of modernization. However, Japan's rapid technological progress and its tremendous impetus to economic growth need further elaboration.

So far, many reasons explaining Japan's success, including administrative guidance, human resource development, total quality control, collectivism, etc., have been proposed. And it is not the purpose of this paper to review them. According to the author's point of view, one of the few determinants which are extremely important and deserve other countries' special attention is the national mechanism facilitating technology transfer and cooperation. Its uniqueness rests on the fact that this mechanism involves not only policy guidance and resource allocation but also the autonomous, and sometimes coercive, participation and support from many parties with different goals and interests. Figure 2 explicates the historical evolution of Japan's national technology transfer mechanism,[6] and Figure 3 abstracts its nation-wide cooperative structure of the major parties concerned.[7] It is worth noting that the framework as shown by Figure 3 was first deployed soon after the Meiji new government was organized one century ago.

Insert Figures 2 & 3 here.

The effective operation of this mechanism makes possible the great use of imported technology and enhances the indigenous R&D by pooling together many complementary resources.

Based on this foundation, several national technological programs, such as VLSI, biotechnology, etc., were launched and implemented successfully in Japan after the mid-1970s.[8] On the contrary, similar efforts outside military, aerospace and nuclear areas in the U.S. and several western European countries have faced big difficulties.[9]

In fact, Japan's cooperative framework is also conducive to the grouping of industrial corporations and integration of many elements of "national value chain." In the innovation process where uncertainty incurs high transaction cost, Japan's clan-like network originated from long-term relationships and mutual trust has its special advantage over many western countries where many independent innovative companies spend relatively much more effort in finding appropriate partners, negotiating fair terms, transfering technology across compartmentedly organizational boundaries, monitoring execution and preventing opportunism. Moreover, Japan's cooperative mechanism also enables its manufacturers to obtain better economies of scale and protection from market fluctuations.

Therefore, Japan's system greatly contributes to its greater appropriability of economic benefit from innovation by taking concerted actions quickly, absorbing fluctuations and sharing risks among interrelated members, and accumulating learning experience "internally." Actually, this system also leads to Japan's special strength in process technology.

International Management of Supporting and Forward Bases

Since the Meiji Restoration, Japan has been diligently and deliberately managing several eastern Asian countries as its supporting and forward bases. The only difference after World War Two is that Japan gave up its several colonies and military imperialism, and had to resort principally to

the more implicit economic operation. Japan realizes very deeply that without the so-called "Great Eastern Asian Circle" to back it up, Japan could hardly be optimistic in competing with western powers whose threat triggered Japan's nationalism and modernization in the late nineteenth century. Guided by this national policy, Japan has long been adopting a unique strategy to "accelerate" the international product life cycle.

For most other advanced countries, the export of a product usually begins when the domestic market approaches maturity, and the export of technology and capital for production to foreign countries begins when the export of the product approaches maturity. Despite its lag behind many western countries in financial resource and technological capability, Japan usually shortens the above cycles by one or two stages, and moves many production bases to Taiwan, South Korea, etc. as exemplified by several major products in Table 1, if there is no obvious "boomerang effect."

From the table, for instance, it is evident that the domestic market and the export of transitor radios began almost at the same time in the late 1950s. In the late 1960s, Japan for the first time imported IC technology from the U.S., but it immediately subcontracted the assembly to Taiwan, Hong Kong and South Korea. This strategy aims at moving ahead of, or at least not later than, western companies, even those from which Japan acquired new technologies. By doing so, Japan tries to attain the following goals:

(1) It can enter the market early and thereby gain the greatest possible profit.

(2) It can make earlier use of the better and cheaper local resources for international competition.[10]

(3) It can affect the local industrial standards, both formal and informal, which will very likely result in favoring the connection with

Japan and isolating the western latecomers.

(4) It can spare its relatively scarce resources for more advanced fields, which can be interpreted as a strategy accelerating "technological and industrial metabolism."

Insert Table 1 here.

With far less average direct investment than its western counterparts in individual foreign projects, Japan's firms have successfully established comprehensive networks in most eastern Asian countries through technical cooperation, subcontraction, purchasing, financial credit arrangements, and supply of key materials, parts and equipments. Moreover, Japan's relative strength in process technology which usually has less externalities than many product innovation designs do also helps encourage its cooperation with some aggressive Asian countries. This fact could be illustrated by the case of the close connection between Japan and Taiwan.

Before the oil shock which caused a drastic change in import cost structure, Taiwan's imports from Japan accounted for more than 40% of its total imports. Meanwhile, Taiwan's exports to Japan came to only about 15% of its total exports. On the other hand, although the share of exports to the U.S. in recent years has been nearly 40% of Taiwan's total exports, the materials and parts purchased from Japan usually amount to 40% of the total cost of the exported products. Furthermore, according to some unofficial estimate, about 40 to 60% of the export orders by value received by Taiwan are controlled directly or indirectly by Japanese-owned companies. In effect, similar or even more "severe" situations could also be found in South Korea and several other Asian countries. Therefore, to a

considerable extent, these countries have become Japan's "satellite" production and indirect export bases.

Effects of Japan's Strategy

Japan's national technological cooperative framework as described above has the effect of moving the Japan's curve -- the second one in the simplified model (see Figure 1) -- to the left. However, it is Japan's international strategy of managing foreign bases that moves both the Japan's and its follower countries' curves to the left and makes Japan and these countries gain relatively more economic benefit than otherwise could be expected. This example highlights the possibility of creating extra benefit by joint forces of followers among whom some close vertical integration of elements of "international value chain" can take place, though Japan in this case may enjoy the lion's share of the profit and its follower countries may fall into too much dependency on Japan.

III. The Second Follower's Strategy – Taiwan's Case

Relative Strength in Technology Imitation and Diffusion

Supposing that the total benefit of the adoption of an innovation could be represented by the multiplication of the relative advantage of that innovation and the degree of diffusion,[11] then Taiwan's remarkable progress could be attributed at least as much to its special strength in the second factor as to the first one. Through several decades' investment in infrastructure and education, Taiwan has established a very favorable environment for diffusion of innovation and cultivated a strong base of high quality manpower to carry out the technological imitation and improvement.

Another relative strength of Taiwan lies in its traditional machinery industry. This industry owns a large number of diligent, experienced entrepreneurs and workers, even many of whom do not possess adequately modern hardware and advanced knowledge. Through them many promising technologies, if not beyond Taiwan's potential capability, will very probably be imitated and diffused rapidly and widely using similar or smaller production scales and/or with equivalent or lower product quality. The machinery industry thus supports many other industries of Taiwan in making full use of imported technology through imitation, adaptation and diffusion.[12]

Certainly, in this development process Taiwan's government policies of import substitution and export promotion, and protection of some crucial domestic industries have also played an important role.

Synergistic Links with Japan and Western Countries

Taiwan's close tie with Japan, which is particularly good at process technology and productivity, also gives it some similar advantages. This special strength combined with other indigenous characteristics has further induced many western companies to move their production bases to Taiwan. Taiwan's potential vulnerability resulting from its heavy dependence on Japan is thus partly mitigated.

Ironically, many western companies seek this kind of cooperation with Taiwan in order to compete with Japan. And this trend has become more significant in recent years especially given the fact that many American companies prefer to close their production bases in the U.S. In this sense, Taiwan -- a second follower -- benefits a lot from its attractiveness to the innovator -- the U.S. in this simplified model. Yet without the long-time close link with the first follower -- Japan, this

extra benefit might not have occurred.

New Threats from Protectionism and Advanced Technologies

Recent protectionism reacting to the trade deficit in many western countries has forced Japan to refrain from unrestrictively exporting to the U.S. and other countries. This pressure also unfavorably affects the trading position of Taiwan and some other export-oriented countries and Japan's indirect export through them. As a result, Japan has modified its traditional strategy and tried to invest directly in those advanced countries which constitute its principal markets. As a matter of fact, Japan nowadays is the most active in creating the "triad alliances." Its former production and indirect export bases in some NICs, including Taiwan, are thus becoming less desirable.

On the other hand, many advanced production technologies, such as automation and flexible manufacturing systems, have also reduced some relative advantage of Taiwan's more traditional production capability. Many advanced countries can now economically produce many high value-added products in their own countries.

Still the more steeply declining learning curves in many new products, especially those associated with modern information technology, have made the time-consuming international technology transfer or subcontraction less attractive.

Facing these threats, some companies in Taiwan in recent years began to counterfeit a variety of products, particularly in information technology-related fields, in order to survive. These actions incurred strong responses from some advanced countries and forced Taiwan's government to intervene. However, taking personal computer as an example, the speed of imitation, which usually can succeed in three to six

months after the announcement of a new product in the U.S., and the far lower price, often only one fourth of that of the original brand, also surprise many foreign companies. And, interestingly, this recognition again brings many new orders to Taiwan.

This embarrassing dilemma reveals the very unbalanced technological capability of Taiwan, which could be summarized into a brief evaluation of the bottleneck of manpower in developing some high-tech information products as Table 2 shows.

Insert Table 2 here.

New Emphasis on Product Innovation Strategy

From the above analysis, the essential strategy for a second follower like Taiwan to adopt now is to upgrade its potential for product innovation. This does not mean that it should try major product innovations, but does mean that it should join the competition in the earlier stages of some new products or product classes than ever before. Continuing to import well-defined product ideas and produce them, even with some competitive advantage in production capability, will very likely suffocate its future in the allegedly approaching technology innovation era as that was analyzed in the first part of this paper. In other words, Taiwan cannot follow Japan's historical strategy track. It has to adjust its development direction in time. Figure 4 briefly explains this situation.

Insert Figure 4 here.

However, Taiwan's present environment, which facilitates imitation

and incremental process improvement, is not the same as that which activates product innovation. For this reason, one feasible strategy is to move its R&D and related product design and innovation functions to some advanced countries with appropriate infrastructure.

As to the international alliances, the increasingly prevalent practice of cross-licensing suggests the difficulty in seeking right partners if one has nothing valuable to exchange. Some external acquisition strategies for entering new businesses as proposed by some researchers in advanced countries[13] may not be so helpful as originally expected, because, even in advanced countries, there have been few successful stories, not to mention Taiwan which is just about to learn how to manage this new challenge.

Therefore, in addition to the new strategy emphsizing more internal development and the novel international deployment of innovation functions, Taiwan presently may still have to mainly rely on its special strength in process technology in exchange for more advanced product designs. The recent investment of US$300,000,000 to Taiwan Semiconductor Manufacturing Co. and its cooperation with Philips Co. (Netherlands) in application specific integrated circuits (ASICs), despite its potential risk, can thus be justified as a reasonable strategy in the sense that it helps prevent Taiwan from being excluded from the "triad alliances."[14]

Notes

1. A similar model was first raised by Raymond Vernon in 1966 and then revised by him in 1979. See Vernon, Raymond, "The Product Life Cycle Hypothesis in a New International Environment," *Oxford Bulletin of Economics and Statistics* 41(4), 255-267 (1979), and "Sovereignty at Bay: Ten Years After," *International Organization* (summer, 1981).
2. For productive unit as unit of analysis, see Abernathy, William J. and Utterback, James M., "Patterns of Industrial Innovation," *Technology Review* 80, 41-47 (1978).
3. For product class as unit of analysis, see Moor, William L. and Tushman, Michael L., "Managing Innovation over the Product Life Cycle," in *Readings in the Management of Innovation*, Moor, William L. and Tushman, Michael L. eds., Pitman Books, Marshfield, Mass, 1982.
4. For the definition and analysis of "business value chain," see Porter, Michael, *Competitive Advantage*, The Free Press, New York, New York, 1985. In fact the concept of "value chain" can apply to the national and international levels as this paper suggests.
5. The "triad alliances" among the U.S., Europe and Japan are discussed in, for example, Ohmae, Kenichi, *Triad Power*, The Free Press, New York, New York, 1984.
6. This is a condensation of Chapter 35 of Saito, Masaru, *Technology Transfer* (in Japanese), Bunshindor, Tokyo, 1980.
7. For a more detailed discussion, see Chiang, Jong-Tsong, *The Formation of Japan's Integrated Strength* (in Chinese), Chapters 1 & 7-10, STAG/ITRI, Taipei, Taiwan, 1984.
8. For Japan's VLSI program, see Sakakibara, Kiyonori, "From Imitation to Innovation: The Very Large-Scale Integrated Circuit Program," MIT

Sloan School Working Paper No. 1490-83. For other national programs, see, for example, Japan Long-Term Credit Bank, *Japan's High Technology Industries*, Tokyo, 1983.

9. For the difficulties faced by the U.S., see, for example, Horwitch, Mel, "Managing Large-Scale Programs: The Managerial Dilemma," *Technology in Society* 6, 161-171 (1984).
10. Japan's strategy of accelerated product life cycle and the first two goals as discussed here are analyzed in more details in Saito, Masaru, *op. cit.*, Chapter 38, Sec. 2.
11. This model is discussed in Chiang, Jong-Tsong, *The Industrial Technology Development and Transfer in Taiwan* (in Chinese), 18-19, ITRI, Taipei, Taiwan, 1980.
12. For more detailed analysis, see *ibid.*, 33-36, 162-188 & 239-242.
13. See, for example, Roberts, Edward B. and Berry, Charles, "Entering New Businesses: Selecting Strategies for Success," *Sloan Management Review*, 3-17 (spring, 1985).
14. This case is analyzed in Chiang, Jong-Tsong, *Determinants of Management of National Technological Programs -- Taiwan's Experience and Implications*, unpublished 2nd year paper in MIT Sloan School Doctoral Program, 46-51, July 1987.

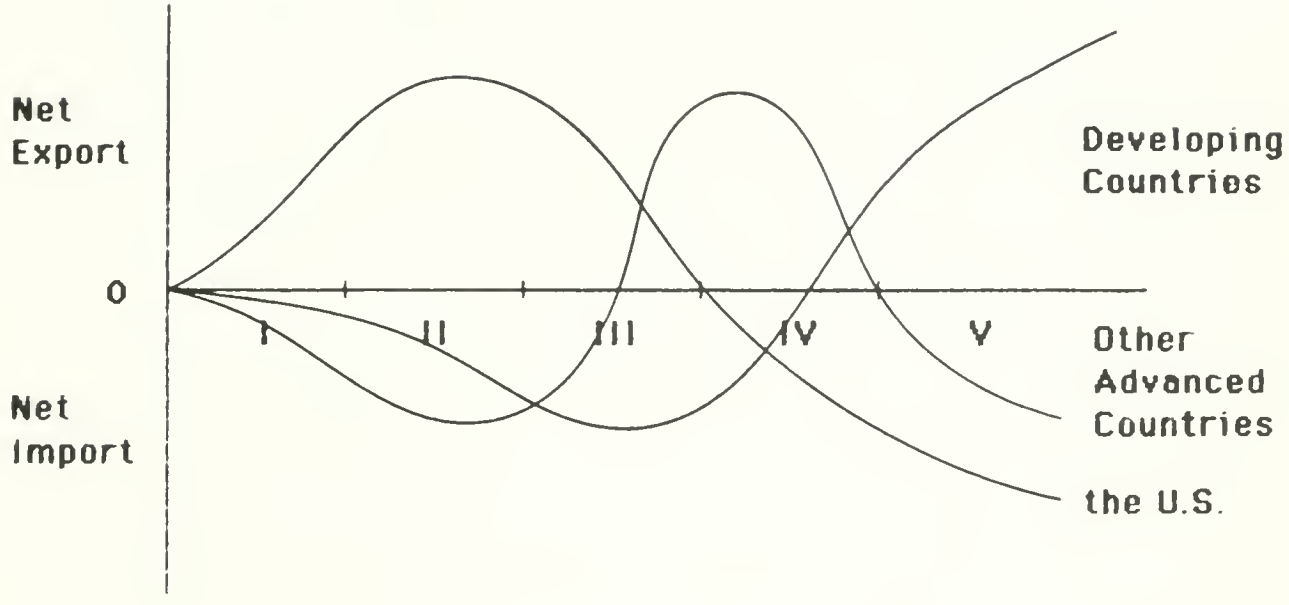


Fig. 1. International Trade Evolution of An Innovative Product

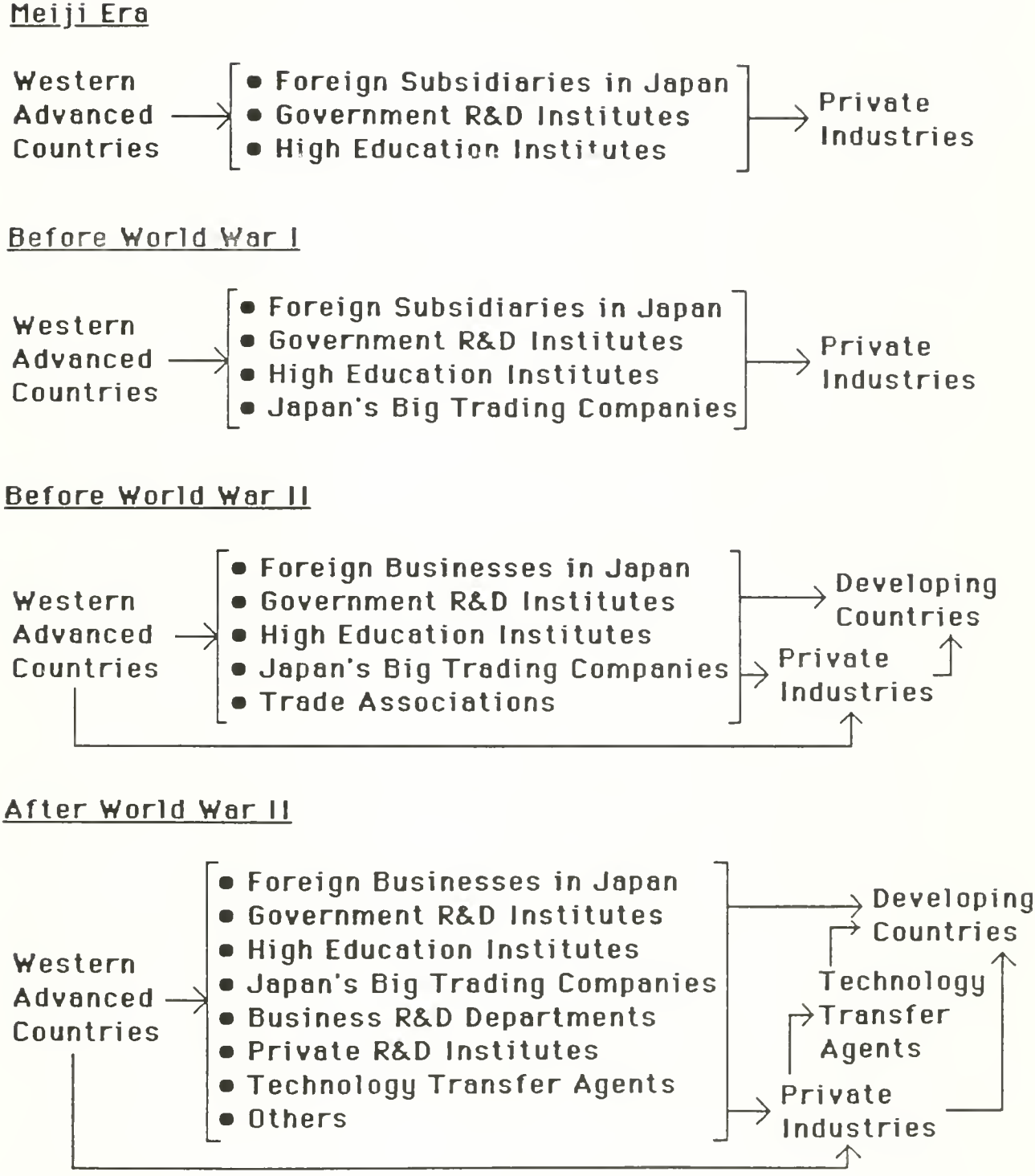
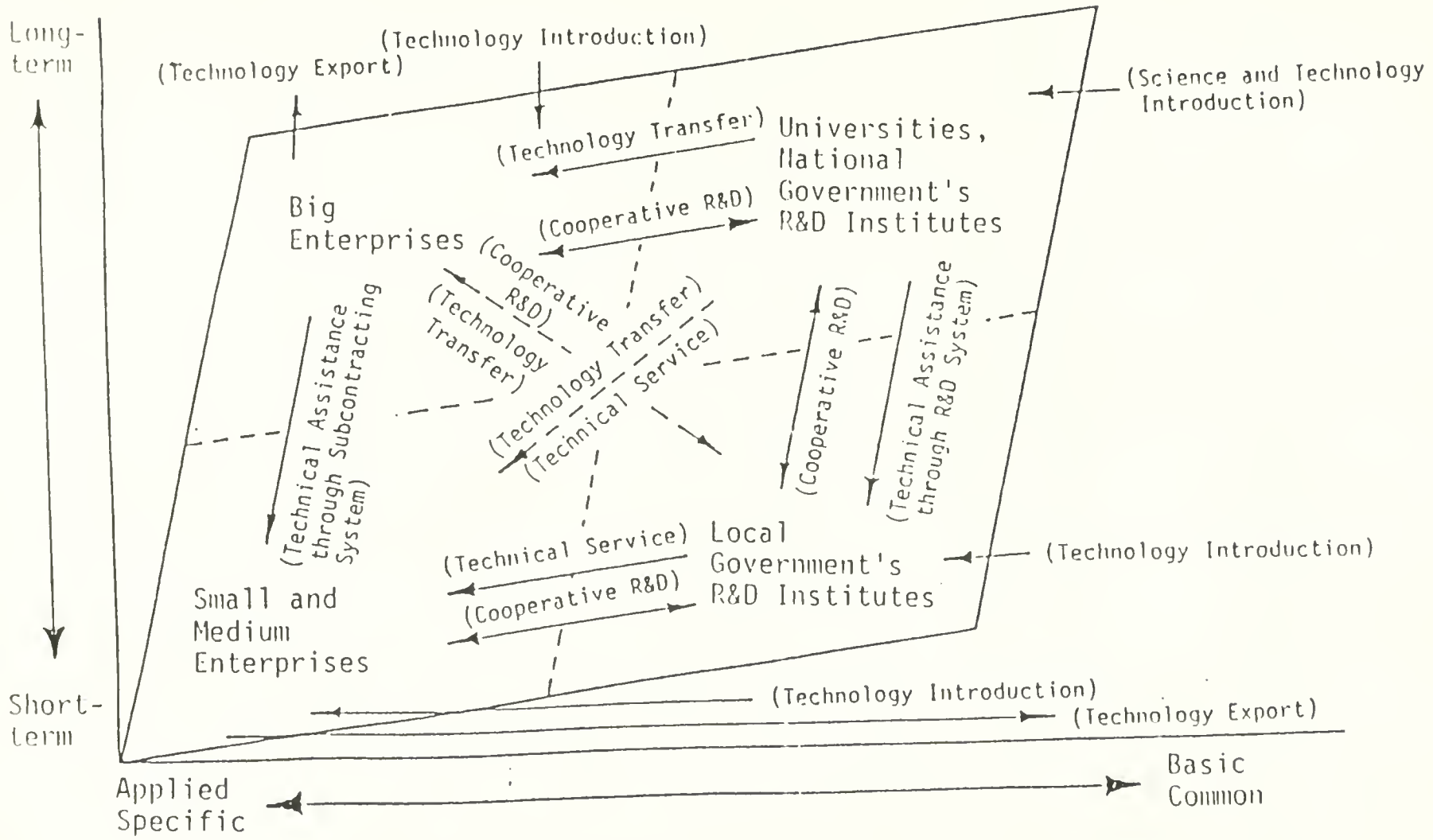


Fig. 2. Development of Japan's Technology Transfer Mechanisms



Source: Jong-Tsong Chiang, The Formation of Japan's Integrated Strength, 1984, p5.

Fig. 3. Japan's Industrial Technology R&D and Transfer System

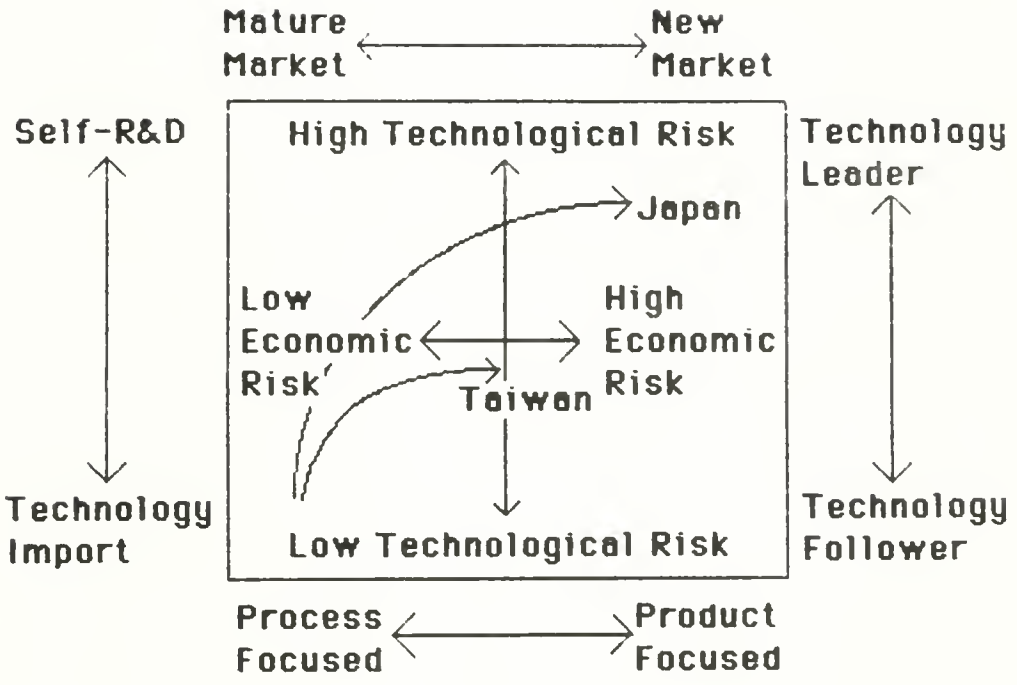


Fig. 4. Technology Strategy Mix and Corresponding Situations

TABLE 1

Japan's Major Products' Life Cycle of Domestic Market, Export and Foreign Investment

	1950s						1960s						1970s		
	1st Half			2nd Half			1st Half			2nd Half			1st Half		
	D	E	I	D	E	I	D	E	I	D	E	I	D	E	I
VCM	□	∘		○	○	∘	○	○	□	⊙	⊙	○	⊙	⊙	○
Plastics	□	∘		○	∘		○	○	∘	⊙	○	□-○	⊙	○	○
Ammonia & Ammonium Sulfate	○	○		○	⊙		⊙	⊙	∘	●	●	□	●	●	○
Synthetic Fibers	□			○	∘		○	○	∘	⊙	○	□	⊙	○	○
Transistor Radios				∘	∘		○	○	∘	⊙	○	□	⊙	○	○
TV Sets	∘			○	∘		○	∘	∘	○	○	□	⊙	○	○
Tape Recorders	∘			□	∘		○	○		○	○	∘	⊙	○	○
IC										∘-○		∘	○		○
Automobiles	□	∘		□	∘	∘	○	○	□	○	○	○	○	○	○

D: Domestic Market Life Cycle E: Export Life Cycle I: Foreign Investment Life Cycle

∘: Introduction Stage □: Pre-growth Stage ○: Growth Stage ⊙: Maturity Stage

●: Stagnation Stage

Source: Masaru Saito, Technology Transfer, 1980, p706.

TABLE 2

Taiwan's Manpower Bottleneck in Developing High-Tech Information Products

Product Development Stage	Key Manpower Required	Availability
Product Concept Definition	•Experienced Design Manager	Few
	•Experienced Marketing Manager	Few
System Design (System Specification)	•Experienced Design Manager	Few
	•System Design Engineer	Few-Some
Product Engineering Design (For Cost Reduction and Quality Assurance, etc.)	•Experienced Design Manager	Few-Some
	•Design Engineer	Some
System Development (According to System Spec and Product Engineering Design)	•Design Project Manager	Few-Some
	•Design Engineer	Some-Many
Manufacturing	•Field Engineer	Many