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FOREIGN CAPITAL AND TECHNOLOGY IN THE PROCESS OF CATCHING UP BY THE DEVELOPING COUNTRIES: THE EXPERIENCE OF THE SYNTHETIC FIBER INDUSTRY IN THE REPUBLIC OF KOREA

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I. INTRODUCTION

THE major factor in the dynamic changes in North-South trade has been the attempt by developing countries to catch up with the industrialized nations in the world market for manufactures. This catching up is reflected in the developing countries' increased share in the world market for specific manufactures and manufactures as a whole, achieved either domestically in the form of import substitution, or through increased market share in the markets of the industrialized countries. A substantial number of studies have been devoted to this phenomenon.[1]

However, another way that the South has been catching up is one that has received little attention: catch-up in the form of improved managerial resources. This process is one of substituting foreign capital, technology, and other managerial resources with local resources. Previous studies have suggested that the multinational corporation (MNC) transfers of managerial resources have facilitated considerably the South's expansion of manufactured exports. However, the way that the South has absorbed those resources and used its own capital, technology, and management know-how to catch up with the MNCs has received very little attention and, consequently, has been studied almost none at all. The localization of ownership and managerial staff in MNC-related firms has been discussed in the context of the policies on foreign direct investment adopted by the developing countries. However, those policies restrict MNC behavior and force them to reduce their presence in developing country ventures. The concept of catching up in managerial resources shows the successive consequence of strategies by local, developing-country firms to import, absorb, and substitute foreign resources.

This paper examines a case of catching up in managerial resources in the typical newly industrializing economy (NIE) of the Republic of Korea. It examines long-term changes in the role of foreign capital and technology that are caused by the efforts of local firms in the development process. The industry selected for

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[1] See [2] for a recent, comprehensive study of this topic.

the study is synthetic fiber, one of the modern manufacturing industries developed since the 1960s that has played an important role in Korea's rapid economic growth.

Section II describes the paper's working hypothesis which provides a new approach to the catch-up phenomenon's development process. Section III uses the techniques of the "international competitiveness index" and the "flying wild-geese pattern" of industrial development to confirm the catch-up in the world market by Korea's synthetic fiber industry. Section IV analyzes the technology and capital import strategies of local firms entering the industry, and Section V examines their behavior in localizing foreign managerial resources. Section VI highlights major points arising out of the paper and discusses the implications that the Korean experience may have for the industrial development strategies of less developed countries.

II. THE CATCH-UP PHENOMENON IN THE DEVELOPMENTAL PROCESS: A NEW APPROACH

A substantial number of studies so far have given evidence for the catch-up phenomena by analyzing the changes in the product and market structure of trade between the industrialized and the developing countries.

However, trade data shows only the results, it cannot show the catch-up effort's process. Vernon's [14] product cycle theory does suggest a framework for understanding the process. However, the analyses by Vernon and like-minded theorists focus on the product life cycle and consequent changes in the comparative advantage of advanced countries and ignore what is happening in the developing countries. This oversight has been covered by Akamatsu, Kojima, and Yamazawa's "flying wild-geese pattern" (or catch-up product cycle) theory which is based on Japan's experience in industrial development.[2]

The theory of the "flying wild-geese pattern," however, does not take fully into account the role of the foreign technology, capital, and management know-how and the dynamic changes they have wrought on the catch-up process. The changes in that role are a consequence of the developing countries accumulation of managerial resources. This paper's working hypothesis is that the developing countries can catch up with the industrialized nations not only in the production and export of products, as reflected in the trade data, but also in the accumulation of technology, capital, and other managerial resources.

The developing countries may try to catch up in the production and export of products without accumulating capital and technology themselves. The industry in question can import these managerial resources from advanced countries through all its development processes. In that sense, such a catch-up is just something that is done by the multinational corporations reallocating productive factors from one country to another. However, a large body of evidence from the developing countries and Canada, France, and other industrialized nations shows that MNC

2. The "flying wild-geese pattern" theory of industrial development was first put forth by Akamatsu [1], and then developed by Kojima [6] [7] and Yamazawa [16] [17].

domination of most industries in the recipient countries is not politically permissible. It is therefore necessary for firms in the recipient country to gradually take over the MNC role in industrial development. The question then becomes one of promoting such a process efficiently. Localization policies in themselves do not always result in successful transfers of managerial resources to local firms. What conditions make such transfers successful? This paper attempts to provide an answer based on the experience of Korea's synthetic fiber industry.

III. THE PROCESS OF DEVELOPMENT FOR THE KOREAN SYNTHETIC FIBER INDUSTRY

A clear definition of the synthetic fiber industry requires the delineation of two general categories of textile fibers: natural fibers such as cotton, silk, and wool and synthetic, chemical fiber such as polyester, nylon, and acryl. Synthetic fibers are produced from petrochemical materials in the form of staples or filaments. Synthetic yarn or fabric is fabricated from these staples or filaments, and may be blended with cotton, wool, or rayon. The fabrics are then used in apparel, industrial or interior applications.

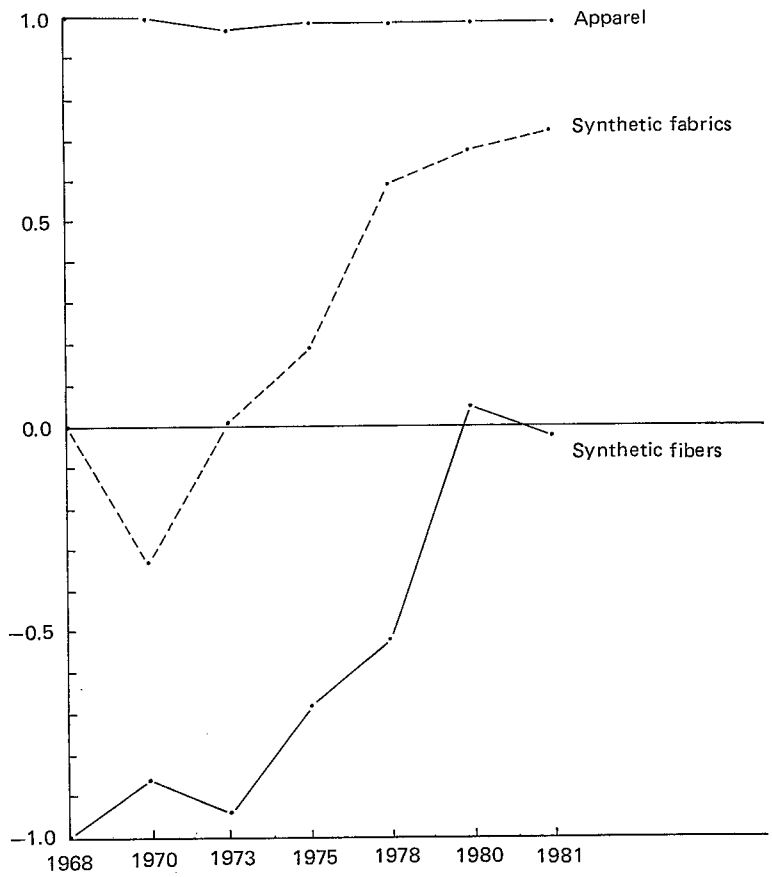
The synthetic fiber industry is that phase of the textile industry that produces staples and filaments. Depending on the market behavior of the firms, however, the industry may be in the fabrics or apparel phase. In Japan, Korea, and many other countries, fiber companies sell part of their staple and filament to the markets but use the rest in vertically integrated or subsidiary plants. They thus sell fabrics (and sometimes apparel) as well as fiber to the market. For simplicity, this paper specifies the synthetic fiber industry as the industry at the staple and filament producing phase, but also takes fabrics and apparel into consideration of the context warrants.

Figure 1 shows the long-term changes in the international competitiveness index of Korea's synthetic fibers, fabrics, and apparel. An industry becomes a net exporter when this index exceeds zero. As expected, apparel, a typical labor-intensive product, has been one of the country's extremely strong export items since the 1960s. Synthetic fabrics are less labor intensive than apparel, and the fabric product area emerged as a net exporter in the mid-1970s with its international competitiveness being strengthened over time. Synthetic fiber, the most capital intensive of the three textile products,[3] appears to change from comparative disadvantage to comparative advantage in the early 1980s, and demonstrates a remarkable process of catching up in the 1970s.

The changes in the international competitiveness index correspond to the changes in the relative position of domestic production (O) over domestic consumption (C) measured as a ratio of production to consumption (O/C). If X and

[3] Technological conditions of Japan's textile industry at the end of the 1960s show an average capital stock per employee approximately 4.5 times higher for synthetic fiber plants than for synthetic fabric plants, and a capital intensity of synthetic fabric plants two to three times greater than that of apparel plants. See [4, p. 199].

Fig. 1. Trends in the International Competitiveness Indices of Korean Synthetic Fiber and Related Products



Source: Author's calculations based on AID-XT (IDE trade data retrieval system based on the United Nations, *Commodity Trade Statistics,* Series D; OECD, *Statistics of Foreign Trade,* Series C, *Trade by Commodities*; and the Republic of China, Taiwan, Inspectorate General of Customs, *The Trade of China: Taiwan District*).
Note: International competitiveness index is calculated as $(X_i-M_i)/(X_i+M_i)$ where X and M stand for export and import, respectively, and i the product in question.

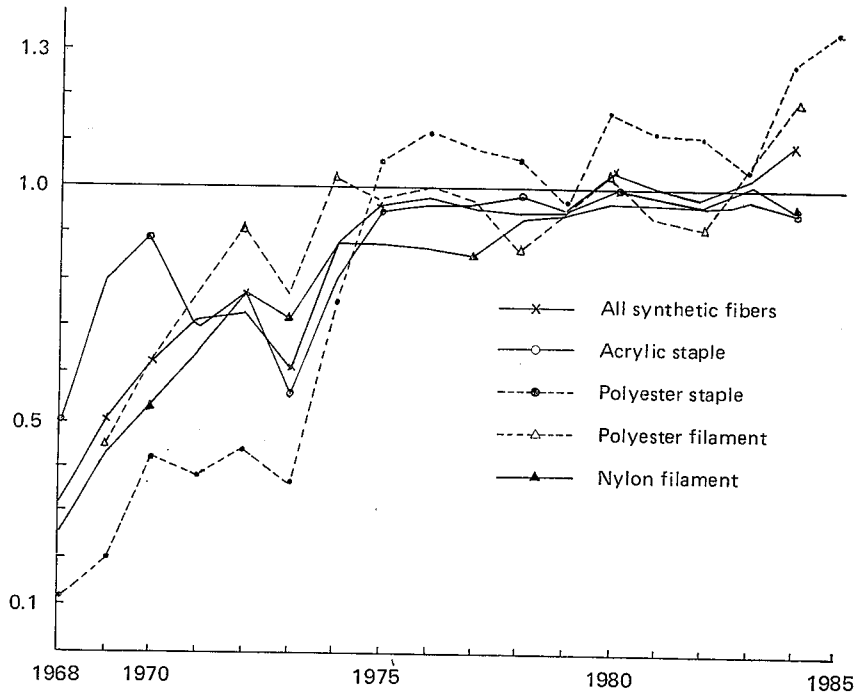
M denote export and import, then the following equation can be written (inventories are ignored):

$$C=O+M-X,$$

or

$$X-M=O-C.$$

Fig. 2. Development of Korean Synthetic Fiber Industries: Trends in Domestic Production/Consumption Ratio



Sources: Calculated from Korea Chemical Fiber Association, *Huasum pyunran* [Chemical textile handbook] (Seoul), various issues; and Nihon kagaku-sen'i kyōkai (Japan Chemical Fiber Association), *Kasen handobukku* [Man-made fiber handbook] (Tokyo), various issues.

Thus, the difference between production and consumption also reflects the trade balance of an industry. This allows the development process of an industry to be examined by following the trends in either export/import ratio (or trade balance) or production/consumption ratio. The former indicator can be transformed into the competitiveness index in Figure 1. Figure 2 uses the production/consumption ratio, breaks down synthetic fibers into four major sectors, and depicts the development process of each sector. This shows that an industry becomes a net exporter when the production/consumption ratio exceeds 1. For synthetic fibers as a whole, both Figures 1 and 2 show that the turning point from net importer to net exporter was in the early 1980s. Note that, in addition to the difference between the competitiveness index and O/C ratio, Figure 1 is in terms of value while Figure 2 is in terms of volume, and the two curves are thus not exactly parallel. Each synthetic fiber sector seems to have a different turning point, but all have experienced the process of catching up with imports.

Unlike synthetic fabrics, however, fiber exports did not expand steadily after completing the import-substitution phase. This was caused by the characteristics

of organization in Korea's fiber industry. There, fiber producers are usually integrated into groups of companies that handle all phases of fiber and textile products from upstream to downstream. Some of the synthetic fiber goes to weavers, apparel makers, and other downstream producers in the same group while some is sold to independent downstream makers. Most group and independent makers downstream are export oriented. This is why Korea tended to concentrate its exports in fabrics and apparel and neglected exports of fibers.

The mechanism behind the trend curves in Figures 1 and 2 is the process of improvement in international competitiveness over time, first in the domestic market and then in the world market.[4] This competitiveness is reflected in prices and quality. The prices of domestically made products have to be improved so that they approach the price level of imported products in the domestic market. In the export phase, the prices of domestic products must be competitive with world prices. Under government protection policies however, import substitution can be achieved without changing relative prices.

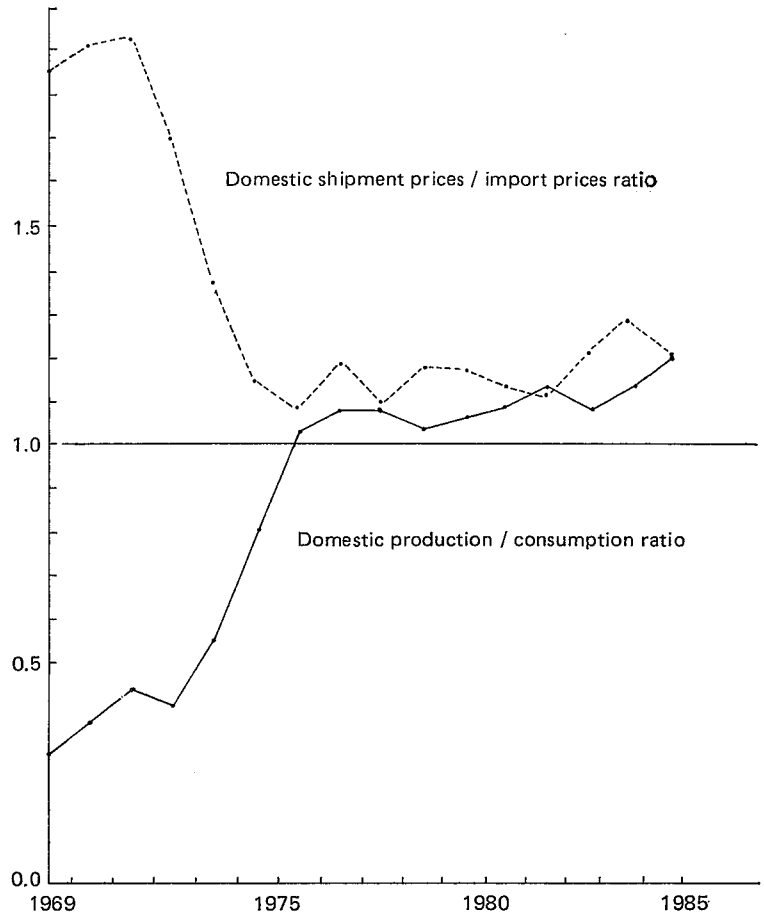
Both protection policies and price effect have accounted for the achievement of import substitution of Korean synthetic fibers. The second five-year plan designated synthetic fibers, petrochemicals, and electrical equipment as major sectors for protection against imports and for promotion by fiscal and financial measures. This ensured a 60 per cent average import tariff on synthetic fibers until June 1986, after which tariffs were reduced to 20 per cent. It also made sure that no imports of synthetic fibers were allowed into the country without an import license. During the import substitution process, however, domestic synthetic fibers were supplied at increasingly competitive prices. Figure 3 shows the downward trend in domestic shipment prices relative to import prices for polyester staple, along with the rise in the production/consumption ratio.

Such a change in prices was caused by changes in production costs of domestic and foreign (imported) products. Either domestic production costs have to go down at a faster rate than foreign costs or the increase in domestic production costs must be at a slower rate than the increase in foreign costs. The former is more likely because Korea's synthetic fiber industry during the period under review was in the early phase of development in which production cost tends to decline substantially as a result of the learning effect. This learning effect arises out of the reduction in costs or the improvement in productivity which comes from upgraded experience and skills in human resources (entrepreneurs, managers, engineers, workers) that occur through production activities.

No data is available so far on synthetic fiber production costs at the industrial level. However, field research by Enos and Park [3, p. 136] provides data on the polyester and nylon plants of Kolon, a major fiber producer, which shows substantial reductions in production cost and large improvements in labor productivity. More particularly, the per-ton production cost of nylon filament in 1984 was about a half of that for 1974, while labor productivity had increased almost three times. Data for polyester filaments shows similar trends.

[4] The theoretical background of this section is the flying wild-geese pattern theory of industrial development.

Fig. 3. Trends in the Development Process and the Relative Prices of Polyester Staple



Sources: Calculated from Korea Chemical Fiber Association, *Huasum pyunran* [Chemical textile handbook] (Seoul), various issues; Korea Federation of Textile Industries, *Sumui kongop tongge* [Textile industry statistics] (Seoul), various issues; and Japan Tariff Association, *Japan Exports & Imports* (Tokyo), various issues.

Notes: 1. Three-year moving average.
2. Import prices are Japan's prices of exports to Korea with 3 per cent added as the gap for c.i.f. and f.o.b. prices.

In sum, both trade and production indicators show that Korea's synthetic fiber industry, in the 1970s and 1980s, was able to catch up with foreign competitors (mainly Japanese), a goal that was reached by enforcing government policy and reducing production costs.

TABLE I

SOURCES AND FORMS OF TECHNOLOGY IMPORTATION BY KOREAN FIBER FIRMS

Name of Company	Source of Technology	Form of Importation	Year of Importation
Polyester			
Sunkyong	Teijin	Joint venture	1969
Kolon Polyester	Toray	Joint venture	1969
Cheil Synthetic	Toray	Joint venture	1972
Tongyang Polyester	Asahi Chemical	Joint venture	1973
Sam Yang	Nippon Estel[1]	Licensing	1968
Daehan[2]	Chemtex	Licensing	1968
Korea	n.a.	n.a.	1966
Cheil Chemical	n.a.	n.a.	n.a.
Tong Kuk	n.a.	n.a.	n.a.
Nylon			
Kolon Nylon	Chemtex, Toray	Joint venture	1960, '69
Tongyang Nylon	Zimmer	Licensing	1967
Korea	n.a.	n.a.	n.a.
Acrylic			
Hanil	Asahi Chemical	Licensing	1964
Taikyong	Nihon Exlan[3]	Licensing	n.a.

Source: Author's survey.

[1] Nippon Estel is now Unitika.

[2] Daehan is a subsidiary of Taikyong.

[3] Nihon Exlan is Toyobo-affiliated.

IV. STRATEGY FOR IMPORTING CAPITAL AND TECHNOLOGY

Major channels of technology import are the establishment of joint ventures with foreign corporations that have the technology, the purchase of only technology through a license agreement, or some other forms such as turnkey and OEM. The foreign direct investment channel gets the firm involved with foreign equity but brings in not only technology but also capital and management know-how.

Almost every fiber firm in Korea has relied on foreign technology to enter the industry. Table I lists the sources and forms (channels) of technology import by Korean fiber firms. Information on three of these companies is unavailable but they are so small as to make their positions in the industry insignificant. The patterns shown in the table are:

(1) *Japan is a major sources of technology.* With few exceptions, the firms got their technology from Japan. This was motivated by the high international levels in fiber technology that Japan achieved in the latter 1960s, which made Japanese technology highly desirable, and by Japan's geographical and cultural proximity, which made technical transfers to Korea less expensive than they would have been from some other country. The exceptions to the rule are Deahan, a

small company, and Kolon—which will be discussed in greater detail later—that used Chemtex technology in the early phases of development. The only major corporation that did not introduce Japanese technology is Tongyang Nylon. However, when it diversified into polyester, Tongyang set up a joint venture (Tongyang Polyester) with a major Japanese fiber firm.

(2) *Joint ventures and licensing arrangements are the major channels of technology importation.* Factors determining the channel that Korean firms select are: (a) Attitude toward control by foreign firms. Until around 1980, Korean government and business remained nationalistic in their preference that foreign firms not control economic activities.[5] This made the Koreans prefer licensing to full foreign ownership or to joint ventures. (b) However, two factors made joint ventures more acceptable. (i) Quality of managerial resources in the technology importing firm. Firms with few managerial resources can start business more smoothly with foreign direct investment. (ii) The bargaining power of local (technology importing) vis-à-vis foreign (technology supplying) firms.

Korean fiber firms that had been in the textile business since before World War II had accumulated capital and management know-how for textile production and tended to use the licensing channel to import fiber technology. This group can be called the licensing group. A typical member is Sam Yang. Sam Yang is a company with a strong nationalistic tradition one that started producing and selling textiles in the 1920s, a background that allowed it to accumulate a substantial amount of managerial resources for the fiber industry.[6] Given that background, their adoption of licensing as a channel for importing technology was understandable. Tongyang Nylon and Hanil are also in the licensing group. They were established in the post–World War II period but were able to use a wide range of measures, including merger and acquisition to expand the scale of textile business and acquire managerial resources rapidly.

The other type of foreign technology importer was the member of the joint venture or the foreign direct investment group. Most were newly emerging firms that had to compete with older companies. That led to the adoption of a strategy of forming joint ventures with Japanese firms so that they could introduce packages of new technology, capital, and management know-how. However, these firms also have strong nationalistic feelings, which are reflected in the patterns of ownership and management of the joint ventures. Every one of the joint ventures, even at its inception, has a foreign ownership of 50 per cent or less (see Table II) and the local owners are the ones who took the initiative in management. Government guidance is responsible for some of this pattern but it also reflects the prevailing attitudes of Korean entrepreneurs in the 1960s and 1970s.

(3) *Bargaining power.* The Japanese partner in all joint ventures is either Toray or Teijin, neither of whom are partners in a licensing arrangement. A lot of other companies are partners in those licensing and the only one that is in

[5] See [12] for a discussion of Korea's policy stance on imports of foreign technology.

[6] This information, as most information in this section, is derived from a July 1986 field survey that the author conducted in Korea.

TABLE II

TRENDS IN EQUITY SHARES OWNED BY JAPANESE FIRMS IN KOREAN SYNTHETIC FIBER COMPANIES

(%)

	Before 1969	1970-73	1974-76	1977-78	July 1984	July 1986
Kolon Nylon	—	45.5 (45.5)	45.5 (45.5)	19.9 (19.9)	23.6*	23.6
Kolon Polyester	50.0 (40.0)	50.0 (40.0)	50.0 (40.0)	28.0 (19.8)	(19.8)	(19.8)
Cheil Synthetic	—	50.0 (40.0)	49.0 (39.0)	29.6 (23.5)	28.6 (22.8)	28.6 (22.8)
Sunkyong	—	50.0 (50.0)	50.0 (50.0)	33.5 (33.5)	11.0 (110)	5.5 (5.5)
Tongyang Polyester	—	50.0 (50.0)	50.0 (50.0)	50.0 (50.0)	50.0 (50.0)	50.0 (50.0)

Source: Author's survey.

Notes: 1. Figures are total of Japanese partner companies. Figures in parentheses are shares held by Japan's fiber firms.

2. — refers to either nonexistence or no participation by Japanese firms.

* Kolon Nylon and Kolon Polyester were merged in 1981.

both is Asahi Chemical. Since the latter 1960s, the Korean textile industry has considered Toray the best provider of nylon technology and Teijin best for polyester technology. The two are pioneers in Japanese synthetic fiber production and both grew rapidly from the late 1950s on and were industrial leaders in the 1960s. The reason why the Korean companies picked leading firms for their Japanese joint-venture partners can be found in the behavior of both the importers and exporters of technology.

Technology import through foreign direct investment allows the importer to use the brand name of the supplier and it is wise for the Korean company to choose a partner of world renown. It is also better to have a leading firm as the partner because this gives the best in technology and management know-how. This was made clear in documents from Sunkyong Fiber, a major Korean firm that was set up as a joint venture between Sunkyong Fabric, now a general trading company for the Sunkyong Group, and Teijin. In 1966, Sunkyong planned production of polyester and approached Teijin for a transfer of technology. Teijin at first refused on the grounds that Sunkyong was at too low a level to absorb its technology and offered instead its acetate technology under a licensing agreement. Hearing this story, a Japanese general trading company approached Sunkyong Fabric and suggested the contact firm A, a late-comer to the Japanese synthetic fiber industry, which was willing to transfer polyester technology on any terms. Sunkyong refused stating that "Teijin is the best source for polyester technology." Teijin finally agreed to set up a joint venture in 1969 [11, pp. 135–36].

Importing technology from leading companies like Toray and Teijin was impossible for Korean firms in the licensing group because these leading exporters would transfer technology only if they could be involved in the equity. Firms in this group had no choice but to seek technology from second class fiber companies whose bargaining power was weaker. One pointed out that this was an advantage in that a technology supplier with weak bargaining power also charged less for the technology. Another company emphasized that the technology fee did influence the choice of technology-introducing channel. If technology fees were too high relative to importer size, the importer would have to invite the supplier into an equity involvement. But if the technology fees were low enough, the licensing arrangement would be the most desirable.

On the Japanese side, Toray and Teijin channeled their technology transfer through direct investment for two reasons:

(1) It allows the supplier to control the market and impose restrictive clauses on the technology importer such as the prohibition of exports to Japanese or third country markets where the supplier has production plants. In fact, suppliers may also impose the same restrictive clauses in licensing arrangements. But, the control is more direct in direct investment, and it is easier to know what the latest developments are in markets where technology is newly used. Clearly, the bargaining strength of the leading firms allowed them to supply technology through direct investment.

(2) At that time, Japanese firms still had contracts for licensing arrangements with European and American firms for polyester technology. Any fees generated from sub-licensing technology to a third company had to be paid to the original licensors and therefore transferring polyester technology to Korea through licensing arrangements was of no benefit to the Japanese companies. Technology fees had to be paid to original licensors on direct investment contracts, too, but here the Japanese firm could fully exploit its managerial resources and derive benefits other than technology fees.[7]

However, weak bargaining power caused some late comers to the Japanese industry to conclude licensing arrangements for polyester technology (Table I). These companies would have preferred the direct investment route, but that channel was closed by both Korean importer groups. They had no alternative but to accept licensing and to derive some subordinate benefit such as supplying raw materials and equipment to the technology buyer. This type of technology transfer met the needs of some Korean firms.

In a word, the Korean fiber firm adopted a capital and technology import strategy that suited its managerial resource endowment and the Japanese fiber company's bargaining power.

[7] Asahi Chemical transferred its polyester and acryl technologies to Korea, but it used different strategies. The polyester technology originally bought from Rhone-Poulenc was transferred through direct investment in a joint venture with Tongyang Polyester, but the acryl technology independently developed by Asahi Chemical was supplied to Hanil through a licensing arrangement.

TABLE III

R & D ACTIVITIES OF KOREA'S MAJOR FIBER COMPANIES

	Sales in 1984 (U.S. $ Million)	R & D Ratio in 1985 or 1986 (%)	Foundation of Company	Estab. of Research Inst.
Kolon	311	2	1957	1976
Sunkyong	300	2	1969	1979
Cheil Synthetic	210	1.8	1972	1979
Sam Yang	341	1	1924	1979
Tongyang Nylon	300	2.5	1966	1971
Hanil	503	1	1964	1976

Source: Author's survey.
Note: R & D ratio = ratio of R & D expenditure in total sales.

V. EFFORTS TO CATCH UP IN THE ACCUMULATION OF MANAGERIAL RESOURCES

How have the two groups of Korean fiber companies—those depending on the direct investment channel and those depending on licensing arrangement channel for their imports of technology—done in catching up with Japanese fiber firms in technology development, ownership, and management?

Within a short period after importing basic technology from Japan, most firms were able to develop their own technologies to greater improve productivity and to conserve energy and raw materials. Table III shows that all major firms had established their own research institutes as early as the 1970s and that with the exceptions of Sam Yang and Hanil, had raised their ratios of R & D expenditures to total sales by 2 per cent, high for the Korean standard.[8] Sam Yang's low level is attributable to a widely diversified structure and the low technological intensity of its non-fiber sectors like foodstuffs. The same can be said of Hanil, which integrated its entire fiber and textile production, but had downstream operations that were much less technologically intensive. Thus, if only the fiber sectors are taken into account, these two firms should have R & D-sales ratios that are as high as the other firms.

On many occasions since the early 1980s, most firms have shown a strong ability in R & D-led technical development. In 1982, Kolon, for example, used its own technology to design a large scale polyester plant. Kolon's top engineers were able to provide full know-how and engineering to foreign as well as domestic buyers. They also participated in starting up the plant Chemtex built in Thailand for the Hantex nylon company.[9] Hanil and Sunkyong Fiber successfully developed the fiber for flame-retardant cloth, a product vastly different from conventional

[8] Korea has carried out substantial R & D activities only since the mid-1980s, with its R & D : GNP ratio rising from 1 : 100 to 2 : 100 between 1983 and 1986. Until the 1970s, R & D was led by the government. For more details, see [12].

[9] Enos and Park [3] use Kolon's technological exports and other factors as evidence of its technological capabilities in their case study of the company.

fiber cloth. Tongyang developed specialty spun yarn, a high value-added product and Sam Yang started exporting technology in the early 1980s.

How do Korean fibers compare in cost and quality with those from Japan? At the time the author conducted a field survey in Korea in July 1986, almost every company told him that as far as standard synthetic fibers are concerned, the Korean products had already caught up with the Japanese in quality and at much lower production costs. In differentiated fibers, however, Korean quality is still inferior and Korean mills turn out only a narrow range of such products. Catching up with Japan in differentiated fibers is the current Korean target.[10]

The process of catch up for Korea's fiber firms through joint venture was much more remarkable than the discussion of general phenomena would imply. In every one of their joint ventures with Japanese fiber producers, the Korean companies had at least 50 per cent ownership and they were the ones who took the initiative in management. They also tried to gradually expand local equity shares and to replace foreign technicians and managers with Koreans as quickly as possible. A few case studies will clarify these points.

(1) Sunkyong Fiber

This company's background of establishment was mentioned earlier. Both Sunkyong Fabric and Teijin had equal initial ownership shares of 50 per cent. From its inception, the joint venture's president was Korean and Sunkyong has always taken the management lead. Teijin sent only three people to serve in the head office of Sunkyong Fiber as vice-president, director, and auditor. Except for the period prior to operation, i.e., that of design, construction, and start-up, there were no Japanese staff members in Sunkyong's mill.

Sunkyong Fiber's two plants are at Suwon, which started producing polyester filament in 1969, and at Ulsan, which started producing polyester staple in 1974. The Ulsan mill offers a good example of how technology was transferred from Teijin and how Sunkyong was able to absorb it and catch up with its venture partner.

In constructing and operating the Ulsan plant, work was divided between Teijin and Sunkyong, with Teijin responsible for basic and advanced design and Sunkyong responsible for ordering and purchasing equipment from a list supplied by Teijin. Testing and administering the factory during the period from construction to the actual on line stage was a joint operation. When operations began, all Japanese engineers went home. After that Korean engineers ran the factory themselves and made all innovations that improved plant productivity and quality. Their accomplishments include a successful speed up of previous polyester filament spinning capacity without new investment. Additional evidence of the Korean ability to catch up in technology is shown in computer programming, for which Teijin originally supplied know-how, but which Sunkyong has developed by itself since 1980.[11]

[10] Through interviews in Tokyo, Japanese companies also gave the same assessments of the cost and quality performance of Korean fiber firms.

[11] Information in this paragraph is partially based on the author's field survey in Korea and partially on [9, pp. 266–68].

(2) Kolon

Kolon Nylon was established in 1957 to manufacture nylon yarn from filament imported from Japan. In 1960, Kolon invited Chemtex, an American fiber company, to participate in equity so that it could import technology to produce nylon filament. Production started in 1963, but confronted many technical difficulties. To overcome these problems, Kolon sought technical assistance from Toray, including the provision of know-how and the sending of engineers. In 1971, Toray became a major equity participant in Kolon Nylon, with a 45 per cent share, and the infusion of capital and technology since then has meant rapid expansion for Kolon (Table II). In 1969, Toray and Kolon Nylon set up a joint venture, Kolon Polyester, to produce polyester filament, and in 1981, the joint venture was absorbed into Kolon Nylon.

How was nylon technology transferred to Kolon? The plant was constructed and operated in its early stages by Kolon and Chemtex engineers. Toray engineers joined in 1963. However, the noteworthy feature is that the number of foreign engineers was gradually reduced so that by the mid-1980s only Koreans were in charge of the plant's technical and administrate duties. Since 1985, Korean engineers have used their own know-how and capability to design —and that include basic design—new fiber plants. Enos and Park [3, p. 124] provide interesting evidence of Kolon's technological catch up. Kolon had to depend entirely on foreign engineers for the basic and detailed design of its Taegu plant's first production line in 1963. Quite a large number of foreign experts were also involved in the construction, star-up, and operational phases. However, in subsequent plant expansion such as the building and expansion of the Gumi plant, Korean engineers have increasingly participated in all phases. When the Gumi plant's third production line was built (1985), Korean engineers were in complete charge of all phases including basic design.

The number of Toray engineers changed from one in the head office and nine in the plant during 1963–78, to one in the plant in 1979–85, and none from 1985 on.[12]

As they have caught up in technology, local partners have gradually expanded their share in Kolon joint ventures, until more than 75 per cent of Kolon was Korean-controlled in the early 1980s (see Table II).

(3) Tongyang Polyester

Tongyang Polyester was set up in 1973 by Tongyang Nylon and Asahi Chemical. Asahi Chemical was in charge of most phases of plant construction, from basic design (August 1973) to start of operations (February 1975), but Korean engineers and managers demonstrated keen attention in surveys and follow-up. They got the Japanese engineers to explain every step of the process until they fully understood everything what was going on. Asahi Chemical was in charge of machinery and equipment purchases but had to consult with and get consent from Tongyang. After the plant started operation all Japanese engineers went

[12] Information on Kolon's technological catch-up is partially based on the author's field survey in Korea and partially on Enos and Park [3].

back to Japan. Six Japanese staff members worked in the Tongyang head office at the beginning, but their number was reduced to two by 1980.

As with other companies, Tongyang Polyester's Korean engineers were strongly motivated to participate in managing the joint venture. They were ready and eager to meet the challenge of catching up with the foreign partner and eventually gain the knowledge that allowed them to run the plant efficiently by themselves. But unlike other companies, the Japanese side still owns half the equity shares. This probably reflects Tongyang's willingness to maintain ties with Asahi Chemical. These ties may contribute significantly to Tongyang Polyester's future strategy for diversification, because Asahi Chemical is Japan's most diversified fiber company with a wide range of products including fiber, plastics, chemicals, and construction materials.[13]

VI CONCLUSION

Many economists emphasize machinery imports and turnkey plants as the dominant channels in Korea's pattern of technology development and claim that proprietary transfers of technology by foreign direct investment or licensing arrangements have been very limited.[14] However, if *machinery import* is considered as a channel, the high import value of machinery and capital goods makes it probably the most important one for most countries.[15] In other words, the importance of the channel is not particular to Korea.

Contrary to the prevailing view of most contemporary studies, foreign direct investment and licensing arrangements are important channels for technology transfer to Korea. This paper has also shown how and why local firms, given their own managerial resources and bargaining power with foreign suppliers of technology, chose either direct investment or licensing arrangements. For foreign direct investment, the local partner adopted the joint-venture approach and took the initiative in management. This strategy of selecting from these two channels and taking the management initiative is also seen in the Japanese experience of industrial development.[16]

The case study on Korea's catching up with Japan given here shows that in the early phases of industrial development, Korea had to depend on Japanese capital and technology for managerial resources, but was subsequently successful in substituting its own.

At least two implications can be drawn from the Korean experience in the synthetic fiber industry:

(1) A developing country can exploit its "advantages of backwardness" by using, as much as possible, foreign capital, technology, and management know-how. Depending on what its own managerial resources are, the way they are

[13] Korea's fiber companies have been actively diversifying since the early 1980s as the Japanese have since the mid-1970s.

[14] See, for example, [15] [5]. This was pointed out to the author by Professor Yamazawa.

[15] See, for example [8, p. 9] for cases from Japan and [13, p. 194] for cases from Thailand.

[16] See [16, ch. 7] and [17] for examples of some industries. For Japanese policies on the selection of the two channels, see [10].

used may be either the importing of a resource package (foreign direct investment) or the importing of technology through a licensing arrangement.

(2) However, the developing country should try to efficiently absorb the imported managerial resources and gradually replace them with its own. This is important for three reasons. First, it provides conditions that ensure steady development of the subject industry and affect the industry less if the MNC should change strategy and leave for some other country. Second, catching up in managerial resources builds the foundation and gives the spill-over effect necessary for developing the aggregate economy. Third, it prevents the over-dependency on foreign resources, particularly on foreign capital, for developing all or most industries that cannot be permitted either politically or nationalistically.

It is therefore wise that the degree of dependence on foreign resources should vary according to the phase of development that a particular industry is in. In the "infant" stage, foreign resources should be used as much as possible, then gradually reduced as other industries that require foreign resources begin to grow. This consecutive development of industries using a varied combination of foreign dependence is economically efficient and politically permissible. The approach is certainly useful for solving one of the major dilemmas of the developing countries: the desirability of foreign resources for economic development and the repugnance of MNC control over economic activities.

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