Korean Industrial Competence: Where It Came From

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The World Bank
Washington, D.C., U.S.A.
ABSTRACT

This paper discusses how the Koreans have established an independent base of technological know-how and marketing expertise in many sectors. The approach is to analyze the balance of domestic and foreign factors in Korea's export-led industrialization.

Although there is widespread recognition that Korea has benefited from uncharacteristically large inflows of foreign investment resources, there is less appreciation of the role of foreign versus domestic factors in other dimensions. In particular, the local technological mastery and marketing savvy embedded in Korea's industrial production have received little systematic attention.

It is found that Korea's industrialization has overwhelmingly and in fundamental respects been directed and controlled by nationals. Inflows of investment resources have largely been in the form of debt. Technology has thus been acquired from abroad primarily through means other than direct foreign investment. In addition, licensing has been of limited importance, and the sales of manufactured exports have typically been at arm's length. Indeed, for most industries, Korea appears to have had little difficulty gaining access to technology and to export markets: that is, world markets appear to be competitive, not restrictive, as is frequently asserted.

The principal implications for countries less far along the path of industrialization are these. First, a high level of technological sophistication is not required to attain substantial industrial competence, and it is possible to become a significant industrial power simply on the basis of proficiency in production. Second, there is tremendous efficacy in relying on export activity as a means of acquiring industrial competence. Exporting thus appears to offer a direct means of improving productivity.
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INTRODUCTION

The fact that a product is manufactured in a country does not necessarily mean that its nationals have mastery over all aspects of the underlying technology. Nor does the export of a product imply the ability to market it independently in foreign countries. Consider exports, for which the degree of local know-how embodied in a particular export depends on the specific character and circumstances of the transaction. The embodiment of local know-how may be least in production for export by the subsidiary of a foreign-owned firm that provides all or most of the know-how, including that for the training of workers. The embodiment of local know-how may be greater in production by a wholly domestic firm to meet an export order from abroad. In this case, the domestic firm may be principally responsible for the organization and management of production, but not necessarily for the foreign marketing, and possibly not even for the product design. The embodiment of local know-how is greater if the local firm has adapted conventional production technology and independently markets products of its own design overseas. The reader can easily supply other cases to demonstrate that there is a continuum of local

This paper was written as part of the preparatory work leading to the research project "The Acquisition of Technological Capability" (RPO 672-48). Westphal had primary responsibility for the writing, which reflects knowledge gained through long association with Rhee in research on Korean industrial development and uses heretofore unpublished results of a survey of Korean exporters by Pursell and Rhee in 1976. The research by Pursell and Rhee is part of a World Bank project under the overall direction of Bela Balassa: "Export Incentives in Developing Countries" (RPO 671-35).

We gratefully acknowledge our debt to Ms. Phi Anh Plesch, who assembled much of the statistical material. We also are grateful for comments on an earlier draft to Bela Balassa, Donald Keesing, Anne Krueger, Sanjaya Lall, Howard Pack, Demetrios Papageorgiou, and Sherman Robinson. Bruce Ross-Larson edited the manuscript for publication.
technological and marketing know-how on which individual export transactions fall. It is evident, moreover, that foreigners may provide technology and marketing through means other than direct foreign investment: licensing, subcontracting, technical agreements, management contracts, marketing arrangements, and a variety of other relationships. Indeed, a wholly domestic firm can be more dependent on foreign technological and marketing know-how than a foreign-owned firm.

The purpose of our inquiry is to make judgments about Korea's industrial competence and to draw conclusions about where it came from. 1/

Judgments about Korea's current level of industrial competence should prove useful in forecasting and planning the future evolution of its industrial sector. More important for the general reader, conclusions about how that competence was acquired should prove useful in programming the industrial development of other countries at earlier stages of industrialization.

"Competence" here refers to technological mastery and marketing savvy: that is, to the effective use of knowledge about production relations between inputs and outputs; about how to organize and manage production; and about how to organize and manage transactions among economic agents. Competence, in all its dimensions, is an inherently elusive concept and cannot be precisely measured. In addition, the breadth and depth of empirical information required to make even rough assessments are such that our inquiry can be no more than a tentative initial exploration. Of the modes of attack

1/ In this paper the Republic of Korea, often referred to as South Korea, is simply called Korea.
we might have taken to analyze Korea’s industrial competence, the one followed here centers on ascertaining how, and in what sectors, foreign resources have been used to complement domestic resources.

Among the complementary inputs that foreign sources can provide are the following: capital resources, whether in cash or in kind; labor services, including those of human capital; information about technology; marketing know-how and expertise; and entrepreneurship, broadly defined to include management and initiative. Even in the absence of physical factor inflows, foreign sources can provide complementary inputs: say, by marketing exports or by transferring technology under licensing agreements. Moreover, commercial transactions across international boundaries can entail vitally important transfers of resources, even when they do not explicitly appear to do so. For example, one of the most important sources of product design and quality control for Korean exporters has been the information that export buyers provide in specifying their orders and making plant inspections.

Recognition must also be given to many noncommercial modes of international transfers of resources. In addition to capital flows from public sources, particularly noteworthy examples include the technical assistance associated with foreign aid and the return of nationals who have acquired knowledge and skills through formal education and work experience overseas.

The questions dealt with in this paper thus concern more than the use of foreign resources as complementary inputs. They also concern the transactional modes associated with those inputs. Knowledge of transactional modes is important because it provides insight about the balance of domestic and foreign factors in taking various initiatives and in providing continuing management and control. In this respect, direct foreign investment by
multinational corporations receives particular attention, because equity participation implies the exercise of some continuing foreign entrepreneurship. In addition, much of the paper concentrates on the use of complementary foreign inputs in the production and marketing of manufactured exports, given the leading role of those exports in Korea's industrialization. Most of the discussion is based on published information, but that centered on manufactured exports makes extensive use of findings from a survey of Korean exporters recently conducted by Pursell and Rhee. 1/ The period covered by the discussion extends through 1975, by which time Korea had clearly attained semi-industrial status. But some reference is made to the subsequent evolution of Korea's industrial competence, until about 1978.

The effect of capital inflows on Korea's growth has received ample attention elsewhere and is not dealt with here. 2/ Less well understood is the way the technological and marketing know-how has been marshaled to use available investment resources effectively. That is the subject of our paper. The historical roots of the industrial competence displayed in the 1960s and 1970s are surveyed in the next section, which is followed by a reconnaissance of statistics on direct foreign investment. The paper then turns in successive sections to consider the acquisition of technology and the marketing of exports. 3/ The concluding section summarizes the main findings.

1/ Throughout the discussion, and unless otherwise indicated, the source of the underlying statistics on direct foreign investment, royalty payments, and the like is data provided by the Economic Planning Board, Republic of Korea. Sources of other statistics are various issues of National Income in Korea and Economic Statistics Yearbook, both published by the Bank of Korea, and of Korea Statistical Yearbook, put out by the Bureau of Statistics of the Economic Planning Board. All dollar figures in this paper are U.S. dollars.

2/ For example, see Frank, Kim, and Westphal (1975, chapters 7-9) and Krueger (1979).

3/ For a discussion of Korean entrepreneurship, a subject not dealt with explicitly in this paper, see Jones and Sakong (1980).
HISTORICAL PERSPECTIVE

For nearly a thousand years before their separation, North and South Korea constituted an autonomous ethnic, cultural, linguistic, and political entity. Because of the extreme isolationism of its last ruling dynasty, traditional Korea did not establish formal relations with any country other than China until forced to do so in the last quarter of the nineteenth century. Since being opened to western influences, the South has experienced three distinct periods with respect to the origin and nature of foreign influence on its industrial development: before 1945, 1945–60, and after 1960.

Japanese influence was paramount until 1945. Indeed the North and South were a single Japanese colony for the last thirty-five years of this period. The period came to a close at the end of the Second World War, when the Japanese were forced to withdraw and the peninsula was partitioned. Beginning with the creation of South Korea as a separate entity, the second period spans the duration of the Syngman Rhee regime, which was overthrown in 1960. The principal objective of Korea's foreign economic policy under Rhee was to maximize the inflow of economic and military aid from public sources. Capital inflows from private sources were not encouraged. The United States and, to much less degree, the United Nations provided virtually all resource inflows during this time, largely in grant assistance.

The third period began in 1960, when the government that replaced the Rhee regime passed legislation to encourage inflows of foreign private resources. That legislation reflected the first of a series of policy changes associated with the gradual adoption of the strategy of export-led industrialization. The strategy was firmly implanted by the end of 1965, a year that
roughly marks the "turning point" in Korea’s export and industrial growth [see Westphal (1978) for details]. As a result, there have since been inflows from private sources through commercial transactions of all kinds. Today, leaving military aid aside, hardly any inflows are on concessional terms.

Before 1945

Modern industrialization in Korea began in the colonial period, when the Japanese government managed the peninsula's economy as an integral part of its empire. Compared with the rest of the Japanese Empire, the Korean peninsula was rich in agricultural land and natural resources. The South had the best conditions for growing rice. The North had nearly all of the major mineral deposits and the best sites for hydroelectric generation. Economic development was thus centered on the production of crude and semi-processed agricultural and mineral products for export to Japan and its other colonies. But there was also substantial development of the manufacturing sector.

Among the summary statistics on industrialization during this period, the share of manufacturing in net commodity product is perhaps the most useful. Based on data in 1936 prices, that share rose from an average of 3.5 percent during 1910-15 to 22 percent in 1940. Over this same period, the net commodity product—also in 1936 prices—grew 3 percent a year (Suh 1978, pp. 38, 46). In line with natural resource endowments, the North’s development was concentrated in mining and in sectors manufacturing metals, chemicals, and nonmetallic mineral products; the South’s, in agriculture and in sectors manufacturing textiles, machinery, handicrafts, and processed food.

The growth of manufacturing during the colonial period depended heavily on the Japanese. Almost all of the capital equipment of the more
modern establishments was imported from Japan. Many entrepreneurs and most engineers and technicians employed in manufacturing were drawn from Japanese residents in Korea, whose number grew from less than 200,000 in 1910 to nearly 700,000 in 1940. 1/ Japanese residents also made up a disproportionately large share of the labor force in manufacturing, particularly the skilled labor force. Although representing less than 3 percent of the peninsula's population, they constituted roughly 17 percent of the full-time male labor force in manufacturing in 1940 (Suh 1978, p. 117). In addition, because of discrimination in their favor, the average educational level of the Japanese residents was far above that of the local Koreans. That is reflected, for example, in school enrollments. There were more than three times as many students per thousand of population for Japanese residents than for Koreans in 1939. The difference was 2.6 to 1 for primary students and much higher for postprimary students. 2/

During the colonial period, Koreans apparently acquired, mostly on the job, substantial knowledge about how to operate modern industries. The relevant industrial experience was not simply that obtained in the South, but also that of several hundred thousand Koreans who returned after the war from having worked in industry in Japan and Manchuria, as well as that of postpartition migrants from the North. Nonetheless, agreement is not universal on just how much human capital was built up during the colonial period.

1/ For details, see Frank, Kim, and Westphal (1975, pp. 6 ff.); Mason, et al. (1980, chapter 3: Historical Foundations of Modern Economic Growth); and Suh (1978, chapter 7).

2/ Suh (1978, p. 153). It should be noted that the figures greatly underestimate the difference in educational attainments between post-school-age populations, because enrollment rates among local Koreans gradually increased as the formal educational system expanded during the colonial period.
period. Suh (1978, p. 153) emphasizes the "imposed" enclave nature of industrialization during the colonial period and concludes that "the training of skilled workers, the supply of entrepreneurs, [the] changing habits of consumption and savings conducive to sustained economic growth, and the modernization of social values consistent with the requirements of industrialization ... were largely confined to the elite group," which consisted mostly of Japanese residents. On the other hand, Mason, Jones, and Sakong [in Mason, et al. (1980), pp. 245-49, 448-51] emphasize the "demonstration effect" of exposure to modern technology and forms of organization (p. 449). They conclude that the colonial bequest of human capital in trained manpower was considerable. Based on our reading of the historical record, especially about the Koreans' ability to operate industrial plants on their own after the withdrawal of the Japanese, and on the evidence of sources of technology reviewed below, we tend with Mason, Jones, and Sakong to emphasize the importance of the learning during the colonial period.

1945-60

As a result of the departure of all Japanese residents, the cessation of trade with all parts of the former Japanese Empire, and the breakup of the peninsula into two political entities, the Korean economy suffered tremendous disruption at the end of the Second World War. Moreover, much of the capital stock was physically inoperative and in need of extensive repair and replacement parts. 1/ In what now is South Korea, manufacturing production in 1945 was substantially less than a fifth of its level in 1940. 2/ But

1/ For details, see McCune (1950, chapters 3 and 8).
2/ See Frank, Kim, and Westphal (1975, pp. 6 ff.) and Jones and Sakong (1980, chapter 2).
in the light of circumstances at the time, it really is remarkable that the
Koreans were able, with relatively little foreign managerial or technical
assistance, to operate nearly half of all the manufacturing plants that had
existed in 1944: there was no existing sector in which they were unable to
produce at least something. With greater assistance from the U.S. military
government--access to raw materials, replacement parts, and technical help--
the Koreans by 1948 were operating facilities to produce a wide variety of
manufactured goods, including shoes, textiles, rubber tires, basic steel
shapes, and such engineering products as pumps, bicycles, tin cans, and ball
bearings. 1/

After Japanese colonialism, the next most important foreign influ-
ence on Korean economic development was the close relationship with the
United States. Although Korea gained political independence in 1948, when
U.S. military rule ended, it continued to rely heavily on the Americans,
both militarily and economically, for a rather long time thereafter. 2/
The circumstances behind the Korean War and the War itself--it began in 1950
and lasted three years--obviously conditioned the relationship in fundamental
respects. American involvement during the first part of the 1950s, as that
immediately after the Second World War, was almost exclusively concerned with
ensuring the existence of Korea as a separate political entity and with
sustaining a minimally adequate level of consumption for the Korean populace

1/ See McCune (1950, pp. 155 ff.).

2/ For details, particularly about economic assistance, see Krueger (1979)
Development).
through commodity inflows. After the Korean War, military assistance con-
tinued to help assure Korea's independence; most of the American nonfood
economic assistance was for the maintenance and use of existing resources. 1/

The relationship with the United States nonetheless served to
augment Korean resources, both directly and indirectly. By far the most
important effect appears to have been on the formation of human capital.
American aid directly contributed to the rapid expansion of education,
which by 1960 led to universal primary education and nearly universal adult
literacy, and it contributed to increasingly higher enrollment rates at all
levels above the primary level. 2/ Aid also financed overseas education and
training for thousands of Koreans. Much harder to assess, but no doubt
important because of universal military service, is the indirect contribution
from American military advisers. They helped the Korean military learn modern
concepts and techniques of management and organization, as well as how to
operate and maintain all types of machinery and equipment. For virtually all
of the male labor force, military service seems to have been an important
source of skill formation and general experience in an organization having
many characteristics of modern industry.

The Koreans also gained some technological mastery from their
relationship with the United States. Important channels for the direct

1/ Roughly 80 percent of U.S. economic assistance to Korea, from the
beginning to the end of concessional flows, was in the form of program
aid. About half of program aid was surplus agricultural commodities,
with much of the remainder being fertilizer and petroleum products. For
details, see Mason, et al. (1980, chapter 6: Foreign Assistance and
Korean Development).

2/ See Krueger (1979) and Mason, et al. (1980, chapter 10: Education).
acquisition of industrial technology included the inflow of technical advisers and the modest volume of project assistance, which further added directly to Korea's capital resources. The U.S. military was another channel: its local procurement program afforded producers in a number of sectors with occasions for assisted learning-by-doing to meet exacting product specifications. Among those benefiting from military purchases were construction contractors, plywood producers, and the tire industry—all would later become major exporters.

Postwar reconstruction can be said roughly to have ended in 1955. Industrialization during the last half of the 1950s was primarily oriented toward raising domestic supply ratios for light manufactured and nondurable consumer goods, such as textiles, which had been produced in Korea for some time, albeit in quantities well below what was necessary to meet domestic demand. Although exports grew relatively rapidly, they remained small in volume and in relation to GNP. The share of exports in GNP was only 3.3 percent in 1960.

After 1960

American economic assistance continued through the 1960s. Beginning in the late 1950s, however, the Americans initiated actions to increase Korean economic independence, the first being a gradual shift from grant aid to concessional lending. In addition, as previously noted, the overthrow of the Rhee regime in 1960 brought with it a pronounced change in policy: the Korean government began to promote inflows of foreign resources of all kinds. As a result, a rapidly increasing diversification of sources of foreign influence has characterized the period since 1960.

1/ For details about Korea's industrial development from 1955 to 1975, see Westphal (1978).
In the early 1960s, as opportunities for easy import substitution rapidly diminished, industrial growth began to falter. At the same time, there was considerable social and political instability, and there were several changes in the government. A number of attempts were made at policy reform and economic liberalization in the first half of the 1960s, as policymakers came to accept that rapid economic development depended on export-oriented industrialization, together with greater effort to mobilize domestic and foreign resources. These attempts culminated in 1964 and 1965, when a number of reforms were successfully implemented.

Most important were fiscal and monetary reforms, which were aimed at increasing public and private saving, and the establishment of a uniform exchange rate, which was the last step in the gradual adoption of a complete set of export incentives. By 1966 exporters virtually operated under a free-trade regime, paying no more than world market prices for inputs, whether imported or locally purchased. They also received substantial preferences in interest rates and direct taxes. Before the reforms, moreover, many modes of activity in pursuit of the rents associated with the allocation of aid flows and import quotas were highly profitable. The reforms wiped out most of these modes and brought the relative private profitability of different activities more nearly in line with their relative social profitability. 1/

Recognition must also be given to foreign capital as a source of much investment finance. The share of capital inflows in total investment has steadily fallen over time, but even as late as 1972-76, the period of Korea's third five-year plan, it was 20 percent. Deserving equal emphasis—if not

1/ See Brown (1973), Krueger (1979), and Jones and Sakong (1980).
more—is the efficient use of foreign capital inflows. Korea's gross incremental capital-output ratio of about 2.4 during 1965-75 was very low in comparison with that of other developing countries. In addition, much of the capital inflow during the 1960s and 1970s was commercial credit, including private loans having public guarantees (table 1). Most of the private loans flowing into Korea have come from Japan, the United States, and Western Europe. Many of those loans, but by no means all, have been suppliers' credits of one form or another. The availability of private foreign capital to Korea has largely been in response to the country's good export performance.

In the decade after 1965, the growth of manufactured exports and the rise in domestic demand fueled a rate of industrialization that was much faster than before. The average annual rate of growth in the index of manufacturing output had been 11 percent between 1955 and 1965; it rose to 24 percent between 1965 and 1975. Underlying the acceleration of growth in manufacturing output, the share of exports in gross manufacturing output—it was nil in 1955—rose from roughly 6 percent in 1965 to almost 25 percent in 1975. In the decade 1965-75, the ratio of exports to GNP more than trebled, and the share of GNP originating in the manufacturing sector more than doubled. Manufactured exports became increasingly diversified, so that in 1975 Korea was a major exporter of footwear, transport equipment, electrical machinery and appliances, and various manufactures of metal and nonmetallic minerals—in addition to textiles, clothing, and plywood, which had led the initial growth of exports.
Table 1. Net Foreign Capital Inflows a/  
(millions of dollars in current prices)

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<td>3,054.4</td>
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<td>Germany (Federal Republic)</td>
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<td>2.4</td>
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<td>3,722.6</td>
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<td>90.9</td>
<td>271.4</td>
</tr>
<tr>
<td>Germany (Federal Republic)</td>
<td>37.0</td>
<td>72.2</td>
<td>69.1</td>
</tr>
<tr>
<td>Other</td>
<td>38.3</td>
<td>305.2</td>
<td>544.9</td>
</tr>
<tr>
<td>Grants e/</td>
<td>832.8</td>
<td>444.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Total net foreign capital inflows</td>
<td>1,137.6</td>
<td>2,261.2</td>
<td>3,733.7</td>
</tr>
</tbody>
</table>

**Sources:** Data provided by the Economic Planning Board, Republic of Korea; Economic Analysis and Projections Department, World Bank. The periods for which cumulative inflows are given coincide with those of successive five-year economic development plans. The first plan covered 1962-66.

a/ Excludes military grants. Figures refer to foreign economic aid received.

b/ Includes all official loans and commercial loans with official guarantees. Figures refer to disbursements less service payments (principal and interest).

c/ Includes loans, whether from public or private sources, made to the private sector without official guarantees. Figures refer to disbursements less service payments (principal and interest).

d/ Figures are on an arrivals basis, net of repatriation of profits, dividends, and principal.

e/ Excludes military grants. Figures refer to foreign economic aid received.
Because of Korea's poor natural resource endowment, resource allocation along the lines of comparative advantage has required an increase in the share of trade in economic activity. As a result, the trend of the share of imports in the supply of tradables has been upward, though import substitution has been important in particular sectors at different times. Cement, metals, chemicals, fertilizer, and, more recently, transport equipment and machinery are among the sectors in which import substitution, often fostered by government promotion, has been important since 1960. Korea's industrial structure thus cannot be characterized as overly concentrated in the light manufacturing sectors: the chemicals and mechanical-engineering sectors are relatively large and rapidly expanding.

It is apparent from this short description that Korea's strategy of export-led industrialization is similar to the postwar pattern of Japanese industrialization—certainly in its reliance upon rapid export growth. The similarity is sufficiently close that one of the most important foreign influences on Korea's industrialization may be the example of Japan, which earlier demonstrated the feasibility of the path Korea is following. Indeed Korean policymakers are well aware of the lessons of contemporary Japanese economic history. But in helping to formulate the policy reforms that led to implementation of Korea's export-led strategy, before it became readily apparent that Korea could emulate Japan, American policy advisers may have had an equally important influence. To the degree that foreign influences have had an effect on economic policy, they may have been fundamentally important, because they would have operated on the incentives and other policy instruments that affect resource mobilization and allocation across the entire economy.
DIRECT FOREIGN INVESTMENT (DFI)

In the remainder of this paper we analyze the technological mastery and marketing performance that lie behind Korea's rapid export-led industrialization during the period since 1960. As explained in the introduction, we are largely concerned with the ways in which technology was acquired and exports were marketed. With respect to transfers of technology and the international division of production, the role of the multinational corporation (MNC) has received considerable emphasis in the literature on trade and development. By definition, an MNC is any firm having some degree of controlling ownership over enterprises in more than one country. Direct foreign investment (DFI) thus is the characteristic form of MNC involvement. We therefore survey the extent and composition of DFI in Korea before going on to examine sources of technology and export marketing more generally.

In common usage, MNCs are often identified as very large firms having a global reach, epitomized by those appearing on Fortune's list of the fifty largest industrial companies in the world. 1/ But it would be a mistake to think that all DFI is by such firms. Indeed much of the DFI in Korea has been by small and medium-size Japanese firms, whose overseas investments are limited to a single small undertaking in Korea. Nor would it be correct to think that MNCs provide complementary resources only through DFI. Many large MNCS, as defined in common usage, have not invested in Korea. But a number of them have licensed technology to local Korean firms or marketed Korean exports overseas, and some have done both.

1/ A recent list appears in Fortune, 13 August 1979, p. 208.
DFI provides a bundle of complementary resources, typically including capital, technology, and management, and sometimes including access to specific intermediate inputs and to overseas markets. This bundling makes DFI a subject of particular interest, for each resource could in principle be independently provided. The general explanation for their being bundled is the synergism among them in specific circumstances, such that the total return to the resources provided in combination exceeds the sum of the returns to each provided separately. The motivation for bundling thus is the investor's desire to maximize profit. Whether and to what extent the host country also reaps some of the rewards of synergism is a matter of great debate, though it obviously depends on the circumstances. 1/ Of at least equal concern are questions related to control, particularly insofar as investor interests conflict with the host-country strategies for developing particular industries. Because of the dearth of requisite information, these issues cannot be directly addressed in the Korean context.

The most important sources of synergism leading to DFI in manufacturing industries are product differentiation and oligopoly. 2/ This fact has a very important implication: DFI does not necessarily imply a general lack of management ability, technological mastery, or marketing savvy on the part of wholly domestic firms within the industries receiving it. The questions raised in this respect are dealt with implicitly in the sections on the sources of technology and the modes of export marketing. This section primarily provides descriptive information about inflows of DFI.

1/ It is not meant to suggest that the host countries benefit only to the degree they reap the rewards of synergism, for there are other benefits quite apart from synergism. On the subject of benefits more generally, see MacDougall (1960).

2/ See Vernon (1966) and Caves (1971).
Magnitude and Composition of DFI

DFI in Korea dates back to the colonial period. Through their subsidiaries, and led by the giant zaibatsu conglomerates, Japanese firms dominated the modern industries then established. The end of Korea's colonial status brought with it the severance of all ties with Japanese firms. There was no DFI between 1945 and 1960, when the first Korean legislation controlling nongrant inflows of foreign capital was promulgated.

The incentives to foreign investors under the legislation of 1960 featured an array of tax concessions, including a five-year holiday from income tax, and guarantees for the repatriation of principal and profit. Subsequent changes, intermittently introduced over time, added to the inducements, so that Korea's legislated incentives to DFI have consistently been among the most generous in Asia. 1/ Major changes were made in 1966 and 1970, when administrative procedures were simplified first by creation of the Office of Investment Promotion in the Economic Planning Board and then by the introduction of a "One-Stop Service Office," which centralized in one place nearly all of a foreign investor's dealings with government. The changes of 1966 also removed limits on the amount and share of total equity held and on the timing of remittances by foreign investors. The changes of 1970 accompanied the establishment of Korea's first free-trade zone explicitly designed to attract direct foreign participation in exports. 2/ In addition, Korean

1/ For a convenient comparison of incentives to DFI offered by the government of Korea and by other Asian governments, see the "Special Survey of Foreign Investments in Asia," The Economist, 23 June 1979, pp. 8-9.

2/ A second free-trade zone was established in 1973. Investments in the two zones accounted for 10 percent of the cumulative inflow of DFI as of year-end 1978.
labor legislation—if not practice—has been considerably more stringent about the means of redress permitted to workers in foreign-managed firms than about those permitted to workers in wholly domestic firms. 1/

The first instance of DFI in the postwar period was in 1962. Inflows initially were small, averaging only slightly more than $3.5 million a year during 1962-66. Inflows thereafter, though rapidly increasing, remained modest: the annual average rose to nearly $20 million during 1967-71 and to more than $110 million during 1972-76. Big changes in overseas origins and sectoral destinations were associated with the growth of DFI. Underlying the most significant of these were the changes in Korea's relations with Japan, the changing circumstances in Japan, and the growing importance of electronics in world industry.

Korea normalized relations with Japan in 1965, after which Japanese DFI was again permitted to flow into Korea. Japanese investors were responsible for 39 percent of total DFI in 1967-71 and for 71 percent during 1972-76. From the first period to the second, there was a more than tenfold jump in the volume of Japanese DFI in Korea, which reflected an almost quintupling of Japanese investment overseas and a more than doubling of the share directed to Korea. 2/

1/ For further discussion of incentives legislation and administrative procedures through 1970, see Yang (1970). For continuous coverage of changes in government policy, see the Monthly Review published by the Korea Exchange Bank.

The causes of the rapid upsurge in overseas investment from Japan have been discussed in detail elsewhere and will not be discussed here, except to note that rising real wages led a number of Japanese firms to locate labor-intensive or technologically mature production in neighboring low-wage countries. 1/ Korea's specific advantages over other such countries included its geographic proximity to and cultural affinity with Japan, both of which probably were important advantages for the sizable number of small and medium-size Japanese firms that invested in Korea. Investments by many of these firms appear to have been in the form of second-hand machinery, which was transferred to Korea after it could no longer be profitably used in Japan. 2/ Some of the investments from Japan—large and small—were by Korean expatriates residing there.

The manufacturing sectors have always been the principal destination for DFI in Korea: they received four-fifths of the cumulative inflow through 1978. Nonetheless, a gradually increasing share has been directed toward the social overhead and services sectors, principally electric power generation, financial services, and tourist services (including hotels). In manufacturing, the initial inflows were heavily concentrated in fertilizer production and petroleum refining. There was little DFI in other sectors during 1962-66. Over the next ten years, however, much of DFI went into the textiles and apparel, electrical machinery (largely electronics), and other chemicals—which sectors together received much more than half of the inflow going into


2/ Lee (1979) further argues that these firms preferred joint-venture partnerships over simply selling machinery because their superior access to the Japanese market meant higher returns if they were also involved in marketing the output.
the manufacturing sectors during this period. This pattern generally mirrored the composition of Japanese investment in Korea, but it also reflected the considerable concentration of American DFI in electronics.

In 1977-78 the volume of DFI averaged only a bit more than $100 million a year. The share of Japan in the total was slightly less than half; that of all the Western European countries was somewhat more than a quarter. Of the DFI directed toward the manufacturing sectors, the majority went into chemicals. Although a substantial proportion continued to flow into electrical machinery, little went into textiles and apparel during these two years.

By the end of 1978 the cumulative gross inflow of DFI into Korea amounted to roughly $875 million, of which 61 percent was from Japan and 19 percent from the United States. The principal sectors for DFI included—in the order of the magnitude of DFI—chemicals, textiles and apparel, and electrical machinery. Much of the foreign investment in chemicals was for the production of synthetic fibers and resins. As previously noted, nearly all of that in electrical machinery was for the production of electronics. Other important sectors for DFI included fertilizer, transport equipment, petroleum products, nonelectrical machinery, and metals and basic metal products—each of which received less than 10 percent but more than 5 percent of the cumulative inflow into manufacturing. Some sectors, such as rubber products and pulp and paper products, received no DFI at all.

Through the end of 1978 the Korean government had approved 857 instances (or cases) of DFI. The vast majority involved either 50-50 joint ventures or minority foreign participation, which was in line with the government’s policy to encourage these forms. As a rule, individual investments
by foreigners were small. The amount of foreign investment involved was less than $100,000 in nearly 250 cases. In only forty cases was the amount more than $5 million. 1/

Relative Importance of DFI

A straightforward but narrow means of assessing the relative importance of DFI is to focus on its role as a source of investment finance. Only a small proportion of the inflow of foreign capital into Korea has been DFI. During 1962-71 DFI contributed a mere 4 percent of the net inflow of foreign capital, excluding grant assistance (see table 1). It contributed 11 percent of the total during 1972-76. (Comparable data could not be obtained for 1977-78.) As previously observed, nearly 80 percent of all DFI went into the manufacturing sectors. But the contribution of DFI to gross investment in these sectors was small—roughly 5 percent in 1962-71 and 11 percent in 1972-76. 2/

Of equal interest is an assessment of the importance of DFI in Korea in relation to that in other developing countries. Cross-country information in table 2 confirms the impression that DFI has not been relatively large in Korea. 3/ The cumulative per capita inflow of DFI into Korea during the

1/ Note that all data on DFI given in this paper are in current dollars as of the time of either approval or arrival: that is, they are not adjusted for changes in the prices of investment goods over time. Data on DFI during earlier periods thus understate investment magnitudes in present prices.

2/ The percentage contributions cited in the text would understate the importance of DFI as a source of investment finance if foreign equity participation brought with it better access to foreign loans and suppliers credits. But the evidence suggests that Korean firms with no foreign equity participation had equally good access to foreign credit.

3/ Note that the word "net" has different meanings in tables 1 and 2. In addition to principal repayment and capital repatriation, interest payments and profit and dividend repatriations are netted out in table 1. Only principal repayment and capital repatriation are netted out in table 2.
Table 2. Comparative Data on Direct Foreign Investment

<table>
<thead>
<tr>
<th>Country</th>
<th>Population, mid-1976 (millions)</th>
<th>GNP, 1976 (billions of dollars)</th>
<th>Net direct foreign investment&lt;sup&gt;a/&lt;/sup&gt; Millions of dollars</th>
<th>Profit repatriations from direct foreign investment, 1972-76 Percentage of GNP</th>
<th>Profit repatriations from direct foreign investment, 1972-76 Percentage of exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>35.9</td>
<td>25.3</td>
<td>120.1 460.2</td>
<td>3.7 7.9</td>
<td>0.1 0.4</td>
</tr>
<tr>
<td>Brazil</td>
<td>110.1</td>
<td>143.0</td>
<td>1,483.5 6,158.3</td>
<td>33.8 22.9</td>
<td>0.5 6.5</td>
</tr>
<tr>
<td>Colombia</td>
<td>24.3</td>
<td>15.7</td>
<td>232.1 148.3</td>
<td>21.4 10.2</td>
<td>0.7 3.9</td>
</tr>
<tr>
<td>Mexico</td>
<td>62.0</td>
<td>65.4</td>
<td>1,283.9 2,617.5</td>
<td>36.6 16.0</td>
<td>1.2 12.5</td>
</tr>
<tr>
<td>Taiwan</td>
<td>16.3</td>
<td>17.1</td>
<td>222.1 274.9</td>
<td>32.3 12.9</td>
<td>0.5 1.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>43.0</td>
<td>16.3</td>
<td>236.1 499.0</td>
<td>26.1 28.0</td>
<td>0.2 0.9</td>
</tr>
<tr>
<td>Turkey</td>
<td>40.9</td>
<td>41.3</td>
<td>161.1 390.3</td>
<td>9.6 6.6</td>
<td>0.2 2.0</td>
</tr>
</tbody>
</table>


<sup>a/</sup> Net of capital repatriations but not of profit (plus dividends) repatriations.

<sup>b/</sup> Net of principal repayments but not of interest payments.
decade 1967-76 was only about a quarter of that into Brazil and Mexico and roughly a half of that into Taiwan. It was about the same as that into Turkey, Thailand, and Colombia. Of the countries for which data are shown, only Turkey received less DFI in relation to GNP than did Korea. 1/ In relation to total inflows of foreign capital, Korea had the lowest volume of DFI, lower even than Turkey, Thailand, and Colombia. 2/ The comparison of rates of profit repatriation, shown in the last two columns of table 2, also indicates the relatively low levels of DFI in Korea.

One factor that might partly explain the low volume of DFI in Korea is its poor natural resource endowment. Indeed there has been little DFI in Korea's primary sectors, which reflects the absence of attractive opportunities for investment, particularly in extractive activity. In contrast, nearly half the stock of DFI in developing countries is in these sectors. But this difference in investment patterns does not affect comparisons with Brazil, Thailand, and Mexico, for the share of manufacturing in the stock of DFI is at least as large in each of these countries as in Korea. 3/

1/ On the average, the stock of DFI in relation to GNP rises with increasing per capita income. In 1975 it respectively was 6.8 percent and 9.7 percent for countries with per capita incomes of $200-499 and $500-999 (U.N. Commission on Transnational Corporations, 1978; p. 57). The figure for Korea, which in 1975 had a per capita income of about $600, was 3.6 percent, or roughly the same as the average for countries having a per capita income of less than $200.

2/ Worldwide, and according to the U.N. Commission on Transnational Corporations (1978, p. 248), DFI accounted for between 10 and 20 percent of the total capital inflows into all developing countries in the early and middle 1970s.

3/ Data for countries other than Korea are from U.N. Commission on Transnational Corporations (1978, pp. 259-60). The same source shows the share of manufacturing for Colombia to be about one-half; the share for Taiwan is believed to be roughly the same as that for Korea.
SOURCES OF TECHNOLOGY

The focus of the paper now shifts from an individual transactional mode—DFI—to a particular resource—technology—and the ways it has been obtained.

The first task in this section, which requires a rather long digression, is to distinguish among the many ways of obtaining technology, paying special attention to the problems confronted in trying to uncover information about the extent of reliance on each. In all respects, the most important distinctions concern whether and how foreigners have been involved in the acquisition or development of technological mastery by Koreans.

There are many means of transferring technology from abroad that involve some form of specific foreign participation. Some of these means require a separate payment for the technology; others do not. This distinction stems from the fact that technology is frequently transferred as part of a "package deal," in which several other complementary resources are also provided, and for which only a single price—covering all the elements—is quoted. Insofar as imports of machinery are relied on to transfer technology (in an embodied form), they are a case in point. The distinction is significant because explicit payments provide a measure, albeit crude, of technology inflows. But there also are means of transfer from foreign parties that do not entail separate payment for the technology, which makes even crude measurement possible only with considerable effort. Moreover, these means probably are far more important overall than means that do entail separate payment.

An even more serious problem in attempting to quantify technology inflows is the lack of centralized documentation. With the exception of a
few clearly identifiable transactional modes, imports of technology typically are not as comprehensively monitored by governments as are imports of goods. Technology transfers incorporated in package deals are almost always neglected. For example, the construction of turnkey plants—a frequent mode of project implementation, particularly in sectors being newly established—is a prominent means of technology transfer for which it generally is impossible to secure detailed information without field surveys. 1/ Often it is not even possible to ascertain the extent of reliance on turnkey plants as the mode of project implementation, though a search of the files of the relevant government agencies would sometimes suffice. The situation is little better with regard to DFI. Although nearly all governments regularly monitor the amounts of investment, no attempt is made to separate the technology component. 2/ There are, in addition, many significant means of technology transfer which are impossible to monitor centrally or to quantify. Examples include the transmission of technological information by suppliers of intermediate inputs and by purchasers of outputs.

1/ In a contract to construct a turnkey plant, the prime contractor agrees to accomplish directly or to subcontract all of the various tasks required to complete plant construction. These tasks include such things as obtaining information about the process technology or technologies involved; transferring such information as will be required to operate and maintain the plant once completed; performing necessary engineering services, such as designing the plant and preparing the blueprints; managing physical construction, which often involves the use of expatriate laborers; selecting and installing equipment; training personnel who will work in the plant; and supervising initial operation, with satisfactory operation being the criterion of completion.

2/ Note in particular cases, however, that part or all of the inflow of technology associated with DFI may be covered by a separate licensing agreement and would thus be reflected in data on licensing agreements and royalty payments.
In short, inflows of technology are greatly understated in the statistics conventionally available, because they do not reflect important means of transfer. Even so, less information is available about local technological effort than about inflows of technology. One serious result is that indigenous development of technological know-how often is underrated or ignored as a means of acquiring technology. Indeed, it all too frequently is forgotten that the effective transfer of technology requires local effort to assimilate and master what is transferred. Mastery is neither automatic nor costless; it requires skillful management and inputs of domestic resources, particularly labor. Furthermore, assimilating technology almost always entails adaptation to local circumstances, a process in which domestic resources participate in varying degrees and which may continue for some time after completion of the original transfer. 1/ Transfers of technology from foreign sources may therefore be accompanied by substantial inputs of local technological know-how, some of which is typically acquired along the way through experience gained in undertaking various forms of technological effort. These considerations exist quite apart from the fact that the technology required in any given venture has many elements, so that part of the technology may be imported, with the remainder being supplied by local sources.

Considered in relation to its use in production, technology is specific to particular ventures—it consists of highly particularized bits of hardware, if the technology is embodied, or software, if it is disembodied. In this context, sources of technology refer to the origins of

1/ Rosenberg (1976, chapters 9 and 10) documents the points being made here.
the hardware and software. But the perspective on technology acquisition
that is afforded by this approach is much too narrow to be meaningful.
Specifically neglected is the fundamental fact that bringing any venture
to fruition involves a great deal of iterative problem-solving and experi-
mentation as the original concept is refined and given practical expression.
Moreover, the sequential process lasts for as long as changes continue to
be made in the operation of the venture. Thus, what really is at issue here
is a country's technological mastery and how it has been acquired. That
mastery consists of the command over technological information and the ability
to use it effectively in particular situations.

Transfers of technology from abroad constitute an important means
of acquiring technological mastery, too, but only insofar as they increase
the stock of domestic human capital through learning. Mastery of production
processes is only one dimension of the human capital formation that may
result. Equally if not more important is the experience gained in one trans-
fer: it can increase the local capacity to undertake subsequent ventures,
so that domestic sources gradually replace foreign sources. There are also
means of acquiring technological mastery that do not involve explicit foreign
participation but that exploit foreign technology nonetheless. Nationals
can be sent abroad for education, training, and work experience; technical
and other journals can be consulted; foreign products can be copied. Indeed,
at least some of the technological information underlying the initiation of
industrial activities in developing countries almost always comes from abroad.
But this fact is far less important than the recognition that acquiring
technological mastery depends on local effort. 1/

1/ For a comprehensive survey of the literature which documents this asser-
tion, as well as for an examination of its implications for development
policy, see Dahlman and Westphal (1981).
Comprehensive measurement of a country's technological mastery is impossible. However relevant they may be, statistics pertaining to educational attainment, deployment of scientific and technical manpower, and expenditure on research and development fail to capture fundamental dimensions. They do not indicate the effectiveness with which resources are used. Moreover, they fail to reflect most of the purposive technological effort by firms to increase productivity and accommodate changing circumstances, an effort that typically takes place in the context of day-to-day operations and outside that of formal research and development. The accumulation of evidence from a number of recent and ongoing studies of technology in developing countries indicates two things. First, such effort is a primary means of acquiring technological mastery and the principal reflection of its acquisition. Second, such effort underlies much of the increase in productivity observed in developing countries. 1/ The raison d'etre for this effort is given by Nelson (1979, p. 18) in his statement that "manufacturing technology is characterized by a considerable element of tacitness, difficulties in imitation and teaching, and uncertainty regarding what modifications will work and what will not." Gaining technological mastery thus is inseparable from technological change and innovation.

The form of innovation most easily discerned is the initiation of a new line of domestic production. But the technological change that

1/ The most extensive evidence comes from Latin America, specifically the research directed by Jorge Katz under the IDB/ECLA/UNDP/IDRC Regional Program of Studies on Scientific and Technical Development in Latin America. For a summary, see Katz (1978).
follows initiation can be even more significant. 1/ Such technological change occurs through a succession of minor innovations that can cumulate to have a pronounced impact on production efficiency. In this respect, innovation is broadly defined as the use of new methods or the modification of existing methods, whether imitative or not. Innovations include stretching the capacity of existing units through various adaptations, breaking bottlenecks in particular processes within the plant, improving the use of by-products, extending the life of equipment, making accommodations to changes in raw materials sources, and altering the product mix. Detailed evidence about the extent and character of such innovations comes only from painstaking case-study research and thus is selective. Estimation of changes in productivity is more easily accomplished and provides a useful indication of the outcome of innovative activity. In addition, knowledge of the diffusion of technology from domestic sources gives some idea of the technological mastery acquired.

Having provided a framework for understanding the sources of technology, we turn to consider the information for Korea. Although incomplete in many respects, that information is sufficient to permit a broad characterization of the ways in which technology was acquired in Korea's industrial sector. Our discussion begins by examining the reliance on DFI, technical assistance, and licensing as means of transferring technology. It then considers more generally how one important subset of producers--exporters--have obtained technology. It concludes with a tentative evaluation of Korea's technological capacity.

2/ For example, Dahlman and Fonseca (1979) report a case in which the annual throughput capacity of a Brazilian steel mill was more than doubled from its nominal rating through a sequence of capacity-stretching innovations in its operation--innovations that took place over seven years and required very little new physical investment.
Direct Foreign Investment

Notwithstanding the relative unimportance of DFI as a source of investment finance, it is possible that DFI could have been important as a means of transferring technology. That would be true if DFI were concentrated in locally innovative ventures that subsequently diffused technology to other producers. As was noted earlier, the establishment of new lines of local production is the form of innovation most easily observed. In this respect, the evidence clearly indicates that DFI has been an important source of technology in only a few sectors, primarily in chemicals, electronics, and petroleum refining.

The first major foreign investments after 1960 were for import substitution in chemical fertilizers and petroleum refining. DFI has also been the principal source of technology for most of the electronics sector, but it should be noted that the sector was initially established by purely domestic firms engaged in what largely were assembly operations (Kim, forthcoming). Joint ventures played an innovative role in establishing facilities to produce basic petrochemicals and derivative synthetic fibers and resins, an important example being polyester fiber and yarn. But DFI has had no part in the production of many other chemical products of equal significance in Korea, such as rayon yarn and acrylic fiber and yarn. These products are all important exports, either directly or indirectly (that is, as inputs into textile exports).

Other forms of innovation, particularly those leading sequentially to gradual improvement of production processes and product designs, are much more difficult to identify. But insofar as they represent minor adaptations,
they are likely individually to be of much less significance. There is little direct evidence on which to base a judgment about the importance of DFI in relation to these forms of innovation. To our knowledge, the most relevant microeconomic information is that provided in studies of exporting firms by Cohen (1973, 1975) and more recently by two of us--Pursell and Rhee.

Cohen's study consists of a careful comparison of domestic and foreign firms producing ostensibly identical products. Foreign firms are those located in Korea and having some foreign equity participation. But the study has rather severe limitations: the period of comparison is relatively short; the sample size--twelve domestic firms, ten foreign firms, and six distinct products--is small; the range of information obtained is limited. Moreover, the study extends only to 1971, by which point Korea had received relatively little of its present stock of DFI. Despite these limitations, it is warranted to quote Cohen's conclusion that "neither the direct nor the indirect economic benefits of this [export-motivated] type of foreign investment are very great, if they exist at all. By most indices foreign firms resemble local firms ..." (1975, p. 119). 1/ Thus Cohen was unable to uncover any evidence of technology diffusion from foreign to domestic firms for the sample of products he studied. 2/

Eighteen foreign firms were covered in the study by Pursell and Rhee (information regarding the scope of this study is given below in the

1/ The quotation refers to comparisons of foreign and domestic firms in Singapore, Taiwan, and Korea. But the conclusion is clearly meant to apply country-by-country as well as collectively.

2/ The products are wigs, radios, transistors, cotton yarn, cotton cloth, and baseball gloves.
section, "Acquisition of Technology by Exporting Firms"). As would be expected, foreign parent or affiliated companies were an important source of technology for these firms. In contrast, foreign and domestic sources of technology were about equally important for domestic firms. 1/

To investigate whether foreign firms tended to be more or less innovative than domestic firms, the firms were asked whether they were the first to introduce any production technologies in Korea—and if so, to provide a brief description of the technology, the number of firms subsequently adopting it, the approximate time lag, and the causal connection (if any) between its introduction by the firm responding and its subsequent adoption by other firms in Korea. Of the nine foreign firms that responded to this set of questions, six had introduced a total of ten new technologies in Korea; of the seventy-nine domestic firms that replied, twenty-seven had introduced a total of forty new technologies.

These results would seem to indicate that foreign firms on the average were somewhat more innovative than domestic firms. But the implication may not be generally valid; two-thirds of the foreign firms produced either synthetic fibers or electrical products. Moreover, a closer look at the responses suggests that Korean firms introduced important innovations even in these industries. In the electrical products industry, for example, televisions, refrigerators, elevators, and escalators were first produced in Korea by a Korean firm and were subsequently produced—after a time lag of about two to five years—by both foreign and other domestic firms, which in some cases benefited by hiring away technicians employed by the innovating Korean firm.

1/ The difference between foreign and domestic firms in this respect is statistically significant according to the conventional chi-square test.
Of course, a comparison of the frequency of innovation by foreign and domestic firms says nothing about the relative importance of the respective innovations. In this regard, the principal things of interest in the responses are the high incidence of innovation by both foreign and domestic firms and the apparent importance of many of the innovations. The six foreign firms introduced the following in Korea: the production of nylon yarn, a technique for manufacturing polyester staple fiber, a technique for dyeing and processing rabbit fur, a new technique for producing cement, the production of three electronic components, the production of small televisions, and techniques for manufacturing audio-speakers and home stereo systems. On the other hand, the twenty-seven domestic firms were responsible for introducing a wide range of products and techniques, including the following: acrylic fiber; rayon yarn and staple fiber; many techniques related to producing textiles, including various dyeing techniques and a technique for weaving high-quality Japanese kimonos; new techniques for manufacturing zippers and synthetic leather; a variety of techniques for producing pumps, ships, transformers, diesel engines, fork lifts, industrial machines, automatic looms, electric motors, and iron and steel products; and the production of radial tires, aircraft tires, tennis balls, golf balls, refined zinc, and canned mushrooms and asparagus.

Many of these innovations were subsequently adopted by other firms in Korea. According to the information provided by the innovating firms, twenty-nine of the fifty innovations, including four of the ten processes first introduced by foreign firms, were subsequently copied by other firms. 1/

1/ The six processes not imitated had been introduced a very short time before the survey.
But only two firms indicated that there was any direct relation between their activities and the subsequent diffusion of the innovations they introduced; that relation consisted of the hiring away of technical staff by the new entrants. Thus it is possible that some of the later entrants would have established the new processes in Korea even without the example of the innovating firm. This further blurs the comparison of the importance of foreign and domestic firms in introducing new technology. 1/

Technical Assistance and Licensing

We now consider technical assistance from bilateral and multilateral sources, typically on concessional terms. We also examine formal licensing to obtain access to proprietary technology, for which royalty payments must be made, usually on a continuing basis over a stipulated period. The sum of both flows does not necessarily equal, or even come close to, the value of explicit payments made for technology. For example, payments made to engineering and management consultants of all kinds are not included, except insofar as they are financed by technical assistance.

Korea's expenditures on royalty payments abroad have until recently been small: the value of technical assistance exceeded that of royalty payments by a large margin through 1967-71. The cumulative value of technical assistance received from bilateral and multilateral sources from 1962 through 1976 was $243.8 million. The comparable figure for royalty payments

1/ In contrast with the Pursell-Rhee results, some recent surveys do not give any indication of significant innovations by foreign firms, but these surveys are even more limited than Cohen's. In a related area, though, Jo (1977) reports evidence—without giving any details—of considerable adaptation of technology to local conditions by MNCs. This does not necessarily imply that foreign firms use more innovative or appropriate technology than do domestic firms, but it certainly is consistent with either result.
to commercial sources of licensed technology is $113.5 million. But this comparison is somewhat misleading for industry alone: only 27 percent of the inflow of technical assistance was directed toward the mining and manufacturing sectors, which were responsible for more than 90 percent of total royalty payments. Moreover, even after making adjustments to reflect this difference, the degree to which these figures respectively measure comparable flows is questionable. Whatever the degree of initiative exercised by the Korean government in directing the flow of technical assistance to maximize the value of the resulting technology transfer—and there is considerable anecdotal evidence of a great deal of initiative—it remains that donor governments and agencies also exercised a significant degree of control. 1/

Japan has been Korea’s principal source of licensed technology: nearly 60 percent of Korea’s royalty payments from 1962 to 1978 were made to Japanese entities. The United States, as the second most important source, received slightly less than a quarter of Korea’s royalty payments. As would be expected, the composition of royalty payments by industry differs from that of DFI. Moreover, it is even more concentrated among sectors. There has been little licensing of technology in the textiles and apparel sector, in which a sizable proportion of DFI was concentrated. The chemicals sector accounted for roughly 40 percent of Korea’s royalty payments; metals and basic metal

1/ Most technical assistance—more than three-quarters of the total—came from the United States and the United Nations. Of the total value received, slightly more than 30 percent was for contractual services; roughly 25 percent was for commodities, many of which were to equip such technical institutes as the Korea Institute of Science and Technology; another 25 percent was for individual consultants who worked in Korea; and the remainder, roughly 19 percent, was used to send Koreans overseas for training and education.
products, 16 percent; electrical and nonelectrical machinery, about 10 percent each; and transport equipment and pulp and paper products, about 3 percent each.  

How do Korea's technology purchases compare with those of other countries? The comparative data are rather unsatisfactory because they include only royalty payments and express these in relation to the value of total commodity exports. It already has been noted that licensing is not the only means of purchasing technology. Moreover, comparisons in relation to the value of exports are difficult to interpret for two reasons. First, technology is also purchased in varying amounts by different countries for use in production for domestic sale. Second, exports differ in product composition across countries, leading to variations in the technology embodied in exports. The comparison nonetheless is of some interest.

For Korea, the ratio of royalty payments to the value of commodity exports ranged between 0.3 and 0.5 percent from 1972 to 1976. This range is to be compared with ratios ranging from 1 to 3 percent for other semi-industrial countries, such as Argentina, Brazil, Chile, and Colombia. Only since 1977 have Korea's royalty payments reached comparable levels. In fact, combined royalty payments of $143.1 million in 1977 and 1978 exceeded

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1/ In addition to other chemicals, the chemicals sector here includes pharmaceuticals, fertilizers, and petroleum products. Payments for pharmaceutical technology have amounted to only 0.6 percent of total royalty payments.

2/ The percentage appears to be higher even in India, where it was 0.8 in 1973. Comparative data (also based on selected individual years for the other countries) are from U.N. Commission on Transnational Corporations (1978, p. 280).
the cumulative total for the preceding fifteen years. Increased reliance on licensing can in large measure be explained by increased emphasis on the development of technologically more advanced industries in recent years.

Aggregate data on royalty payments abroad reveal little about the importance of licensing as a source of technology for locally innovative undertakings. Although there is some information about how the initiators of new lines of production acquired technology, it is severely limited in detail and in the number of industries involved. It nonetheless indicates that some industries—those producing wigs, cement, and rayon yarn, for example—have been established on the basis of technologies acquired from overseas through means other than licensing. This result is not surprising, because not all technologies are proprietary. The information also gives a clear indication of extensive reliance on turnkey plant construction as a means of acquiring technology—sometimes involving licensing, though generally not. 1/ Moreover, the second and subsequent plants typically were not constructed on a wholly turnkey basis, at least in those industries with which we are familiar. 2/

Acquisition of Technology by Exporting Firms

Given the importance of exports in Korea’s industrialization, the means by which exporters acquired technology are of particular interest. Here we can use the survey of 112 exporting firms that Pursell and Rhee undertook

1/ Chung (1977) reached the same conclusion.

2/ Particularly interesting in this regard are case studies under way by the Institute of Economic Research (1979); these show the progressive replacement of foreign by domestic technology suppliers in the construction of successive plants for the manufacture of steel, paper, petrochemicals, and nylon yarn and cord.
in 1976. The firms surveyed, on the average much larger than other Korean firms, were together responsible for slightly more than a third of Korea's commodity exports in 1975 and just less than 15 percent of new contracts for construction services in the same year. The vast majority were 100-percent locally owned. 1/ Twenty-three of the firms had no domestic sales. Represented among "traditional" Korean exports are processed food products, fresh fish, cement, textiles, clothing, plywood, shoes, leather products, wigs, and toys, handicrafts and sporting goods; among "nontraditional" exports--refined sugar, synthetic fibers and resins, tires, basic metal products, tableware, electronics, nonelectrical machinery, transport equipment, and construction services.

The firms were asked to indicate the importance of different designated sources of the technologies they currently used: that is, to distinguish among sources that were "very important," "important," "of minor importance," and "not important or not relevant." Technologies were intentionally not specified; each firm determined the specific technology or technologies for which the importance of alternative sources was indicated. It is apparent from the survey results that the most frequent reference was to process technology, not to product design. Table 3 summarizes the responses of eighty-eight firms that answered the question with respect to a total of 241 technologies. The figures given in the table state the percentage of responses in which each source was considered to have been

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1/ Only one firm was wholly foreign owned; three had majority, and fourteen minority, foreign ownership. These foreign firms were concentrated in the production of electronics and synthetic fibers. Because of their small number, separate figures are not shown for foreign firms in the tables that follow.
Table 3. Relative Importance of Sources of Process Technology

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage composition of responses indicating a source to be &quot;important&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
</tr>
<tr>
<td></td>
<td>exports</td>
</tr>
<tr>
<td>Domestic</td>
<td></td>
</tr>
<tr>
<td>Licensing and technical assistance</td>
<td>3.6</td>
</tr>
<tr>
<td>Experience acquired by personnel through previous domestic employment</td>
<td>12.3</td>
</tr>
<tr>
<td>Suppliers of equipment or materials</td>
<td>6.2</td>
</tr>
<tr>
<td>Buyers of output</td>
<td>3.1</td>
</tr>
<tr>
<td>Subtotal</td>
<td>25.2</td>
</tr>
<tr>
<td>Government-supported institutes</td>
<td>8.7</td>
</tr>
<tr>
<td>Local know-how</td>
<td>21.8</td>
</tr>
<tr>
<td>Total domestic</td>
<td>55.7</td>
</tr>
<tr>
<td>Foreign</td>
<td></td>
</tr>
<tr>
<td>Licensing and technical assistance</td>
<td>11.8</td>
</tr>
<tr>
<td>Experience acquired by personnel through previous overseas employment</td>
<td>9.0</td>
</tr>
<tr>
<td>Suppliers of equipment or materials</td>
<td>12.3</td>
</tr>
<tr>
<td>Buyers of output</td>
<td>11.0</td>
</tr>
<tr>
<td>Total foreign</td>
<td>44.1</td>
</tr>
<tr>
<td>Unidentifiable</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: See the first paragraph of this subsection for the individual export product groups included under the categories "traditional" and "non-traditional."

Source: Tabulated from a survey of 112 exporting firms conducted in 1976 by Pursell and Rhee.
either "very important" or "important." The total of the percentages in each column is 100, the result of their being calculated with respect only to responses indicating that a particular source was either "very important" or "important." The figures are thus to be interpreted as indicating the relative historical importance of different sources of technology. Sources of technology are shown separately for traditional and nontraditional exports, as well as for total exports.

Domestic sources transfer local know-how, which comprises technologies either developed indigenously or assimilated from abroad. (The accumulation of local know-how is discussed at the end of this section.) For all of the export industries surveyed, domestic sources were considered to be important slightly more often than were foreign sources. 1/ As would be expected, domestic sources have had a more important role in the traditional than in the nontraditional sectors. But the difference is not pronounced. In a large number of cases, the respondents stated only that local know-how was important; they did not distinguish among agents and mechanisms. On the basis of other information, however, it is highly unlikely that government-supported institutes had any substantial part in these cases. 2/

For domestic and foreign sources taken jointly, the sources of technology most frequently cited are buyers of output and suppliers of equipment or materials. Because suppliers can provide technology in both embodied and disembodied forms, it is not surprising that they are of somewhat

1/ Hereafter, no distinction is made between "very important" and "important." Both are considered to be "important."

2/ The most commonly mentioned public or quasi-public institutes were the Korea Institute of Science and Technology and the Korea Science and Technology Information Center.
greater consequence than are buyers of output; what perhaps is unexpected is
the small difference between them. Next most important are employees with
previous experience working in firms overseas--some as a result of turnkey
arrangements--and in Korean establishments. Indeed the transfer of labor
among firms counts for more than contacts with suppliers alone or with buyers
alone. 1/

Formal mechanisms of licensing and technical assistance, of only
modest importance overall, are of substantial consequence in the transfer
of technologies from abroad. 2/ Even so, though licensing and technical
assistance is the foreign source of technology that most frequently is con-
sidered to be important, it was considered to be important only a third of
the time that foreign sources were indicated.

For many industries it is important to distinguish between the
mastery of production processes and the ability to design products that
either conform to the structure of--or anticipate changes in--demand. Indeed,
parallel questioning about the sources for product innovation--that is, for
improvements in quality, additions to product lines, and changes in product
design, styling, and technical specifications--revealed that Korean exporters,
almost across the board, rely heavily on foreign sources for product-design
technology, far more so than for basic production, or process, technology.
This is apparent from the information in table 4, which summarizes responses

1/ The importance of labor transfer as a source of technology reflects
high labor mobility. Depending on the industry, between 33 and 51
percent of the production workers recruited to individual firms
in 1975 had previous experience in the job assigned to them. The
importance of labor transfer from overseas reflects the relatively
large number of Koreans who worked or were educated abroad before
their employment in Korea.

2/ Technical assistance here includes that for which the firm pays directly.
Table 4. Relative Importance of Sources of Information for Product Innovation a/ (percent)

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage composition of responses indicating a source to be &quot;important&quot;: for all exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td></td>
</tr>
<tr>
<td>Parent firm</td>
<td>6.2</td>
</tr>
<tr>
<td>Sales staff</td>
<td>8.6</td>
</tr>
<tr>
<td>Buyers of output</td>
<td>8.6</td>
</tr>
<tr>
<td>Other firms, affiliated or not</td>
<td>1.6</td>
</tr>
<tr>
<td>Total domestic</td>
<td>25.0</td>
</tr>
<tr>
<td>Foreign</td>
<td></td>
</tr>
<tr>
<td>Parent firm</td>
<td>1.2</td>
</tr>
<tr>
<td>Foreign publications</td>
<td>3.9</td>
</tr>
<tr>
<td>Overseas travel by staff</td>
<td>19.9</td>
</tr>
<tr>
<td>Buyers of output</td>
<td>26.2</td>
</tr>
<tr>
<td>Other affiliated firms</td>
<td>16.8</td>
</tr>
<tr>
<td>Total foreign</td>
<td>68.0</td>
</tr>
<tr>
<td>Unidentifiable b/</td>
<td>7.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Same as for table 3.

a/ Product innovation includes quality improvements, additions to product lines, and changes in the design, styling, and technical specifications of products.

b/ Includes production staff and "other" sources.
to a question about sources of information for product innovation. 1/ Foreign sources have been by far the most important channels of information leading to product innovation, with buyers of exports being the most important single source.

Foreign buyers contributed to product innovation through the influence they exercised on the characteristics of exported products. Fully 74 percent of the ninety-two firms that responded to this question stated that they either modified the characteristics of their product to accommodate buyers' requests or produced in direct accord with buyers' specifications. As is indicated in table 5, some firms (fourteen, to be exact) produced all or nearly all (81 to 100 percent) of their exports to buyers' specifications. But the majority of firms produced only some of their exports directly to buyers' specifications. The specifications most often influenced were product design and styling (forty-seven firms), followed by packaging (twenty-five), basic technical specifications (eighteen), and minor technical specifications (fifteen).

It also was apparent from the interviews with exporters that foreign buyers contributed importantly in other ways, most frequently as a result of periodic visits to inspect production facilities or of ongoing programs to control and improve quality. Through such things as suggesting changes in individual elements of the production process and improvements in the organization of production within the plant and in management techniques more generally, buyers helped many exporters achieve greater efficiency and

1/ The different breakdowns of sources used in soliciting responses about sources of process technology and of product innovation explain the difference between tables 3 and 4 in this respect.
Table 5. Influence of Foreign Buyers on Design, Style, Packaging, and Technical Specifications of Exports
(number of firms responding)

<table>
<thead>
<tr>
<th>Outcome of influence</th>
<th>Influenced, and details given</th>
<th>Details of influence: percentage of export sales affected</th>
<th>Influenced, but details unknown</th>
<th>Not influenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified own design</td>
<td>47</td>
<td>1 11 4 8 4 8 12 21 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used design provided</td>
<td>52</td>
<td>6 12 10 4 6 14 16 24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Same as for table 3.

lower costs. It thus appears that the transfer of know-how from export buyers has been a major contributor to minor process innovations of the sort that sequentially lead to gradual improvements, the cumulative effect of which can be extremely significant.

Accumulation of Local Know-how

It is not surprising that exporters have depended extensively on foreign sources for product innovation. Such dependence is inevitable when technology is transferred to start new lines of production that serve export markets from their inception—as in much of Korean electronics and shipbuilding production, for example. But dependence can also occur if production has

1/ Kawaguchi (1978) gives evidence from the (Japanese) buyer's side of the considerable efforts made in this direction. Further information from the exporter's side is provided by the as-yet-unpublished survey research of L. H. Wortzel and H. V. Wortzel, sponsored by a World Bank research project under the overall direction of Donald Keesing: "Key Institutions in the Growth of Manufactured Exports from Developing Countries." Morawetz (1980) also finds evidence of impressive contributions by foreign buyers to technological improvements of exporters.
first been established to serve the local market, with exports following later, as is more typical of Korean experience. Here mastery of technology is in the first instance often confined to achieving rudimentary standards of product design. These standards may suffice to gain entry into export markets, but continued growth of exports sooner or later requires that product standards be upgraded. Moreover, successful penetration of export markets frequently requires that product specifications be tailored to the different demands of individual markets. Until some experience has been gained in producing to meet differentiated demands, it undoubtedly is most cost-effective, and may even be necessary, to rely on export buyers for product-design technology. Not to be neglected in this regard is that production for export thus provides a potent means of acquiring product-design technology through learning by doing, which spills over to product development in local markets as well.

The interviews with exporters clearly indicate that the acquisition of technological capacity by Korean industry in basic production processes has progressed further than in product design, at least in relation to product standards in developed-country export markets. In addition, given the high frequency with which domestic sources were said to be important, the interviews attest to considerable Korean mastery of process technology. Much of what was considered by the respondents to have come from domestic sources consists of technology originally developed overseas, subsequently transferred or brought to Korea, and then effectively assimilated and sometimes adapted by Korean industry. Some of this technology, particularly in the traditional export sectors, was part of Korea's inheritance from its colonial past.
The basic production technology for nonsynthetic textile yarn and fabric is an obvious case: several leading textile exporters were established before independence, and many senior managers and technicians gained their initial experience in the industry during the colonial period. Plywood—also an important export, particularly during the 1960s—offers another example: the first plant to produce plywood was constructed in 1935. Plywood is equally an example of an industry that benefited from technical assistance provided under the U.S. military's program of local procurement during the 1950s. Nonetheless, when queried about the sources of technologies in use today, producers of both textiles and plywood overwhelmingly indicated local sources.

The distinction between domestic and foreign sources thus has little to do with the locus of the inventions that originally created the technology. It has far more to do with the importance of the assimilation and adaptation of technology by local producers, and of the diffusion of technology through formal and informal contacts and through labor transfers among domestic firms. Further evidence of the importance of diffusion from domestic sources comes from the sizable number of exporting firms that indicated direct knowledge of diffusion to other firms of technologies they had introduced into Korea.

In industries for which process technology is not product-specific, mastery has frequently led to the copying of foreign products as a means of enlarging technological capacity. The mechanical-engineering industries, among others, afford many examples; such processes as machining and casting, once learned through producing one item, can easily be applied in the production of other items. One case that has been closely studied is textile
machinery, particularly semiautomatic looms for weaving fabric (Rhee and Westphal 1977). In this, as in some other cases, Korean manufacturers have not only been able to produce a capital good that meets world standards, albeit for an older vintage; they have, in addition, adapted the product design to make it more appropriate to Korean circumstances. (The adapted semiautomatic looms fall between ordinary semiautomatic and fully automatic looms in terms of the labor intensity of the weaving technology embodied.)

In other industries in which technology is more product-specific, such as chemicals, mastery of the underlying principles has enabled greater local participation in the technological effort associated with the subsequent establishment of closely allied lines of production.

Recognition of the importance of local technological learning also is central to understanding how technologies initially, introduced in Korea only very recently—within the past five to ten years—are now considered, in relation to subsequent undertakings in the same lines of production, to have come from local sources. Korea's very high industrial growth rate has permitted rapid rates of technological learning because of the short intervals between the construction of successive plants in many industries. In some industries, including synthetic resins and fibers, the first plants were often built on a turnkey basis and on a small scale, much smaller than either the size of the market or the size that would exhaust scale economies. Construction of the second and subsequent plants followed quickly, with Korean engineers and technicians assuming an increasing role in project design and implementation, and at scales much closer to or equal to world scale. 1/ To

1/ The observed pattern of time-phased plant construction in these industries might be an optimal strategy, with small scales chosen for the first plants to minimize the costs and risks entailed in learning the technology. But it is not known whether these or other considerations were the controlling ones at the time the first plants were constructed.
the degree that local personnel undertook various functions involved in plant construction, Korea's technological mastery in these industries can be said to extend beyond operation of the production process to project design and implementation.

From all indications, Korea's technological mastery has developed rapidly. It is of interest to ask--With what result?--and to attempt an answer in the context of cross-country comparisons. We know of only one comparative investigation (Christensen and Cummings 1979) of changes in total factor productivity that includes Korea among the countries studied, the rest of which are countries that belong to the OECD. The study relates to gross private domestic product in all sectors, not just in industry, which would be preferable for our purposes. The results, however, are consistent with the proposition that rapid development of technological mastery has been an important source of the fast rise in Korea's industrial output, more so than in most OECD countries. Between 1960 and 1973, aggregate output in real terms grew 9.7 percent a year; total factor productivity increased 4.1 percent a year, and thus accounted for slightly more than 40 percent of output growth. 1/ Of the OECD countries, output grew faster only in Japan (10.9

1/ As for all the other countries, the growth in total factor productivity is attributable to a variety of sources, including among others: changes in the composition of activity toward higher productivity sectors, increased capacity use, and improvements in labor quality due to rising educational attainments, in addition to "pure" technological change, which is what concerns us here. For manufacturing alone, Kim and Roemer (1979, p. 90) estimate that 44 percent of the growth in output (at 18.9 percent a year between 1960 and 1973) was attributable to increased total factor productivity. But this contribution is reduced to 4 percent if separate account is taken of increased capacity use and labor quality, with the former being by far the more important. While recognizing the importance of increased capacity use, we are skeptical about whether its effect has been as pronounced as estimated by Kim and Roemer.
percent a year); likewise, total factor productivity increased more quickly only in Japan (4.5 percent a year). For all other OECD countries, the annual increase in total factor productivity ranged between 1.3 and 3.1 percent.

Korea's technological mastery is further manifested in rapidly growing exports of industrial know-how--through turnkey plant construction, through direct investments to establish manufacturing facilities, and through licensing and the sale of various technical services, including engineering and management consultancy. Examination of the content of these exports provides additional and particularly valuable information about Korea's technological mastery. As is shown in Rhee and Westphal (1978), the know-how exported typically appears to be either the mastery of conventional production technology for industrial activities that are well established Korea--such as cement and textiles--or the ability to organize and manage project implementation, plant operation, and marketing. 1/ Except in a few instances, exports of know-how do not extend to project or plant design, this element having been separately secured by the project sponsor or subcontracted to non-Korean firms.

This feature of Korea's technology exports highlights the fact that a number of industries have little mastery of the fundamental aspects of the underlying engineering know-how. As might be expected, these industries typically either are new to Korea or are experiencing rapid technological change globally. Nonetheless, several of them are important export industries—as a result of exports by foreign-owned firms or, if by domestic firms, on a clearly subcontractural basis (see the discussion in the next section).

1/ See Jo (undated) for an analysis of an extensive set of data on Korean direct investment overseas.
Electronics is a notable example, not only because it is an important export, but because it illustrates that technologies for processes and product designs can be intimately interconnected. As of 1978 Korea's electronics industry lacked nearly all of the process technology required to implement newly developed product designs, with the result that there was virtually no indigenous product-design activity, except in the realm of copying technologically unsophisticated products. 1/ In this industry, as in some others, mastery does not extend very far beyond assembly; only the technologically simpler components are domestically produced.

We conclude this section with a generalization and a caveat. The generalization is that Korea's technological mastery is much greater in production than in investment activity. Or to put it another way: Relative to world standards, Korea's proficiency in plant operation far surpasses that in product and plant design. 2/ As with any generalization, this one

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1/ See Suh (1975) and Kim (forthcoming). Kim documents considerable learning from the production of basic consumer products, such as televisions and tape recorders, as well as communications equipment and simple testing instruments. But critical elements of semiconductor technology are lacking nonetheless. Semiconductors, particularly in the form of integrated circuits, are the building blocks of electronics production. Briefly stated, they consist of silicon wafers onto which impurities are introduced in preset patterns through the use of masks to obtain the desired circuitry. As of 1978 there was no domestic capacity to produce either the elemental wafers or the masks, as well as other important inputs for semiconductor production. Inability to produce masks is an obviously major lacuna, because they are the vehicle by which product designs are implemented. Problems of communication make it practically impossible to purchase tailor-made elements from unaffiliated overseas firms.

2/ The emphasis on plant design rather than on other aspects of capacity creation is intentional. It is meant to highlight that more is involved than simply the inability to produce certain capital goods, and to point to the relative lack of basic engineering know-how.
has important exceptions, some of which are apparent from the foregoing discussion. But it contains an important kernel of truth. Now the caveat: The bias of Korea's technological mastery is neither unnatural nor a bad thing. It stems from the natural sequence according to which plant operation is learned before the capability for plant design is acquired. In addition, the continued use of foreign resources in investment activity has undoubtedly been necessary for the achievement of extremely fast production growth, for there are constraints on how quickly the requisite mastery can be acquired. What is significant in this regard is the evidence in many areas of gradually increasing use of domestic resources.

ORGANIZATION OF EXPORTING ACTIVITY

Like the application of technological know-how, the organization of export activity involves many separable functions and thus affords scope for the division of labor between domestic and foreign factors and for the gradual acquisition of skills as nationals take over more and more functions. That exports have often been produced to buyers' specifications indicates that foreigners have provided complementary resources of considerable importance to the growth of Korea's exports. But it is not inconsistent that Korean firms have had an important part, indeed an increasingly important part, in organizing their own export activity. In this section we examine how Korea's exports are sold—to see what is implied about the division of labor between domestic and foreign factors and how it is evolving. We begin by examining exports by foreign firms: that is, by firms located in Korea but owned partly or wholly by foreigners.
Exports by Foreign Firms

Much DFI has been approved on the condition that it involve exports. In 1978, 331 foreign firms were required to export all of their output. And of the 526 foreign firms approved with permission to sell some of their output in the domestic market, more than a quarter (144) had to export at least 50 percent of their output; fewer than half (245) had no condition regarding exports attached to their approval. There is little clearly reliable, comprehensive data on the operation of foreign firms in Korea. The Economic Planning Board, which is the ultimate source of nearly all available data on foreign firms, undertakes periodic surveys of them, but the scope of most of these surveys is narrow. 1/ A time series is available only for exports, but even here the coverage of years is incomplete.

The initial inflows of DFI into Korea were for import substitution and thus almost exclusively oriented toward the domestic market. 2/ DFI made virtually no contribution to the expansion of exports during the crucial

1/ The government undertakes surveys both regularly and episodically. A comprehensive special survey was conducted in 1975 (and another was under way at the time of this writing). But the Economic Planning Board considers the survey to have been a "trial run," the results of which are largely unreliable. Correspondingly, subsequent government reports do not use this survey; the quite different figures from other surveys are used instead. This in turn makes suspect two papers by Jo (1976, 1977), which rely heavily on the 1975 survey. The estimates cited by Jo indicate greater participation by foreign firms than is shown in recent government reports. For example, cumulative DFI approvals through 1974 are a third larger in the estimates cited by Jo; commodity exports by foreign firms in 1974 are nearly two-thirds larger. So far as could be determined, these discrepancies are not due to differences in underlying definitions.

2/ The exports of petroleum products shown in Korean trade statistics are peculiar, because they include sales to the U.S. military forces stationed in Korea.
1962-66 period, when export expansion replaced import substitution as the primary engine of Korea's industrial development. DFI began flowing into the export sectors in the 1967-71 period, but only in modest volumes. Foreign firms thus accounted for only 6 percent of Korea's total commodity exports in 1971 (table 6). 1/ Thereafter the accelerated inflows of DFI in the 1970s led to a rapid rise in the proportion of exports by foreign firms, because most of the DFI during this period was oriented toward exporting. In 1975, the most recent year for which data are available, wholly or partly foreign-owned firms were responsible for 17.6 percent of Korea's commodity exports.

<table>
<thead>
<tr>
<th>Table 6. Commodity Exports by Foreign Firms, 1971-75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Commodity exports (millions of dollars in current prices)</td>
</tr>
<tr>
<td>By foreign firms</td>
</tr>
<tr>
<td>Percentage share of foreign firms in total</td>
</tr>
</tbody>
</table>

Source: Data provided by the Economic Planning Board, Republic of Korea.

Given the share of foreign firms in the capital stock in manufacturing—no more than 10 percent—they appear to contribute a relatively high share of manufactured exports, even though their share in those

1/ Exports of services by foreign firms are virtually nil and are therefore disregarded here. In turn, foreign firms have had a somewhat higher share in manufactured exports than in total exports. On the average over the 1970s, manufactured goods constituted roughly 95 percent of foreign firms' commodity exports and 85 percent of total commodity exports.
exports is less than 20 percent. The disproportionality largely results from the disproportional representation of foreign firms in the principal export sectors, rather than from their having higher propensities to export than do domestic firms in the same sector. Nonetheless, there are a few sectors—electronics being the most important—in which foreign firms on the average do export a greater proportion of their output (Suh 1975).

In 1978 roughly 30 percent of the stock of DFI was in Korea's principal export sectors—textiles and apparel and electrical machinery, the latter largely consisting of electronics products. During the mid-1970s textiles and apparel constituted nearly 40 percent of commodity exports, electrical machinery roughly 10 percent. The sectors respectively accounted for about 20 and 60 percent of the manufactured exports by foreign firms. These firms were responsible for about a tenth of the exports of textiles and apparel and three-quarters of those of electrical machinery. Foreign firms accounted for only about a tenth of the exports of manufactures by other sectors.

It also is only with respect to exports of these two commodity groups that DFI appears to have been a necessary condition underlying a significant fraction of observed export flows. This is most obviously true for electronics, the one export sector that has been dominated by foreign firms, many of which are wholly owned subsidiaries. 1/ Rapid changes in technology within the industry worldwide largely explain Korea's dependence on MNCs in exporting electronics; many of the exports are intrafirm transactions or based on subcontracting, with the MNC providing the production know-how and critical inputs.

The situation in textiles and apparel is markedly different: MNC involvement is much less, and marketing rather than technological factors have been responsible for MNC involvement. What is more, exports of textiles and apparel began growing long before DFI became important to their expansion. Of the DFI that subsequently flowed into these sectors, 90 percent was from Japan, and most of the resulting exports appear to have gone to Japan. In this regard, Wortzel and Wortzel (see the note on page 45) have suggested that exports of clothing to Japan are greatly facilitated if either the firms doing the exporting or those supplying the fabric are at least partially Japanese owned. This outcome may be for no reason other than to assure the precise style or quality desired by Japanese consumers; but it may also follow from the problems faced by non-Japanese in penetrating the domestic Japanese marketing network. But not all Korean textile exports to Japan face these problems, if they indeed exist: for example, most silk exports to Japan are by wholly domestic firms. Exports of textiles and apparel to other destinations have typically been unrelated to DFI.

For other export sectors, the question is whether DFI might have made a substantial contribution in a way less readily apparent—for example, through opening new export markets that later were largely filled by domestic firms. Here the evidence suggests that the opposite typically was true: domestic firms began exporting before the foreign firms arrived. For example, of the products surveyed by Cohen (1973, p. 191), wigs, radios, cotton yarn, cotton cloth, and baseball gloves were first exported by domestic firms; only transistors were first exported by foreign firms.

To summarize the evidence of involvement by foreign firms in Korea's exports: DFI began to have some importance in Korea's export drive only after
export-led industrialization had become established as the ruling strategy. 1/ Moreover, only about a quarter of the growth of manufactured exports during the 1970s was associated with the operation of foreign firms. Domestic firms continued to expand their manufactured exports at a rapid pace, roughly 45 percent a year during the first half of the 1970s. In addition, exports by foreign firms were heavily concentrated in two commodity clusters—textiles and apparel and electrical products. Foreign firms had limited involvement, or none at all, in most of the product categories that were among Korea's important exports: in the earlier period, wigs and plywood; in the later period, transport equipment (especially ships), footwear, iron and steel (particularly sheets and plates), manufactures of metal, nonmetallic mineral manufactures (notably cement), rubber manufactures (notably tires), and precision instruments. Nonetheless, foreign firms have helped to initiate the production of some intermediate inputs used in exports. Since the late 1960s, much

1/ Information other than that surveyed in the text further confirms that "intrafirm trade" (Helleiner 1979) has constituted only a minor part of Korean exports. Considered as evidence, the information summarized in this note is conceptually deficient, but it is nonetheless worth presenting for completeness, given the frequency with which such information is used in similar contexts.

First, manufactured exports by Korean-based majority-owned foreign affiliates (MOFAs) of United States companies have been miniscule, amounting to less than $10 million dollars in 1976, for example. The share of exports in their total sales averaged less than 1 percent during the mid-1970s, compared with 9 percent for all developing country-based MOFAs (U.S. Department of Commerce, Survey of Current Business, various issues).

Second, the 20-percent share of related-party transactions in U.S. imports of manufactures from Korea, is considerably less than the 37-percent average for all developing countries (Helleiner and Lavergne 1979). Computations by the authors indicate that differences in the composition of exports account for roughly half of this difference, the other half being due to the lesser importance of related-party transactions in Korean exports at the disaggregate level.
of the DFI that has not gone into sectors producing direct exports has flowed into those producing indirect exports, particularly petrochemicals and derivative synthetic fibers and resins.

Other Modes of Exporting

Most of Korea's manufactured exports have been produced by wholly domestic firms. But managing export activity entails more than simply overseeing production; determining what to produce and where and how to sell it is at least as important. Even though production is by domestic firms, some or all of the functions of organizing export activity may be carried out by overseas firms.

The mode of export activity that is entirely organized abroad is international subcontracting, by which an overseas firm arranges to have some of the production related to its own activity undertaken by the exporting firm. 1/ The overseas firm typically is a manufacturing enterprise: it usually provides, in addition to detailed technical advice and instructions, critical intermediate inputs; it usually receives the export for assembly or further processing. The exporting firm may supply individual components, or it may perform selected stages of processing. Exports by MNC subsidiaries often follow this pattern, particularly for such durable goods as electronics. But exports by wholly domestic firms can also follow this pattern.

1/ We apply the term international subcontracting to export activity that is wholly organized by an overseas firm. This usage differs from that of some other authors, for whom the definition turns on whether the exporting firm markets its products overseas (for example, Sharpston 1976). Overseas marketing is only one aspect of organizing export activity. Thus, in our usage, the term international subcontracting is applied to a much narrower range of export activity.
Of Korea's major export markets, it is possible to get some idea of the relative importance of international subcontracting in Korean exports only for the United States. The data pertain to U.S. imports under tariff items 806.30 and 807.00, for which the import duty applies only to foreign value added. 1/ During the 1970s, Korea's share in such imports from all developing countries averaged about 6 percent. This share is to be compared with Korea's share in all manufactured imports from developing countries into the United States: 13 percent. But even more revealing is a comparison of i) the value of imports entering under these tariff items against ii) the total value of all imports falling within product categories that are eligible for entry under these tariff items if they embody American-produced inputs. 2/

For imports from Korea, the share of the former in the latter has averaged about 11 percent; for imports from all developing countries, the share has averaged nearly 25 percent. Moreover, there has been a slight downward trend in this share for Korea. It thus appears that Korea's exports have not been as dependent on international subcontracting as have the exports of developing countries more generally.

1/ For details, see Helleiner (1973, pp. 37 ff.). Imports under these tariff items embody intermediate inputs made in the United States and processed in some way in the exporting country. Identification of these imports with international subcontracting rests on the assumption that the processing was subcontracted, which need not be true in all cases. Not all imports embodying American-made inputs are eligible to enter under these tariff items. Nor must subcontracting entail the use of inputs obtained from the United States. Thus, imports under these tariff items may either overstate or understate the magnitude of U.S. imports that result from international subcontracting.

Information obtained directly from Korean exporters provides an insight into how Korea's export activity has been organized. All of the firms surveyed by Pursell and Rhee were asked to rank different kinds of buyers of their exports according to their importance in each of the geographical markets to which they exported. Table 7 summarizes the responses of the forty-one firms that answered. They answered with respect to an average of more than three market areas. The figures shown in the table are to be interpreted as indicating the relative importance of different kinds of export buyer.

Importers—that is, foreign firms that specialize in international trading activity and only incidentally engage in other activities—have been by far the most important buyers of Korea's exports. In fact, they were ranked first in importance in nearly two-thirds of the export markets represented. Wholesalers and manufacturers were ranked as important considerably less than half as often as importers, and only slightly more often than the exporting firms' networks of overseas branches and affiliates. Japanese trading companies rank after these networks in relative importance, followed by overseas retail chains and department stores, which count for only a little more than do the recently created Korean trading companies.

During the mid-1970s, therefore, most of Korea's manufactured exports were sold in the first instance to foreign "middlemen," who stood at least one step away from the point of final sale. Nonetheless, the exporting firms typically performed some of the functions involved in organizing their export activity, so that the mode generally was not that of international sub-contracting but was one of relying on middlemen to conduct various marketing
<table>
<thead>
<tr>
<th>Kind of Buyer</th>
<th>Percentage Composition of Responses Indicating a Kind of Buyer to be First, Second, or Third in Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importer</td>
<td>38.9</td>
</tr>
<tr>
<td>Wholesaler</td>
<td>14.6</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>14.3</td>
</tr>
<tr>
<td>Exporting firm's own overseas branch or affiliate</td>
<td>11.3</td>
</tr>
<tr>
<td>Japanese trading company</td>
<td>9.0</td>
</tr>
<tr>
<td>Retail chain or department store</td>
<td>4.1</td>
</tr>
<tr>
<td>Korean trading company</td>
<td>3.7</td>
</tr>
<tr>
<td>Foreign parent company</td>
<td>0.7</td>
</tr>
<tr>
<td>Others</td>
<td>3.4</td>
</tr>
<tr>
<td>All</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Same as for table 3.
functions required to communicate information and distribute and merchandise products. For example, Korean exporters did not wait passively for orders from visiting buyers. Instead they sought out buyers in overseas markets and solicited orders on the basis of samples and other information about their abilities. Thus nearly all of the firms surveyed had formal sales representation abroad. And of those having such representation, only a quarter were solely represented by non-Korean firms. Japanese trading companies were the exclusive overseas sales agents of only a handful of firms.

There even were sales to manufacturers which did not involve international subcontracting. Such intermediate products as steel plate were frequently sold in the open market and out of inventories rather than being produced to meet specific export orders. And although some overseas importers were involved in international subcontracting, the vast majority were not. Often the initiative for particular sales rested with the Korean exporter; overseas importers generally relied on the Korean exporter for production know-how and for elements of product design. In turn, exports to overseas branches and affiliates and through Korean trading companies were most frequently sold in the next instance to middlemen, sometimes retailers, who were relied on for merchandising and typically for market information as well.

The information summarized in table 7 points to the importance of foreign participation, especially in marketing Korea's exports to the final overseas purchasers. But it equally indicates that successful exporting does not require widespread and close integration more or less directly with the operations of firms overseas—of the sort epitomized by international subcontracting and similar operations of MNCs. This impression is buttressed by the
fact that most exporters sold to a number of buyers, not just to one or two.
Of eighty-seven firms that responded to a question about the importance of
individual foreign buyers, fifty-nine indicated that at least one foreign
buyer normally accounted for more than 10 percent of their export sales. But
the share of a firm's exports accounted for by any one such "large buyer"
typically was less than 20 percent.

The firms were also asked about initial contacts leading to entry
in individual new markets. The answers perhaps provide the best available
information about the relative importance of Korean and foreign initiatives
in the sale of Korea's exports during the recent past. Foreign buyers were by
far the most frequently mentioned sources of initial contacts—in more than 40
percent of the cases. Nonetheless, visits overseas, either by the firm's own
staff or by its representatives, were indicated to be the sources of initial
contacts in nearly 20 percent of the cases. All together, these visits—plus
discussions following trade fairs, enquiries from other Korean firms, and
enquiries directed from the Korea Traders Association and other trade and
industry associations—were claimed to be responsible in 44 percent of the
cases. Thus, to the degree that one is willing to identify these sources
with there having been a Korean initiative, it appears that almost half of
Korea's recent penetration into new markets has been the outcome of Korean
initiatives.

It should also be noted that Korean initiatives are relatively more
frequent outside Korea's traditional geographical markets than within them.
Thus Korean initiatives are indicated to be the sources of the initial con-
tacts in 100 percent of the market entries in Latin America; 54 percent
in the Middle East; and 50 percent in Africa. These markets also happen to be those in which Korea's exports are expanding most rapidly. In 1961 Japan and the United States were the destination of 67.8 percent of Korea's exports; in 1971, 74.4 percent. Their share in Korea's exports had fallen to 52.4 percent by 1977, when Europe's share was 17.3 percent. Third World markets now account for about a third of Korea's exports.

It is important to emphasize one point before ending this section: Although Korean firms increasingly perform a number of marketing functions related to organizing their export activity, foreign participation continues to be particularly important in some dimensions of marketing. We have already indicated the importance of foreign buyers as a source of product designs for export. Foreign participation is equally significant in other respects as well. For example, of the surveyed firms that were exporting wigs, shoes, clothing, tableware, sporting goods, and electronics products, nearly all sold a sizable fraction of their exports—in most cases more than three-quarters—under foreign brand names, a reflection of their reliance on overseas firms for merchandising, even at the wholesale level. In addition, most Korean exporters spend little, if anything, advertising on their own behalf, and a majority rely on overseas firms to provide after-sales service. Nonetheless, they are steadily increasing the scope of their overseas marketing activities. This pattern is evidenced by—among other things—the proliferation of overseas sales representatives as Korean exporters move to develop their own distribution networks.
CONCLUSIONS

Korea's export-led industrialization has overwhelmingly and in fundamental respects been directed and controlled by nationals. Although foreign resources have continued to make substantial contributions since the early 1960s, the transactions involved have typically been at arm's length. Thus, although Korea has relied rather heavily on inflows of investment resources, the inflows have overwhelmingly been in the form of debt, not equity. Except for industries established during the colonial period, technology has been acquired from abroad largely through means other than DFI. The purchase of technology through licensing has been of modest importance as the initial source of process technology; machinery imports and turnkey plant construction have been of much greater consequence in the transfer of technology, and a tremendous amount of know-how has entered with Koreans returning from study or work abroad. What is very important, the assimilation of technological know-how has been great. Moreover, Korean exports have critically depended upon transactions between related MNC affiliates or upon international subcontracting in only a few sectors, such as electronics. 1/ Nonetheless, though the organization of export activity is in part locally managed, marketing is largely performed by overseas firms acting as middlemen. But, what again is important, the acquisition of marketing savvy is well under way.

Korea's strategy to gain industrial competence has thus relied heavily on indigenous effort through various forms of learning by doing and

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1/ Korean exports thus conform to the hypothesis advanced by Hone (1974) and Nayyar (1978) and further supported by Balassa (1979): the most important foreign influence on the growth of manufactured exports from developing countries is exerted by buyers in arm’s-length transactions, and not—as suggested by Helleiner (1973, 1976)—by MNCs or firms engaged in international subcontracting.
emphasized transactions at arm’s length in the use of foreign resources. 1/
Several considerations arise in relation to extracting lessons from Korea’s success in following this strategy. We will deal first with those concerning the nature of technology and product differentiation in the industries on which its industrial growth has crucially depended. This will permit us to gauge the likelihood that Korea can successfully pursue the same strategy in the future. Then we will consider whether Korea’s past success in following this strategy has in any way depended on circumstances unique to Korea. This in turn will permit us to draw some conclusions relevant to programming the industrial development of other countries, particularly those at earlier stages of industrialization.

Many of the principal industries in Korea’s past industrialization—such as plywood or textiles and apparel—use technologies that can be characterized as mature, in that the mastery of well-established and conventional methods embodied in equipment readily available from foreign suppliers is sufficient to permit efficient production. 2/ Furthermore, the products of many of these industries are either quite highly standardized (plywood, for example) or differentiated in technologically minor respects and not

1/ That Korea was following, whether explicitly or implicitly, a consistent though evolving strategy having the elements stressed here is clearly indicated in various writings by Dr. Hyung Sup Choi. A key figure in Korean science and technology policy, he served lengthy tenures as head of the Korea Institute of Science and Technology and then as Minister of Science and Technology. See, for example, Choi (1977).

2/ Note that this does not imply the absence of rapid technological change in the industry in developed countries. It simply means that developing countries can—at least for a while—maintain a comparative advantage, once established, based on mastery of conventional methods more appropriate to their factor endowments.
greatly dependent on brand recognition for purchaser acceptance (textiles and apparel, for example). In short, for most of the industries that have been intensively developed to date, the technology for processes and for product design is not proprietary. With respect to acquiring technology or marketing overseas, there consequently are few advantages to be gained from either licensing or DFI, except in peculiar circumstances.

Electronics is an exception. It is an industry in which technology is changing rapidly worldwide, product differentiation is based on sophisticated technological know-how, and purchasers' brand preferences are evident. But it appears to be an exception that proves a rule, for electronics is precisely the industry in which Korea has extensively relied on DFI to enter production, particularly for export, and has so far failed to gain local mastery of fundamental aspects of production know-how.

In postwar Korea, however, electronics and certain chemicals perhaps are unique in their almost exclusive reliance on DFI for acquiring the very latest technology as well as market access. On the basis of licensing, Korea was able to acquire the most modern shipbuilding technology in the world, just as it was able to incorporate the most recent technological advances in its integrated steel mill. Other examples, which we will not cite here, further attest that Korean industry has been able to initiate, and in most cases successfully to operate, a variety of "high-technology" industrial activities by means of licensing and turnkey arrangements. Moreover, even in electronics, an intensive effort is under way—through the current expansion and development of the Korea Institute of Electronic Technology—to obtain basic technological know-how and production capability by means of licensing.
What seems apparent from recent experience is that the shift toward promoting more technologically sophisticated industries implies greater reliance on licensing as the mode of acquiring technology. But this is not a matter of absolutes, for it remains possible to substitute for licensing by replicating foreign technology through local effort. The difference is simply that the cost of doing so is higher in the industries more recently promoted. What is not so apparent is whether firms overseas will license technology without restricting its use. They may impose severe restrictions on the sales of licensed products. They may prefer to give access to technology only through DFI. Or they may even deny access. Equally unclear is whether the shift also implies greater dependence on licensing and DFI for market access, if only to gain rapid consumer acceptance through the use of familiar brand names.

About all of these issues, the experience of the Korean automobile industry is instructive. Unlike such countries as Brazil and Taiwan, whose automotive exports take place through international subcontracting to subsidiaries of the large MNCs, Korea has started to export complete automobiles produced by wholly domestic firms with no involvement by the large MNCs. Korea’s approach undoubtedly means slower growth of automotive exports and higher cost in the short run. It entails problems of gaining consumer acceptance not encountered under international subcontracting, and it requires the establishment of a network of overseas dealers and servicing facilities. But in the long run, having an independent sector under wholly Korean management may well pay off, just as the same approach continues to earn high rewards for the Japanese.
The example of the automobile industry suggests that Korea can and will continue to follow a strategy that emphasizes local technological effort and control. But recent government pronouncements suggest that the emphasis may be changing toward greater encouragement of DFI. Whatever the case, the tradeoffs involved in acquiring competence become increasingly complex, the more technology-intensive the industry being developed. Based on Korea's record so far, strategies for particular industries are likely to evolve in a pragmatic manner as more experience is gained.

What, then, is the relevance of Korea's experience to other developing countries? If any element in Korea's past situation is unlikely to be widely duplicated, it probably is Korea's abundance of entrepreneurial resources, which in effect removed a major advantage of DFI: the possibility of substituting foreign for domestic entrepreneurship. Moreover, Korea's entrepreneurial talent has not been deployed only in industry; government also has benefited. Indeed, Korea's remarkable industrialization would not have occurred without the design and implementation of effective government policies that have fostered industrial dynamism. 1/ But rather than speculate about the universality of entrepreneurial ability and the prospect that other countries will adopt policy approaches to permit its productive deployment, we will concentrate on the lessons that apply in countries having entrepreneurial resources, even if those resources are latent, as they once were in Korea.

Korea clearly has not had to rely on foreign entrepreneurship to identify profitable ventures or to manage their operation. This fact

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1/ On the design of government policy, see Westphal (1978, 1981); on its implementation, see Jones and Sakong (1980).
has made it possible to "unbundle" the package of resources that typically is made available by DFI, and has thus permitted the selective use of individual foreign resources. But, as we have argued, transfers of technology from abroad constitute only an initial stage in acquiring technological mastery. Of far greater consequence is local effort to master the technology that is transferred and to apply the mastery in other undertakings, thereby to reduce reliance on foreign technological mastery and to foster locally based innovative activity. In a similar vein, the organization of export activity entails a variety of functions that must be learned if their performance is gradually to be taken over by nationals. Korea's industrial competence must therefore be considered as resulting primarily from indigenous effort.

It is very significant that Korea's experience in these respects runs counter to contemporary pronouncements about the shape of, and the constraints imposed by, the existing international economic order. In the context of calls for a "new international economic order," it frequently is alleged that international markets are noncompetitive and that developing countries either are denied access to technology and export markets in unbundled form or are given access only on highly unfavorable terms. It often is further asserted that foreigners necessarily play the leading role--through the transfer of technology--in the acquisition of technological capacity, and--through the initiative they exercise--in the organization of export activity. If true, both characterizations imply a severe constraint on industrial development. But far from supporting these characterizations, Korea's experience shows them to be false for many of the industries whose development was important for its achievement of semi-industrial status.
These industries are not simply those producing labor-intensive products, such as textile fabrics or apparel. Also among them are various capital-intensive industries—cement and steel, for example—as well as a number of skill-intensive or technology-intensive industries—shipbuilding and certain types of machinery production, for instance. In these and in many other areas, Korean industrialists have been able to purchase technology on competitive terms, typically embodied in machinery imports and turnkey plant construction by foreigners, but sometimes disembodied in licensing and technical services contracts. Likewise, they have been able to sell their exports on competitive terms, typically to foreign middlemen, who nonetheless perform only some of the organizational functions, but sometimes directly to the final users.

In a number of industries, the initial acquisition of production know-how occurred during the Japanese colonial period. This fact should not be ascribed too much importance, because Korea has relied upon foreign suppliers to provide much of the capital equipment used in most of these industries and has only recently embarked on a concerted program of import substitution in the capital-goods sector. Moreover, in this connection it is useful to recall a generalization made earlier in the paper—to the effect that Korea's technological mastery has progressed much further in plant operation than in plant and product design. It thus appears that the know-how to operate production processes efficiently is, to a large degree, independent of the ability to use the underlying engineering principles in investment activity. But that is not to deny that Korean industry has acquired and exercised the capacity to select the technologies to be
imported. Nor is it to deny that Koreans have become increasingly involved in various phases of project implementation. Nonetheless, it is not too great an overstatement to say that Korea has become a significant industrial power simply on the basis of proficiency in production. There is an important lesson here: A high level of technological sophistication is not required to attain substantial industrial competence.

There is another important lesson about the tremendous efficacy of export activity as a means of acquiring industrial competence: Merely by their export activity, Korean firms have enjoyed virtually costless access to a tremendous range of information, diffused to them in various ways from the buyers of their exports. The minor innovations that have resulted have been significant in increasing production efficiency, changing product designs, upgrading quality, and improving management practices. Exporting thus appears to offer a direct means of improving productivity, in addition to the indirect stimulation that comes from trying to maintain and increase penetration in overseas markets. This beneficial externality of export activity has gone largely unnoticed in the literature on trade and development. But the Korean experience indicates that it is very real and is part of the explanation of why countries following an export-led strategy have experienced such remarkable success in their industrialization efforts.
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