Exports of Capital Goods and Related Services from the Republic of Korea

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Abstract

Korea's spectacular export growth -- from $50 million worth of goods in 1962 to $25 billion in 1982 -- is a well-known, well-documented success story. Less well known is the recent surge in Korea's exports of capital goods and related services. These exports include those directly related to overseas projects to establish and operate productive systems. They also include non-project-related exports of capital goods, such as most kinds of transportation equipment or machinery sold to trading firms for resale. The project-related exports comprise overseas construction, exports of capital goods procured in connection with specific projects, and various flows of technological information and technical and managerial services. The value of such exports from Korea was small until 1977, when the annual value nearly surpassed the cumulative value for the preceding 15 years. For the five years from 1977 to 1981, contracts for these exports amounted to more than $40 billion. During the same period non-project-related capital goods exports were worth roughly $8 billion.

This paper examines Korea's exports of capital goods and related services, their role in Korea's development strategy, and the way they conform to Korea's dynamic comparative advantage.
L'extraordinaire croissance des exportations de marchandises coréennes, dont la valeur est passée de 50 millions de dollars en 1962 à 25 milliards de dollars en 1982, est un phénomène qui a été bien étudié, mais le récent essor des exportations de biens d'équipement et de services complémentaires a moins retenu l'attention. Tantôt ces exportations sont directement liées à des projets à l'étranger visant à installer et à exploiter des systèmes de production, tantôt elles ne sont pas liées à des projets, par exemple, fourniture de matériel de transport ou de machines de toutes sortes à des entreprises commerciales qui les revendent. Les exportations liées à des projets englobent des chantiers de construction à l'étranger, des biens d'équipement, divers flux de données technologiques et de services techniques et de gestion. Alors que, jusqu'en 1977, la valeur de ces exportations était faible, cette année-là, leur montant a presque dépassé le total des quinze années précédentes. De 1977 à 1981, les marchés de ces exportations se sont montés à plus de 40 milliards de dollars et ceux de biens d'équipement non liés à des projets à environ 8 milliards de dollars.

Le présent document examine les exportations coréennes de biens d'équipement et de services complémentaires, leur rôle dans la stratégie de développement du pays, et la manière dont elles sont adaptées à la dynamique de l'avantage comparatif de la Corée.
El espectacular crecimiento de las exportaciones de Corea, de US$50 millones en mercancías en 1962 a US$25.000 millones en 1982, es un hecho ya muy conocido y bien documentado. Lo que no se conoce tan bien es la reciente irrupción de las exportaciones coreanas de bienes de capital y servicios afines. Estas exportaciones incluyen aquellas relacionadas directamente con proyectos para el establecimiento y funcionamiento de sistemas productivos en otros países. Comprenden además exportaciones de bienes de capital no relacionadas con proyectos, como la mayor parte de los equipos de transporte o maquinaria vendidos a empresas comerciales para su reventa. Las exportaciones relacionadas con proyectos incluyen elementos para obras de construcción en el extranjero, exportación de bienes de capital adquiridos en relación con proyectos específicos, y diversos flujos de información tecnológica y servicios técnicos y administrativos. El importe de dichas exportaciones de Corea fue pequeño hasta 1977, cuando su valor anual casi sobrepasó el valor acumulado de los 15 años precedentes. Durante el quinquenio de 1977 a 1981, los contratos para estas exportaciones ascendieron a más de US$40.000 millones. Durante el mismo período, las exportaciones de bienes de capital no relacionadas con proyectos tuvieron un valor aproximado de US$8.000 millones.

Este documento examina las exportaciones coreanas de bienes de capital y servicios afines, su papel en la estrategia de desarrollo de Corea y la forma en que se amoldan a la dinámica ventaja comparativa de este país.
Acknowledgments

We owe a special debt of gratitude to the many Korean government officials and businessmen who cooperated with us in our search for information and understanding. Thanks are also due to Bela Balassa, Carl Dahlman, Hyung-ki Kim, Sanjaya Lall, Richard Nelson, and Howard Pack for comments. Bruce Ross-Larson edited the manuscript for publication.

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Contents

Korea's Strategy .......................... 2
  Exports and technological capability 3
  Technological evolution .......... 6
  Changes in government priorities 10
  Importance of the chaebol ...... 14

The Nature of Exports of Capital Goods and Related Services .... 16

Overview of Korea's Exports ........ 22
  Overseas construction .......... 26
  Plant exports ............... 28
  Direct investment .......... 34
  Disembodied technology exports 38

Revealed Technological Capability ..... 41
  In plant exports .......... 41
  In direct investment ...... 51

Revealed Comparative Advantage .... 55

References ................................ 62

Tables

1. Elements of Production and Investment Capability .......... 8
2. Licensed Project-related Exports, by Sector and Kind .... 23
3. Exports of Producer and Consumer Durables .......... 31
4. Plant Exports, by Sector and Region of Destination .... 32
5. Licensed Direct Investment in Manufacturing, by Sector and Region of Destination 36
6. Use of Domestic Capital Goods by Exporting Firms ... 49
Summary

Under Korea's strategy of export-led industrialization, export activity has been important in exploiting the country's static comparative advantage. It has also been important in dynamically changing Korea's comparative advantage through accelerating the broadening and deepening of Korea's industrial base. Export activity made possible the initiation of new industries much earlier than they could otherwise have been established without sacrificing economies of scale. And it has enlarged Korea's technological capability in two ways: by facilitating technology transfers from abroad and by stimulating technological effort. Export promotion in Korea has thus been a strategy as much for developing industry as for capitalizing on its industrial competence at each point along the way. Korea's promotion of exports of capital goods and related services is simply a continuation of the same strategy.

Five kinds of project-related exports are distinguished in the paper: overseas construction, plant exports, direct investment, consulting services, and licensing and technical agreements. Overseas construction refers to contracts for construction projects in which the contracting Korean firm provided more than the services of migrant labor. Plant exports comprise some but not all conventional capital-goods exports; they include complete productive systems, such as manufacturing plants and social overhead facilities, as well as individual elements of such systems. Direct investments have been of three kinds: investments to gain access to natural resources, investments related to overseas trading activity, and investments in manufacturing capacity. Licensing and technical agreements comprise transfers of codified technology and the provision of management and technical assistance. Consulting services vary widely.
Overseas construction and plant exports for social overhead projects have predominated, accounting for more than 95 percent of the cumulative value of licensed project-related exports at the end of 1981 and probably well over half the actual value of exports of capital goods and related services during 1977-81. The bulk of this export activity has been to the Middle East and to OECD countries, and it appears to have been performed in accord with detailed specifications provided by the purchaser. Of the remainder of Korea's project-related exports, many appear to transfer idiosyncratic manufacturing technologies created through experience-based adaptive engineering. Discrete Korean technological knowledge thus underlies a small but significant part of Korea's project-related exports. Most of these exports are to less developed countries and transfer technologies with which Koreans have long experience. In turn, Korea's non-project-related capital goods exports are mostly ships and railway vehicles. The technological capability involved in these exports is much the same as that involved in its plant exports for social overhead projects.

The main technology factor underlying Korea's revealed comparative advantage in exports of capital goods and related services is its mastery of construction and metal-working activities involved in the execution of investment projects. These activities require the ability to organize and manage undertakings that are often complex, an ability in which Korean firms appear to have an advantage. For example, their technological capability permits them to complete projects in far less time than is considered normal. Korea enjoys a cost advantage in these activities owing both to its mastery and to its comparatively low wages and salaries for skilled workers, technicians, and managers.
The technology factor that underlies most of Korea's exports of capital goods and related services is thus much the same as that which underlies most of its other manufactured exports: proficiency in production, in this case in construction and metal-working. The rapid growth of these exports largely reflects the rapid accumulation of that proficiency.

There is little question that Korea's exports of capital goods and related services exploit its existing comparative advantage, in terms of both its endowment of human capital and its mastery of what might be termed the production-engineering aspects of project execution. These exports are also changing Korea's comparative advantage. For one thing, they have made it possible to establish capabilities that could not otherwise have been realized without a tremendous sacrifice of scale economies. For another, they have compressed the time for experience to be accumulated and afforded a wider variety of experience in diverse circumstances. For a third, participation in overseas project execution with foreign firms has been an important vehicle for acquiring additional capabilities and new technologies.

The resulting broadening and deepening of Korea's industrial competence appears to be an important factor motivating the government's promotion of exports of capital goods and related services. In the short run, the gains from exploiting existing comparative advantage in these exports are considerable. But in the long run, the gains from further developing Korea's technological capability may be even more considerable.
Exports of Capital Goods and Related Services
from the Republic of Korea

Real capital formation requires more than the fabrication of capital goods. Other elements include technology and the many services involved in the design and execution of investment projects. All these elements are internationally traded. Indeed, imports are the source of many of them in most less developed countries. Not unexpectedly, import substitution for the elements of real capital formation has progressed furthest in the more advanced, semi-industrial countries. These countries have gone beyond import substitution to become substantial exporters of many of these elements, not simply of capital goods. Among these countries, Korea has the largest volume of such exports.\footnote{1}{The Republic of Korea, often referred to as South Korea, is here simply called Korea.} And among Korea's exports of these elements, the exports of related services greatly exceed the exports of capital goods.

This paper analyzes how Korea's exports of capital goods and related services conform to its dynamic comparative advantage. Changes in Korea's pattern of comparative advantage have been associated with the development of its industrial base, which has been broadened by the addition of new industries and deepened by the upgrading of existing industries. These developments are inseparable from the extension of Korea's technological capabilities through efforts to assimilate new technology and to adapt or otherwise extend previously assimilated technologies. In fact, we would argue

\footnote{2}{See Dahlman and Sercovich (1983). Under the heading of "exports of technology," their survey encompasses nearly all the principal forms of exports of capital goods and related services.}
that the acquisition of additional technological capabilities has been the dominant force in changing Korea's pattern of comparative advantage. This is not to deny that comparative advantage requires more than the ability to make effective use of technology. Nor is it to overlook the importance of rapid capital accumulation as a source of Korea's fast growth. But various forms of capital must be distinguished when analyzing the causes of changes in comparative advantage. Technological capability resides in human and institutional capital, which are distinct from physical capital. Thus we assign the central role in changing Korea's pattern of comparative advantage to its accumulation of human and institutional capital.

Much of our discussion is concerned with the relationship between the acquisition of technological capability and the exports of capital goods and related services. With this relationship in mind, we first examine why and how the government has promoted these exports. We then consider how to classify and analyze the elements of such exports, after which we survey their extent and composition. We conclude by assessing Korea's revealed comparative advantage in its exports of capital goods and related services. We also reach some conclusions about the technology factor that underlies them and hence about which of these exports, if any, can be considered exports of technology.

**Korea's Strategy**

The reasons for the Korean government's promotion of exports of capital goods and related services are best understood in light of the evolving role of export activity in Korea's development. Exports of the elements of real capital accumulation reflect the continuation of the central role that export activity
has played in Korea's industrialization. But they also reflect the progressive expansion of Korean industry into new lines of activity.

Exports and technological capability

Korea's rapid and sustained export growth began in the early 1960s, when the government's strategy shifted to export promotion. This strategy was expected to accelerate growth by relaxing the foreign exchange constraint and to increase efficiency through resource reallocation in line with comparative advantage. These expectations were more than fulfilled. For most of the ensuing period, exports led Korea's economic growth. Exports also led the economy's development in a more fundamental sense: in the establishment of new industries and in the acquisition of added technological capability in existing industries.

Korea's initial export success came largely in industries, such as textiles, established during the Japanese colonial period, before 1945. Exceptions, such as wigs, used technologies easily assimilated, given the technological capabilities then existing in closely related areas. Thus the underpinnings of Korea's export performance during most of the 1960s can be satisfactorily understood in the conventional paradigm of static comparative advantage. Exports were concentrated in industries in which Korea either had or could easily acquire the needed technological capability. Moreover, these industries had factor intensities in line with Korea's relative factor endowment. The predominant gains from these exports were the obvious ones: greater capacity use and increased allocative efficiency.

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3/ The discussion that follows relies on Westphal (1978, 1979) and Westphal, Rhee, and Pursell (1981) for historical perspective.
It was only in the late 1960s that export activity became important in establishing new industries in which Korea did not already have technological capability. Two wars and their aftermath had opened a hiatus in the establishment of new industries. The hiatus was closed in the early 1960s with the inception of three industries—portland cement, chemical fertilizer, and oil refining—which were to serve the domestic market with no expectation of substantial exports. Then, in the late 1960s, some new industries were established to serve both the domestic and export markets. Several of them were characterized by pronounced economies of scale. For these industries, constructing plants at scales sufficient only to meet expected domestic demand would have resulted in production costs well above internationally competitive levels. Thus exports were used to gain the economies of scale needed to realize the potential comparative advantage that Korea had in such industries. Here, a notable example is the integrated manufacture of basic steel products.

Some other new industries had negligible domestic sales at their inception. A few of these, electronic components being an early example, were created by direct foreign investment or relied on other forms of international subcontracting for technology transfer and market access. The rest, such as large-scale shipbuilding, obtained technology through licensing and turnkey-plant contracts and did not have guaranteed markets at their inception.

Export activity can enlarge technological capability in two ways, by facilitating technology transfer and by stimulating technological effort (Westphal 1982). Transfers of technology often accompany direct foreign investments to establish plants that are designed to produce for export. They may also be an integral part of transactions involving other means of international subcontracting. But there are few such instances in Korea,
since direct foreign investment and international subcontracting have not been important in most Korean exports. Export activity can also lead to transfers after the acquisition of rudimentary technological capability. Though less obvious, these transfers have been very important in Korea. Buyers have contributed product designs and helped install or improve methods of quality control. They have also contributed to greater productivity and lower costs by suggesting changes in production processes and improvements in management techniques and production organization — all at no cost to the Korean firms (Westphal, Rhee, and Pursell 1981).

Though there is little direct evidence about the effect which export activity may have in stimulating technological effort, export activity undoubtedly enforces and fosters the acquisition of technological capability. Exporting requires the ability to meet product specifications at a competitive price. And the drive to penetrate overseas markets stimulates efforts leading to the gradual upgrading of product quality. These may even be the most important ways in which export activity adds to technological capability. But this cannot be directly inferred from studies showing that export activity has a strong, positive effect on factor productivity.4/

In sum, under Korea's strategy of export-led industrialization, export activity has been important in exploiting static comparative advantage. It has also been important in dynamically changing Korea's comparative advantage through accelerating the broadening and deepening of industrial competence. Export activity made it possible to start new industries much earlier than they could otherwise have been established without sacrificing economies of scale. In turn, for all industries and for a

long time after their inception, export activity added to technological capability, reflected in a wide variety of minor technological changes.\(^5\)

Thus export promotion in Korea has in effect been a strategy as much for developing industry as for capitalizing on the industrial competence at each point along the way.

When the export promotion strategy was adopted in the early 1960s, government policy-makers undoubtedly did not fully appreciate the link between export activity and the development of industrial competence. The strategy was initially chosen on narrower grounds, and it took time for all of the aspects of this link to be recognized. But there can be little doubt that by the late 1970s export promotion had become an explicit strategy for developing industry. The government's promotion of exports of capital goods and related services is perhaps the prime example of its use of export promotion as a strategy to achieve the dual objectives of developing industrial competence and capitalizing on the competence already existing.

**Technological evolution**

To comprehend the evolution of Korea's technological capability, it is necessary to distinguish capability in production from capability in investment. The first is used in operating productive facilities; the second, in creating additional productive facilities. The difference between the two

\(^5\) To the degree that improvements in productive efficiency and other forms of technological change derive from experience in production and capacity expansion, export activity must necessarily lead to faster productivity growth if it is associated with greater volumes of production over time. This argument is the basis for Abegglen and Rapp's (1972) conclusion that export activity has played a major role in the growth of Japanese industrial productivity. Our argument is somewhat different in alleging that export activity has substantial effects that are typically not associated with production for the domestic market.
areas of capability is amplified in table 1, which provides a list of the principal activities in each area. The table is more indicative than definitive, for a clear-cut association of an activity with one or the other capability may not always be possible.

Until the mid-1970s the government's strategy largely operated on the accumulation of production capability. And for most of Korea's industries, the capability in production far outstripped the capability in investment. But Korea did not lack a capital goods sector. Korea's acquisition of an industrially related investment capability had its start in the Japanese colonial period, when the sector was first established. Over time, all the important metal-working processes, such as casting and machining, were assimilated by Korean firms and used in copying many types of imported equipment, with the designs subsequently modified on the basis of experience to make them more appropriate to Korean circumstances. Thus evolved the capability to design and produce capital goods, largely those used in industries that had a relatively long history in Korea. But most export industries relied heavily on imported equipment, owing in part to government incentives favoring its use (see below).

In the more recently established industries, efforts to accumulate investment capability were facilitated by the fast pace of Korea's industrial growth, which shortened the intervals between the construction of successive plants. The first plants were often built on a turnkey basis with indigenous involvement "limited" to assimilating as much of the production and

6/ Westphal, Rhee, and Pursell (1981), pp. 51-52 and 71-72. The terms "production capability" and "investment capability" do not appear in that paper, but as used here they capture what the authors were trying to convey.
<table>
<thead>
<tr>
<th>Elements of Production and Investment Capability</th>
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<tbody>
<tr>
<td><strong>Production Capability</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Production management - to oversee the operation of established facilities</td>
</tr>
<tr>
<td>Production engineering&lt;sup&gt;b&lt;/sup&gt; - to provide the information required to optimize the operation of established facilities, including:</td>
</tr>
<tr>
<td>Raw material control - to sort and grade inputs, seek improved inputs</td>
</tr>
<tr>
<td>Production scheduling - to coordinate production processes across products and facilities</td>
</tr>
<tr>
<td>Quality control - to monitor conformance with product standards and to upgrade them</td>
</tr>
<tr>
<td>Trouble-shooting - to overcome problems encountered in the course of operation</td>
</tr>
<tr>
<td>Adaptations of processes and products - to respond to changing circumstances and to increase productivity</td>
</tr>
<tr>
<td>Repair and maintenance of physical capital - according to regular schedule or when needed</td>
</tr>
<tr>
<td>Marketing - to find and develop uses for possible outputs and to channel outputs to markets</td>
</tr>
<tr>
<td><strong>Investment Capability</strong></td>
</tr>
<tr>
<td>Manpower training - to impart skills and abilities of all kinds</td>
</tr>
<tr>
<td>Preinvestment feasibility studies - to identify possible projects and to ascertain prospects for viability under alternative design concepts</td>
</tr>
<tr>
<td>Project execution - to establish or expand facilities, including:</td>
</tr>
<tr>
<td>Project management - to organize and oversee the activities involved in project execution</td>
</tr>
<tr>
<td>Project engineering - to provide the information needed to make technology operational in a particular setting, including:</td>
</tr>
<tr>
<td>Detailed studies - to make tentative choices among design alternatives</td>
</tr>
<tr>
<td>Basic engineering - to supply the core technology in terms of process flows, material and energy balances, specifications of principal equipment, plant layout</td>
</tr>
<tr>
<td>Detailed engineering - to supply the peripheral technology in terms of complete specifications for all physical capital, architectural and engineering plans, construction and equipment installation specifications</td>
</tr>
<tr>
<td>Procurement - to choose, coordinate, and supervise hardware suppliers and construction contractors</td>
</tr>
<tr>
<td>Embodiment in physical capital - to accomplish site preparation, construction, plant erection, manufacture of machinery and equipment</td>
</tr>
<tr>
<td>Startup of operations - to attain predetermined norms</td>
</tr>
</tbody>
</table>

<sup>a</sup> The activities listed refer to the operation of manufacturing plants, but similar activities pertain to the operation of other types of productive facilities as well.

<sup>b</sup> Our usage of "production engineering" departs from conventional usage in that we use the term far more broadly to include all of the engineering activities related to the operation of existing facilities. In our usage, the term encompasses "product design" and "manufacturing engineering" as these terms are generally used in reference to industrial production. See the entries under these headings in the McGraw-Hill Encyclopedia of Science and Technology (New York: McGraw-Hill Book Company, 1977).
investment capability as was practical. Construction of the second and subsequent plants followed quickly, with Korean engineers and technicians assuming a rapidly expanding role in project design and execution.

Indigenous involvement in project implementation expanded through concerted effort to assimilate the know-how involved in project design and execution.\textsuperscript{7/} Much of this effort involved apprentice-like participation in the establishment of individual plants. The process was effectively one of highly selective and experience-centered import substitution, in which successively more complicated aspects of investment capability were acquired and put into practice. The result was a growing capability in all elements of investment activity. Import substitution proceeded most rapidly in embodiment activity (construction, equipment manufacture, and the like) and in the less technically demanding areas of management, procurement, and startup. Its pace was slowest in basic engineering.

It was probably not until the mid-1960s that this process of increasing indigenous involvement in project implementation became entrenched in Korean industry. The government, in turn, did not effectively accord strategic priority to accumulating investment capability until later. Indeed, before the shift in priorities, government policy discriminated against domestic investment capability, most notably by giving tariff exemptions on imported capital goods (automatic for exporters, but also for selected import-competing industries) and by liberal licensing of imported capital goods financed by suppliers credits that carried interest rates lower than those on the domestic market. The policy bias against the capital goods sector was reversed in the early 1970s: blanket tariff exemptions were abolished, import

\textsuperscript{7/} See, for example, Seoul National University (1980).
licensing was made somewhat restrictive, and several specialized credit facilities were established to provide financing on competitive terms for domestic capital goods.

**Changes in government priorities**

The first prominent sign of the change in government priorities was the **Heavy and Chemical Industry Development Plan**, a long-term plan covering the decade to 1981 and published in 1973.\(^8\) Among other things, this plan called for the rapid buildup of capacity to manufacture capital goods, particularly the fabricated structural elements and heavy equipment used in industrial plants producing basic intermediate goods and in power generation and transmission and other social overhead facilities.

The plan was heavily focused on import substitution, reflecting the government's intention to reduce the Korean economy's dependence on export activity. But very soon thereafter the government abandoned its intention. This, together with gradual recognition of the extent of its overambitiousness, led to several revisions of the plan. From the earliest revisions, the plan became increasingly focused on export activity. Thus exports quickly became a central part of the government's plans for the capital goods sector. Export activity came to be seen as being necessary to take advantage of the economies of scale that characterize such production. It also came to be seen as being in line with Korea's dynamic comparative advantage.

Export activity also became an integral part of the government's

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\(^8\) In Korean parlance, the heavy and chemical industries comprise basic intermediate products, electrical and nonelectrical machinery, and transport equipment.
efforts to promote the acquisition of technological capability more generally. Among the important promotional measures that encompassed export activity in a broadly focused developmental perspective were several legislative acts passed during the mid-1970s. These included:

- **Technological Development Promotion Act** — largely concerned with the assimilation of imported technology and the promotion of local research, development, and engineering (R&D & E) in industrial enterprises; also the promotion of technical services exports under the headings of licensing and technical agreements.

- **Engineering Services Promotion Act** — largely concerned with the development of local capability in technical services related to project execution by engineering firms; also the promotion of their overseas activities under the heading of consulting services.

These measures were supplemented by others designed to foster the education and training of qualified personnel in various technical fields and to establish an infrastructure of scientific and technological institutions.9/

The exports newly promoted with the change in priorities were exports of capital goods and related services. Their promotion was in part a way to accelerate the development of skill- and technology-intensive industries. But government incentives were not simply focused on exports from new lines of activity. They were granted equally to exports that used existing capabilities. An obvious example is overseas construction. Moreover, as will be discussed in the following sections, most of Korea's exports of the elements of real capital accumulation -- like most of its "conventional" manufacturing exports -- have been goods and services in which Korea would be expected to have a comparative advantage on conventional static

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9/ We know that the Ministry of Science and Technology and the Korean Institute of Science and Technology were created in the mid-1960s and were active before the mid-1970s. But we judge that the real shift in priorities came well after their establishment.
criteria, albeit only if the criteria are applied with adequate recognition of the rapid changes in Korea's relative factor endowment.

The government instituted several incentive policies to promote exports of capital goods and related services. In addition to the legislative measures cited above, separate promotion acts were passed for plant exports (defined in the corresponding subsection below) and overseas construction. The Export-Import Bank Act created the Korean Export-Import Bank and set the framework for regulating credit, insurance, and guarantee schemes for medium- and long-term export finance. Other legislation was also involved, such as that for temporary migrant laborers working overseas. Several key ministries implemented the policies: Construction, Science and Technology, Commerce and Industry, and the Economic Planning Board.

Exporters of capital goods and related services, like all Korean enterprises, benefit from the deferment of taxes (within limits) on business income used to finance R, D, & E and the commercialization of technology new to Korea, as well as from a variety of special credit facilities to finance such expenditures. They also benefit from all the incentives accorded to exporters of commodities, including access on preferential terms.¹⁰/ The government's leverage over industrial development has come primarily from its control of the banking system and credit rationing. Preferential access to credit for the financing of fixed investment and of working capital has long been a potent instrument in the promotion of new industrial activities. Various schemes also exist to provide preferential export financing as well as insurance and guarantees against associated risks. And the government assists

¹⁰/ See Westphal (1978) for a description of these incentives, largely unchanged in form since the mid-1970s, except for the formation of the Export-Import Bank.
in the overseas promotion of exports of capital goods and related services and expedites the search for and negotiation of contracts by prospective exporters. In addition, producers of project-related exports (defined at the beginning of the section that gives an overview of Korea's exports) receive special incentives: tax credits in proportion to their income from export activities (up to 50 percent of taxable profits) and deferment of taxes (within certain limits) on income placed in reserve accounts for purposes related to their exports. (We mention these incentives to show the policy instruments that exist, not to imply that exports are in some sense unduly subsidized. We do not have the information to determine the subsidization implicit in these incentives.)

The Korean Export-Import Bank, established in 1976, provides medium- and long-term credit and operates insurance and guarantee schemes. Information from 1980 shows the preference its operations accord to exports of capital goods and related services. During most of that year, its basic interest rate on long-term credit for such exports was 8.0 percent to the Korean exporter and 8.5 percent to the purchaser, compared with the preferential rate on ordinary exports of 12.0 percent and the generally applicable nonpreferential rate of 24.5 percent, both of which were for short-term credit. Loans to finance plant exports were for up to 85 percent of the contract value and had a top maturity of 10 years. Those for other exports were for up to 80 percent of the contract value and had a top maturity of from five to eight years, depending on the purpose of the loan.\footnote{The Export-Import Bank of Korea, \textit{Quarterly Exim Bulletin}, March 1981, p. 3.} By the end of 1980, the bank had disbursed $1.2 billion in loans. Nearly two-thirds of this
helped finance Korea's rapidly growing exports of ships. Another 15 percent was associated with plant exports. Other major categories of lending supported exports of railroad vehicles, overseas investments in fishery and forestry development, ship chartering, and lines of credit extended to overseas banks.12/

Importance of the chaebol

The leading agents of exports of capital goods and related services are the chaebol, the large, conglomerate business groups that came into prominence in the mid-1970s.13/ The government gave some of these firms special status as integrated trading companies in 1975. This was done to decentralize (from government) the administration of export incentives and other promotional efforts. So, the integrated trading companies were given additional export incentives in the form of looser administrative controls and tax write-offs for overseas marketing. Government policies toward these firms have changed — mostly in minor respects — several times since then. In 1980-81 the list of officially recognized chaebol had 26 large groups, which together controlled 465 firms.14/ Eight of these — along with two public conglomerates — appeared on Fortune's 1980 list of the 500 largest industrial

13/ The chaebol are active in all sectors of the economy but are most important outside agriculture. In manufacturing, they are most prominent in the heavy and chemical industries, particularly fabricated metal products, machinery, and equipment. For further information, see Jones (1980).
14/ Hankook Ilbo, January 2, 1981, p. 2. We have used this list in the tabulations that underlie various statements in the sections that follow concerning chaebol involvement in capital goods and related services exports.
corporations outside the United States. One, the Hyundai Group, was the largest nonpetroleum industrial corporation resident in the less developed countries; it ranked seventy-second in 1980.

The chaebol, in company with several big Korean construction firms, figure prominently among the world's largest international contractors. By one compilation, 13 Korean firms were among the 201 largest international contractors, size being judged by the value of foreign contracts won in 1979. The Korean firms accounted for 8.1 percent of the value of foreign contracts won by these contractors, or more than half the combined shares of all less developed countries (15.0 percent) and an amount exceeded only by firms from the United States, Japan, West Germany, and France. The Hyundai Group, which ranked eighth, was the largest contractor resident in the less developed countries; two other Korean companies also ranked ahead of contractors from other less developed countries.

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16/ Fifty-two of the firms appearing on Fortune's "Foreign 500" for 1980 were resident in less developed countries, including Spain, Israel, and Portugal. Of these, 20 were classed as being in the petroleum industry, three in mining. Korea, as noted, had 10 firms on the list, of which one was in the petroleum industry and none in mining. With 11 firms on the list, only Spain, outside the developed countries, had more than Korea.

17/ Engineering Export Promotion Council of India, Project Export News, July 15, 1981. We thank Sanjaya Lall for bringing this compilation to our attention.

18/ Of the 13 Korean firms listed, only three were also on Fortune's "Foreign 500;" seven were among the 26 chaebol.
The Nature of Exports of Capital Goods and Related Services

The absence of widespread agreement on how to characterize exports of capital goods and related services makes it necessary to sketch the framework used in this paper. The exposition provides the analytical typology underlying the discussion of Korea's exports that then follows.

Our definition of exports of capital goods and related services is a very broad one. They comprise all flows that involve the transmission of technological knowledge and the performance of activities that reflect the application of technological knowledge in establishing and operating productive systems. A narrower definition would include only the flows related to the establishment of productive systems. There are various reasons for favoring the broader definition used here. One is the ambiguity inherent in determining whether a particular flow is related to investment or to production. How, for example, should a license to produce a new product in an already established production facility be classified?

Another, more fundamental reason derives from the perspective within which students of economic development find interest and significance in exports of capital goods and related services. In the final analysis, such exports are considered to be singular because they reflect an internationally competitive technological capability that goes beyond "rudimentary" production capability. Other exports may also reflect internationally competitive

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19/ We follow Dahlman and Westphal (1982, p. 105) in defining a technology as "a collection [or system] of physical processes which transforms inputs into outputs, together with the social arrangements — that is, organizational modes and procedural methods — which structure the activities involved in carrying out these transformations."
technological capabilities. But they do not necessarily or to the same degree reflect an independent ability to provide the elements needed to expand a country's production possibility frontier. Here it is very much to the point to recall that in today's world the international division of labor permits countries to import practically all the elements needed to establish and operate productive systems. With this perspective, there is little reason to draw a sharp boundary between activities that reflect the application of technological knowledge in relation to establishing productive systems and similar activities in relation to operating productive systems.

For analytical purposes it helps to distinguish several broadly defined elements present — either singly or in combination — in the exports of concern here:20/

- **Technological knowledge**: the information about physical processes and social arrangements which underlies and is given operational expression in technology.

- **Technical services**: the activities of translating technological knowledge into the detailed information required to establish or operate a productive facility in a specific set of circumstances.

- **Embodiment activity**: the activities of forming and maintaining physical capital in accord with given and complete design specifications.

- **Training services**: the activities of imparting the skills and abilities that are employed in economic activity.

- **Management services**: the activities of organizing and managing the implementation of investment projects and the operation of productive facilities.

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20/ Note that we exclude flows that consist simply of financial capital or intermediate inputs as well as those that consist principally of the services of migrant labor unassociated with any of the elements listed immediately below in the text.
Marketing services: the activities of matching the capacity of productive facilities to existing and latent market demands.

Many exports of capital goods and related services combine at least two of these elements, as should be apparent in the following discussion.

Even though the boundaries between these elements are fuzzy, it is useful to distinguish them because each is grounded in a different kind of ability. The distinctions are therefore important for analyzing a country's revealed comparative advantage in exports of capital goods and related services. Consider first the exports that do not entail continued or long-term involvement in managing or operating productive facilities. Broadly speaking, comparative advantage in these exports comes from differences in the real cost of transferring technology and from the differentiation of technology. We will discuss each of these aspects in turn.

Assume for the moment that technologies having the same purpose -- that is, to produce the same output -- are available from more than one supplier; assume, too, that these technologies are identical, or undifferentiated. Also assume that there are no imperfections in the international market for them. Then the only sources of comparative advantage -- aside from possessing the technology -- are differences in the cost of transfer: that is, in the cost of performing the activities entailed in technology transfer. Such differences can in principle be explained by differences the relative stocks of capital of various forms.

"Technology transfer" is here used in the broadest possible sense to encompass any activity that involves foreigners in establishing productive facilities or in providing technologically-related assistance to the operation of existing facilities.
Technology transfer comprises many diverse tasks (see table 1), each of which involves a distinct type of technological capability. Some of these tasks require mastery of the technology specific to a productive system. Basic engineering requires mastery of the core processes; labor training requires mastery of the relevant production skills; and so on. Other tasks require mastery not of the specific technology, but of other technologies. Detailed engineering for buildings requires mastery of architectural skills; fabrication of structural elements requires mastery of metal-working technology; and so on. Management requires experience-based ability to orchestrate interrelated tasks of different kinds. Any one of these separate activities may be the function of a specialized agent — even managing the transfer, since projects are sometimes so complex that their management is assigned to a specialized prime contractor, which has no other responsibility in the project.

Some capital goods exports consist simply of the manufacture of machinery and equipment (or parts thereof) and the fabrication of structural elements in accord with detailed design specifications by the purchaser (or an agent acting on its behalf): that is, they consist simply of embodiment activity. Others of these exports, though made to order, may also include domestic design engineering, the scope of which depends on the completeness of specifications provided by the purchaser. Still others comprise machinery and equipment conventionally produced in the country. These latter two categories of exports also consist of embodiment activity. And insofar as they do not simply embody foreign designs obtained under license, they incorporate capability in the design of capital goods; that is, they incorporate an implicit element of technical services.
Overseas construction, in turn, often consists simply of embodiment activity, as when labor services are supplied with a complementary flow of management services. The only analytically important difference between this kind of overseas construction and exports of capital goods made to conform to given, detailed design specifications is in the embodiment activity performed. And even this difference disappears for some kinds of overseas construction. Metal-working, distinct from construction, is the primary embodiment activity in exports of capital goods. But metal-working can also be an important part of overseas construction, as it is— for example—in the erection of chemical plants.

We have so far assumed that technologies are undifferentiated, that there is only one technology to produce an output. But this assumption generally is not valid. Thus a country's exports of capital goods and related services may reflect a comparative advantage that comes from possessing differentiated technologies more appropriate to the circumstances of the importing countries than comparable technologies (comparable in the sense of producing similar outputs) from other suppliers.\(^{22/}\) Indeed, awareness is rapidly growing that less developed countries, particularly semi-industrial countries, have developed idiosyncratic technologies through adaptive engineering based on experience in using technologies first imported from more developed countries.\(^{23/}\) These technologies have been developed largely

\(^{22/}\) "Appropriate" means yielding the highest benefit-cost ratio to the purchaser. The concept implies differentiation of technology, but it is not wholly separable from considerations relating to the cost of transfer.

\(^{23/}\) We owe the term "idiosyncratic" to its frequent and effective use in various discussions by Jorge Katz (see Ablin and Katz 1978; and Katz 1978, 1980).
through purposive effort to adapt them to increase their productivity in circumstances that differ in many ways from the circumstances of the more developed countries. Correspondingly, their idiosyncrasies differ from situation to situation -- and are not always simply in the direction of greater labor intensity.

Some of the exports of concern here entail continued involvement in the operation of productive facilities. Direct foreign investment is one example. It is widely appreciated that technological idiosyncrasy is an important motivating element for such exports. But in this context technological idiosyncrasy often has more to do with a capability for continuing innovation, a dynamic aspect that goes beyond offering differentiated technologies at one point in time. Cross-country differences in factor prices, resource endowments, and market characteristics also play a role, as do country-specific commercial and incentive policies. In short, these exports are motivated by a complex of firm- and country-specific elements that go well beyond simple differences in current technology or in the real cost of transferring technology.

It is not easy to isolate the technological idiosyncrasies, if any, that underlie particular exports of capital goods and related services. It is not even easy to determine whether and how a particular technology is idiosyncratic, or to determine whether known idiosyncrasies make the technology appropriate for use in particular circumstances. To do so requires careful and detailed case study analysis, for which data and research resources alike are lacking. Nor is it easy to assess cost advantages among different activities involved in these exports, because most of them package several activities. Indeed, it is not even possible with conventional statistics to quantify exports of capital goods and related services in terms
of the elemental activities involved, because these statistics reflect packaging in the underlying contracts. But these are not arguments against using a coherent typology. Instead, they indicate the difficulties of trying to assess a country's revealed comparative advantage in such exports. These difficulties will become more apparent in the following discussion of Korea's export performance.

Overview of Korea's Exports

Having discussed the evolution of Korea's strategy and sketched a framework for analyzing exports of capital goods and related services, we now marshal the evidence about these exports. We begin with an overview based on the summary data in table 2. These data pertain to what we will call "project-related" exports. As will be further discussed below, such exports include all forms of the exports with which we are concerned except for some types of capital goods exports.

Five kinds of project-related exports are distinguished in the table: overseas construction, plant exports, direct (overseas or foreign) investment, licensing and technical agreements, and consulting services. The data are for licensed exports and were tabulated from information made available to us by the ministries responsible for licensing them.²⁴/

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²⁴/ The data for licensed exports pertain mainly to the value of valid contracts made. But the estimates are based on licenses granted, so that it is more precise to refer to these data as giving the value of licensed exports. The value of licenses granted does not necessarily match the value of valid (or final) contracts, because licenses may lapse if contract negotiations are not completed or projects are not undertaken. But the estimates are periodically revised to delete the value of licenses known to have lapsed for these reasons. Correspondingly, the earlier the year in which the licenses were granted, the closer is the indicated value of licensed exports to the value of valid contracts.
### Table 2

License-related Exports, by Sector and Kind
(Cumulative, through the end of 1981)

<table>
<thead>
<tr>
<th>Manufacturing sectors (2-digit ISIC)</th>
<th>Disembodied technology exports</th>
<th>Overseas construction</th>
<th>Plant exports</th>
<th>Direct investment</th>
<th>Licensing and technical agreements</th>
<th>Consulting services</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, beverages, and tobacco</td>
<td></td>
<td></td>
<td>4</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Textiles, apparel, and leather</td>
<td></td>
<td></td>
<td>17</td>
<td>2</td>
<td>25</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>Wood and wood products</td>
<td></td>
<td></td>
<td>22</td>
<td>8</td>
<td>10</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Paper products and printing</td>
<td></td>
<td></td>
<td>6</td>
<td>*</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Chemicals, rubber and plastic products</td>
<td></td>
<td></td>
<td>1,186</td>
<td>88</td>
<td>9</td>
<td>7</td>
<td>63</td>
</tr>
<tr>
<td>Nonmetallic mineral products</td>
<td></td>
<td></td>
<td>696</td>
<td>224</td>
<td>30</td>
<td>49</td>
<td>999</td>
</tr>
<tr>
<td>Basic metals</td>
<td></td>
<td></td>
<td>173</td>
<td>13</td>
<td>*</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>Metal products, machinery, and equipment</td>
<td></td>
<td></td>
<td>-</td>
<td>60</td>
<td>9</td>
<td>37</td>
<td>77</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td></td>
<td></td>
<td>-</td>
<td>37</td>
<td>1</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td>2,055</td>
<td>472</td>
<td>67</td>
<td>139</td>
<td>155</td>
</tr>
<tr>
<td>Social overhead sectors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power generation and distribution, communications</td>
<td></td>
<td></td>
<td>2,046</td>
<td>144</td>
<td>-</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Water treatment and desalination</td>
<td></td>
<td></td>
<td>883</td>
<td>291</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Offshore drilling facilities</td>
<td></td>
<td></td>
<td>-</td>
<td>1,000</td>
<td>-</td>
<td>-</td>
<td>1,000</td>
</tr>
<tr>
<td>Steel structures</td>
<td></td>
<td></td>
<td>-</td>
<td>650</td>
<td>-</td>
<td>-</td>
<td>650</td>
</tr>
<tr>
<td>Building construction</td>
<td></td>
<td></td>
<td>22,134</td>
<td>-</td>
<td>36</td>
<td>-</td>
<td>53</td>
</tr>
<tr>
<td>Civil works</td>
<td></td>
<td></td>
<td>16,134</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other social overhead</td>
<td></td>
<td></td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td>41,777</td>
<td>2,098</td>
<td>36</td>
<td>13</td>
<td>72</td>
</tr>
<tr>
<td>Services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>54</td>
</tr>
<tr>
<td>Operations management</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Geological survey</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Data processing</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Air transport</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Repair</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Other services</td>
<td></td>
<td></td>
<td>121</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>79</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td>121</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>121</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>43,953</td>
<td>2,570</td>
<td>103</td>
<td>166</td>
<td>306</td>
</tr>
</tbody>
</table>

- zero or not separately distinguished.
* value less than US$500,000.

**Source:** Compiled by the authors on the basis of data made available by the responsible ministries.

**Notes:** See the text for definitions of kinds and caveats about double-counting. Additional notes follow:

Overseas construction: the sectoral composition through 1976 has been estimated assuming that it was the same as that for 1977-81; exports during 1977-81 accounted for 91 percent of the cumulative total.

Direct investment: additional licensed flows, not reflected in the table, were as follows:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>90</td>
</tr>
<tr>
<td>Forestry</td>
<td>41</td>
</tr>
<tr>
<td>Fishery</td>
<td>10</td>
</tr>
<tr>
<td>Transport and storage</td>
<td>3</td>
</tr>
<tr>
<td>Trade</td>
<td>40</td>
</tr>
<tr>
<td>Real estate</td>
<td>20</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>220</td>
</tr>
</tbody>
</table>

Licensing and technical agreements: royalties have been converted to lump sums on the basis of projected sales and profit figures given by the licensees.

Consulting services: the sectoral composition through 1978 has been estimated assuming that it was the same as that for 1979-81; exports during 1979-81 accounted for 77 percent of the cumulative total.

Totals may not reconcile due to rounding error.
Licensing is part of the administration of export incentives and applies to all exports in Korea. For most exports, licensing has been automatic. But plant exports came under separate and nonautomatic licensing in the late 1970s, the purpose apparently being to avoid situations in which Korean exporters would bid down the value of their exports by competing among themselves. Nonautomatic licensing also applies to direct investment, the purpose being to insure compliance with explicit government objectives for such investment (see Jo 1981a, p. 68; Kumar undated, passim.)

Overseas construction refers to contracts for construction projects in which the contracting Korean firm provided more than the services of migrant labor. More will be said about the content of these exports below. Some but not all capital goods exports are included under plant exports. (Information on total capital goods exports is given in table 3, which is discussed in conjunction with plant exports below.) In Korean usage "plant exports" include complete productive systems (such as manufacturing plants and social overhead facilities) and individual elements of such systems (such as textile machinery and distribution transformers). The elements differ from other capital goods exports in that, to be designated as plant exports, they must be purchased for installation in specific productive systems. Plant exports thus include machinery and fabricated structures that are made to order, but they also include standard items made for stock, if

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Korea has also exported the services of temporary migrant labor separate from its overseas construction. According to data provided by the Office of Labor Affairs, the cumulative value of contracts for labor services in the Middle East — the biggest market for such exports — was nearly $850 million at the end of 1981, with net receipts of about $210 million. Migrant laborers worked in construction and as sailors, fishermen, drivers, mechanics, nurses, and miners, among other occupations.
these are procured in connection with the execution of specific projects overseas. To qualify as a plant export, the transaction has to exceed a minimum value ($100,000 during the period covered) and satisfy minimum local content requirements that differ by the kind of plant export. Unlike some other countries, Korea includes exports of capital goods that are not accompanied by complementary technological services, such as training, installation, or after-sales service. But also unlike some other countries, Korea excludes transport equipment.

The distinctions among the five kinds of project-related exports are not clear-cut. In theory, overseas construction should exclude projects that incorporate on-site construction activities if they also in part consist of supplying capital goods (including fabricated structural elements) produced in Korea. But Korean firms were apparently free to have such projects licensed either as plant exports or as overseas construction.\footnote{Firms also had the option of breaking a contract into separate elements covering different activities and having them licensed accordingly, which appears sometimes -- but not always -- to have been done.} Thus the figures in the first two columns of the table do not unambiguously distinguish the value of embodiment activity by type -- construction versus other activity, mostly metal-working.

In addition to the implicit technical services possibly involved in overseas construction and plant exports, the contracts licensed under these headings may have included transfers of proprietary technology and the performance of technical, training, or management services which were not separately licensed. In other words, contracts that packaged several activities may have been licensed under the dominant activity alone, with the
licensed value reflecting the value of the package. We know that this was not a uniform practice. Some of the contracts under licensing and technical agreements as well as under consulting services were to provide complementary elements to projects in which Korean firms were also involved in construction or plant export contracts. Nonetheless, the figures shown in the fourth and fifth columns of the table may not reflect the total licensed value of licensing and technical agreements plus consulting services.

Finally, the reporting of each type of export by a different administrative agency may result in some double-counting.\(^{27}\) We know that the same activity (as distinct from the project served) cannot receive incentives from more than one agency or under more than one promotional measure, but we do not know whether different agencies list more activities than they give incentives to. In turn, where direct investment is involved, there necessarily is double-counting insofar as the Korean equity contribution was in the form of other types of project-related exports, as frequently was the case.

In short, the figures in table 2 are to be taken as indicative rather than definitive. But our impression is that the misclassification and double-counting of these figures does not negate their usefulness for identifying the central tendencies in Korea's project-related exports.

**Overseas construction**

Korea got into the business of project-related exports through

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\(^{27}\) There is one exception. Double-counting is very unlikely between licensing and technical agreements and consulting services, since the same ministry administers the licensing of both.
overseas construction, which remains far and away the largest component of these exports. The cumulative value of licensed overseas construction at the end of 1981 was $44 billion, compared with $47 billion for the five kinds of project-related exports distinguished in table 2.

Much of Korea's competence in construction activity came from learning-by-doing gained through contracts under U.S. military procurement in Korea. Its overseas construction began in 1966 and was for some time concentrated in Southeast Asia, where it largely served U.S. military procurement in Guam and Viet Nam. The experience gained serving the U.S. military outside Korea added further capability, specifically in construction work overseas. Thus the stage was set for the dramatic and sustained increase in these exports in 1975, when Korean contractors began to take part in the Middle East's building boom. Roughly 90 percent of the cumulative value of all contracts has been for work in the Middle East.

We have unpublished information -- from a 1976 survey in which Rhee was involved -- about the cost composition of a reasonably diverse and representative sample of overseas construction contracts.\(^{28/}\) Wages made up a bit less than a fifth of the cost, with most wage payments going to Koreans. A high proportion of the materials, which on the average accounted for a third of the cost, came from Korea. Much of the remaining cost was overhead. A minor proportion of the construction equipment was Korean-made. As with much

\(^{28/}\) Included in the sample were the following projects ongoing in 1976: a port in Malaysia; highway, Indonesia; refinery, Kuwait; shipyards, Iran and Bahrain; power plant, Bangladesh; chemical plant, Hong Kong; naval, harbor, military, and training facilities, Saudi Arabia; hydroelectric facility, Papua New Guinea. The average contract amount was $37.6 million; the standard deviation, $59.8 million.
of Korea's overseas construction, many contracts were subcontracts, with the Korean firms responsible only for construction in projects that involved other elements as well. The Korean firms typically did not in turn subcontract part of their responsibility, though in several cases they did.

Overseas construction appears to consist largely of embodiment activity, though it also includes related organizational and managerial services. Precise information is lacking on the incorporation of technical services related to project design. But the design engineering was Korean on smaller projects involving buildings -- such as schools, warehouses, office structures, apartment blocks, and the like -- and simple infrastructure, since agreements for such work appear both in some overseas construction contracts and separately under technical consultancy exports. In turn, the design engineering needed for some large projects, such as those involving large-scale industrial plants, was provided under separate contracts with non-Korean firms.

Plant exports

Korea's plant exports began as an adjunct of its overseas construction activity, and further impetus came from the government's promotion of the capital goods sector under the Heavy and Chemical Industry Development Plan. Though plant exports grew rapidly, it was not in the direction expected by the government. The government's plans (it will be recalled from the section on Korea's strategy) emphasized the establishment of capacity to produce fabricated structural elements and heavy equipment, in part to undertake plant exports related to large-scale overseas projects. With the notable exception of shipbuilding, where Korea's success is well
known, these plans were far from fully realized.\textsuperscript{29/} The government had successively to scale back its plans during the second half of the 1970s. And various severe problems plagued the projects promoted by the government to establish domestic capacity in heavy industry. Some of these problems -- manifest in capacity imbalances and general overcapacity -- remained to be resolved in the early 1980s.

Though moving at a much slower pace than the government first hoped, Korea's capital goods sector has expanded its capacity quite rapidly, diversifying into new areas. As shown in table 3, exports of metal products and capital goods have grown faster than total commodity exports. The exports most closely associated with plant exports are isolated in the table under the heading "locus of plant exports." These exports accounted for nearly a third of the combined value of capital goods exports during 1977-81, with most of the remainder comprising ships and railway vehicles.

Plant exports from Korea first reached substantial proportions in 1977, for which the data show licensed projects of $436 million. The cumulative value of projects licensed before 1977 was only $85 million. The annual value of licensed projects shows considerable volatility after 1977, falling to $204 million in 1979 and then rising to $470 million in 1980. Licenses ranged from a $100,000 contract for power transformers in Indonesia to a $209 million contract for a cement mill in Saudi Arabia. The cumulative value of licensed plant exports at the end of 1981 was nearly $2.6 billion, or equal to about 6 percent of the value of licensed overseas construction.

\textsuperscript{29/} This is reflected in the predominance of small-scale projects among Korea's plant exports (see table 4).
Projects worth roughly $1.3 billion had been fully completed by the end of 1981.

Putting this information together with the trade statistics in table 3, we infer that, for 1977 onwards, plant exports accounted for a considerable share of Korea's exports of capital goods — inclusive of structural elements fabricated in Korea but exclusive of transport equipment. This share could not have been less than a quarter and could have been much greater, depending on how much the plant exports consisted of on-site construction activity and various services not reflected in the valuation of capital goods exports, and on how much the plant exports not yet fully completed in 1981 had generated capital goods exports during 1977-81.

The composition of plant exports by sector and region of destination is pertinent to understanding the nature of these exports. Detailed data are in table 4, which also gives figures for finished projects as well as for licensed projects by the chaebol. A disproportionate share of plant exports came from the chaebol (see the last columns in table 4). Their share in the value of social overhead projects was 98 percent. Among manufacturing projects their share was 84 percent, but this drops to 58 percent if the two outliers identified in the next paragraph -- both chaebol projects -- are excluded. Chaebol projects were larger on the average than those of the nonchaebol; the difference is on the order of 9:1 if the outliers are excluded. Asia was the largest market for the nonchaebol.

30/ Even the nonchaebol among plant exporters were reasonably large in "absolute" terms: that is, in the number of workers or value of capital employed. To our knowledge, all of them employed well over 100 workers, for example.
### Table 3

**Exports of Producer and Consumer Durables**

<table>
<thead>
<tr>
<th>Title</th>
<th>Annual growth rate, 1971-81</th>
<th>Share of total commodity exports, 1977-81</th>
<th>Locus of capital exports</th>
<th>Other durable goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shares</td>
<td>(thousands of US dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Shares</th>
<th>Share of total commodity exports, 1977-81</th>
<th>Locus of capital exports</th>
<th>Other durable goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactures of metal, n.e.s. (69)</td>
<td>59.6</td>
<td>4.6</td>
<td>951,481</td>
<td>134,838</td>
</tr>
<tr>
<td>Finished structural parts and structures, n.e.s. (691)</td>
<td>129.2</td>
<td>1.3</td>
<td>32,947</td>
<td></td>
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<tr>
<td>Metal containers for storage and transport (692)</td>
<td>66.1</td>
<td>0.04</td>
<td>329,478</td>
<td></td>
</tr>
<tr>
<td>Tools, for use in hand or with machines (695)</td>
<td>59.0</td>
<td>0.2</td>
<td>134,838</td>
<td></td>
</tr>
<tr>
<td>Other manufactures of metal</td>
<td></td>
<td></td>
<td></td>
<td>2,359,202</td>
</tr>
<tr>
<td>Nonelectrical machinery (71)</td>
<td>44.4</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery and appliances (other than electrical) and machine parts, n.e.s. (719)</td>
<td>66.8</td>
<td>0.6</td>
<td>477,367</td>
<td></td>
</tr>
<tr>
<td>Textile and leather machinery (717)</td>
<td>41.0</td>
<td>0.2</td>
<td>148,440</td>
<td></td>
</tr>
<tr>
<td>Machines for special industries (718)</td>
<td>46.3</td>
<td>0.1</td>
<td>99,006</td>
<td></td>
</tr>
<tr>
<td>Power generating machinery, other than electrical (711)</td>
<td>41.0</td>
<td>0.1</td>
<td>89,628</td>
<td></td>
</tr>
<tr>
<td>Metalworking machinery (715)</td>
<td>59.6</td>
<td>0.1</td>
<td>83,375</td>
<td></td>
</tr>
<tr>
<td>Office machinery and implements (714)</td>
<td>32.9</td>
<td>0.5</td>
<td>391,958</td>
<td></td>
</tr>
<tr>
<td>Agricultural machinery and implements (712)</td>
<td>20.8</td>
<td>0.02</td>
<td>14,398</td>
<td></td>
</tr>
<tr>
<td>Other nonelectrical machinery</td>
<td></td>
<td></td>
<td></td>
<td>144,713</td>
</tr>
<tr>
<td>Electrical machinery (72)</td>
<td>41.5</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric power machinery and switchgear (722)</td>
<td>48.2</td>
<td>0.8</td>
<td>570,821</td>
<td></td>
</tr>
<tr>
<td>Equipment for distributing electricity (723)</td>
<td>85.2</td>
<td>0.4</td>
<td>283,295</td>
<td></td>
</tr>
<tr>
<td>Telephone and telegraph equipment (724)</td>
<td>52.4</td>
<td>0.1</td>
<td>91,277</td>
<td></td>
</tr>
<tr>
<td>Electrical machinery, n.e.s. (729)</td>
<td>41.0</td>
<td>0.4</td>
<td>327,979</td>
<td></td>
</tr>
<tr>
<td>Measurement and control apparatus (7295)</td>
<td>75.8</td>
<td>0.2</td>
<td>122,788</td>
<td></td>
</tr>
<tr>
<td>Electrophysical equipment (726)</td>
<td>44.2</td>
<td>0.01</td>
<td>25,288</td>
<td></td>
</tr>
<tr>
<td>Electric hand tools (7296)</td>
<td>82.9</td>
<td>0.002</td>
<td>1,466</td>
<td></td>
</tr>
<tr>
<td>Particle accelerators (7297)</td>
<td>*</td>
<td>*</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Other electrical machinery</td>
<td></td>
<td></td>
<td></td>
<td>6,559,787</td>
</tr>
<tr>
<td>Transport equipment (73)</td>
<td>82.7</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ships and boats (735)</td>
<td>97.2</td>
<td>5.1</td>
<td>3,857,153</td>
<td></td>
</tr>
<tr>
<td>Railway vehicles (731)</td>
<td>109.5</td>
<td>1.2</td>
<td>885,190</td>
<td></td>
</tr>
<tr>
<td>General and special purpose trucks (7323)</td>
<td>51.8</td>
<td>0.2</td>
<td>139,006</td>
<td></td>
</tr>
<tr>
<td>Buses and trolleys (7322)</td>
<td>91.9</td>
<td>0.03</td>
<td>17,629</td>
<td></td>
</tr>
<tr>
<td>Trailers and nonmotorized vehicles (7333)</td>
<td>100.3</td>
<td>0.01</td>
<td>10,599</td>
<td></td>
</tr>
<tr>
<td>Other transport equipment</td>
<td></td>
<td></td>
<td></td>
<td>1,099,235</td>
</tr>
<tr>
<td>Precision instruments, photographic supplies, and time pieces (86)</td>
<td>54.4</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precision instruments (861)</td>
<td>48.2</td>
<td>0.6</td>
<td>455,619</td>
<td></td>
</tr>
<tr>
<td>Other categories</td>
<td></td>
<td></td>
<td></td>
<td>751,640</td>
</tr>
<tr>
<td>Producer and consumer durables</td>
<td>49.5</td>
<td>26.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locus of plant exports</td>
<td>59.1</td>
<td>3.7</td>
<td>2,827,637</td>
<td></td>
</tr>
<tr>
<td>Other capital goods</td>
<td>66.2</td>
<td>8.5</td>
<td>6,393,344</td>
<td></td>
</tr>
<tr>
<td>Other durable goods</td>
<td>43.7</td>
<td>14.5</td>
<td>10,914,397</td>
<td></td>
</tr>
<tr>
<td>Total commodity exports</td>
<td>34.9</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** World Bank Trade Data System.

**Note:** Aircraft (734) re-exports are excluded. Totals may not reconcile due to rounding.

(*) No exports in 1971.

(-) Negligible.

(a) Numbers in parentheses give SITC codes according to the Standard International Trade Classification, Revision No. 1.

(b) "Plant exports" are defined in the text. The locus of plant exports includes SITC categories in which constituent elements of plant exports are most likely to appear. For reasons discussed in the text, only some of the exports appearing under these categories are plant exports, but it is not possible to determine just which of these exports are plant exports.

(c) Excludes division 7194, nonelectrical domestic appliances.

(d) Excludes division 7114, aircraft engines.

(e) Includes divisions 7323 through 7325 and 7327.
Table 4

Plant Exports, by Sector and Region of Destination
(Cumulative, through the end of 1981)

<table>
<thead>
<tr>
<th>OECD countries</th>
<th>Asia, excl. Japan</th>
<th>Middle East</th>
<th>Latin America</th>
<th>Africa</th>
<th>Total</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finished projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value</td>
<td>Number of cases</td>
<td>Value</td>
<td>Number of cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food processing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3,800</td>
<td>1</td>
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<tr>
<td>Textiles</td>
<td>0</td>
<td>9,149</td>
<td>1,051</td>
<td>0</td>
<td>10,200</td>
<td>8</td>
</tr>
<tr>
<td>Garments</td>
<td>0</td>
<td>2,577</td>
<td>0</td>
<td>1,682</td>
<td>4,259</td>
<td>5</td>
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<tr>
<td>Footwear</td>
<td>0</td>
<td>2,814</td>
<td>0</td>
<td>0</td>
<td>2,814</td>
<td>2</td>
</tr>
<tr>
<td>Plywood &amp; lumber</td>
<td>0</td>
<td>21,145</td>
<td>0</td>
<td>412</td>
<td>21,557</td>
<td>20</td>
</tr>
<tr>
<td>Paper</td>
<td>0</td>
<td>3,233</td>
<td>0</td>
<td>2,505</td>
<td>5,738</td>
<td>4</td>
</tr>
<tr>
<td>Tires</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>88,345</td>
<td>88,345</td>
<td>1</td>
</tr>
<tr>
<td>Cement</td>
<td>150</td>
<td>9,952</td>
<td>212,041</td>
<td>0</td>
<td>224,177</td>
<td>10</td>
</tr>
<tr>
<td>Metals</td>
<td>0</td>
<td>6,134</td>
<td>570</td>
<td>420</td>
<td>6,319</td>
<td>14</td>
</tr>
<tr>
<td>Metalworking</td>
<td>6,761</td>
<td>11,347</td>
<td>29,674</td>
<td>0</td>
<td>49,382</td>
<td>17</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>0</td>
<td>0</td>
<td>10,867</td>
<td>0</td>
<td>10,867</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>869</td>
<td>22,330</td>
<td>13,706</td>
<td>0</td>
<td>37,355</td>
<td>19</td>
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<tr>
<td>Subtotal</td>
<td>7,780</td>
<td>92,481</td>
<td>267,909</td>
<td>4,959</td>
<td>471,937</td>
<td>102</td>
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<tr>
<td>Social overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power generation &amp; transmission</td>
<td>5,291</td>
<td>51,637</td>
<td>54,966</td>
<td>0</td>
<td>10,974</td>
<td>122,868</td>
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<tr>
<td>Communication facilities</td>
<td>177</td>
<td>20,979</td>
<td>0</td>
<td>0</td>
<td>21,156</td>
<td>8</td>
</tr>
<tr>
<td>Subtotal</td>
<td>5,468</td>
<td>72,616</td>
<td>54,966</td>
<td>0</td>
<td>10,974</td>
<td>144,024</td>
</tr>
<tr>
<td>Construction-related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water treatment plants</td>
<td>2,391</td>
<td>813</td>
<td>4,126</td>
<td>0</td>
<td>0</td>
<td>7,330</td>
</tr>
<tr>
<td>Desalination plants</td>
<td>150,000</td>
<td>0</td>
<td>133,903</td>
<td>0</td>
<td>0</td>
<td>283,905</td>
</tr>
<tr>
<td>Offshore drilling facilities</td>
<td>783,807</td>
<td>215,928</td>
<td>0</td>
<td>0</td>
<td>999,755</td>
<td>15</td>
</tr>
<tr>
<td>Onshore structures</td>
<td>13,611</td>
<td>16,112</td>
<td>88,125</td>
<td>0</td>
<td>2,545</td>
<td>118,593</td>
</tr>
<tr>
<td>Coastal facilities</td>
<td>7,560</td>
<td>10,958</td>
<td>512,928</td>
<td>0</td>
<td>0</td>
<td>531,466</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>1,187</td>
<td>11,349</td>
<td>0</td>
<td>391</td>
<td>12,927</td>
</tr>
<tr>
<td>Subtotal</td>
<td>961,067</td>
<td>317,614</td>
<td>805,397</td>
<td>0</td>
<td>13,910</td>
<td>2,097,988</td>
</tr>
<tr>
<td>Total value</td>
<td>968,847</td>
<td>410,095</td>
<td>1,073,306</td>
<td>4,959</td>
<td>112,718</td>
<td>2,569,925</td>
</tr>
<tr>
<td>Finished projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>7,360</td>
<td>147,930</td>
<td>999,671</td>
<td>420</td>
<td>106,692</td>
<td>2,569,925</td>
</tr>
<tr>
<td>Number of cases</td>
<td>29</td>
<td>140</td>
<td>79</td>
<td>4</td>
<td>24</td>
<td>276</td>
</tr>
</tbody>
</table>

Exports by chaebol: licensed projects

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>968,171</td>
<td>357,390</td>
</tr>
<tr>
<td></td>
<td>1,030,991</td>
<td>2,034</td>
</tr>
<tr>
<td></td>
<td>108,115</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2,466,701</td>
<td>197</td>
</tr>
</tbody>
</table>

Source: Compiled by the authors on the basis of data made available by the Ministry of Commerce and Industry.
Manufacturing projects. The provision of manufacturing plants and their elements constituted nearly a fifth of the value of licensed projects, and more than a third of the number. The difference in shares by value and by number reflects the small size of manufacturing projects, considerably less than half the average value for social overhead projects. But this comparison overstates the relative size of the manufacturing projects, for it is distorted by two "outliers," or atypically large projects: a cement mill in Saudi Arabia worth $209 million and a tire factory in the Sudan worth $88 million. Excluding these, the average value of a manufacturing project was $1.7 million, with most projects being for less than this amount. Most of the licensed projects were finished by the end of 1981.

Taking both the value and the number of manufacturing projects into account, but leaving aside the two outliers mentioned above, one arrives at the following ranking of sectors: metal-working (or metal products and machinery) was most important by a wide margin; next were plywood and lumber, cement, metals, and textiles; of considerably less importance were paper, garments, and footwear; last came tires, shipbuilding, and food processing. The most important markets for Korea's manufacturing projects were the Middle East, which accounted for almost 60 percent of the total licensed value, followed by less developed countries in Africa and Asia, with roughly 20 percent in each region. The sectoral diversification was greatest in Asia (excluding Japan, as will hereafter be implicit). When the two outliers are excluded from the total, Asia becomes the most important market, with a share of more than 50 percent. The market shares of the Middle East and Africa drop to 33 percent and 6 percent.
Social overhead projects. Social overhead projects made up the lion's share of Korea's plant exports. They were more numerous by far and had an average licensed value of $12.1 million. Very large projects for offshore drilling and coastal facilities were responsible for more than two-thirds of their licensed value. The former were not completed at the end of 1981 and were mostly in the OECD countries (outside Japan); the latter were largely completed and were primarily in the Middle East. Other projects were related to desalination plants, power generation and transmission facilities, onshore structures, communication facilities, and water treatment plants. The Middle East initially was Korea's largest market for social overhead projects, with a share in the value of finished projects of more than two-thirds. More recently, the OECD countries have emerged as the most important market: their share in licensed projects, at 46 percent, was somewhat more than that of the Middle Eastern countries. Other less developed countries, in Asia and to much less extent in Africa, formed the remainder of the market.

Direct investment

A steady flow of outward investment by Korean firms started in about 1967, with a few cases in the preceding years. By the end of 1981 the cumulative licensed outflow of direct investment was $323 million, of which $103 million was in manufacturing or social overhead sectors, the rest in other sectors indicated in the notes to table 2.

Most of Korea's direct investment falls into three categories: investments to gain access to natural resources, of which Korea (like Japan) has a limited endowment; investments related to overseas construction and trading activity, which were to facilitate the marketing of Korea's exports of both goods and services; and investments in manufacturing capacity, where
Korean technological advantages appear to have played a role, as will be discussed in the next section. The first two categories were of roughly equal importance in value, though overseas trading ventures were by far more numerous. The third category accounted for only 20 percent of the value — and less than 10 percent of the number — of Korea's overseas investments. We nevertheless concentrate here on the third category because it is the most likely to be motivated by technological advantages.

The first investment in overseas manufacturing was in 1973; it was not until 1978 that more than two licenses were granted during a year for such investments. As is detailed in table 5, 34 ventures had been licensed by the end of 1981, with an average investment in each of nearly $2 million. Most investments were for less than this amount. The smallest was for $25,000, in a printing firm in Japan; the largest was for $25.7 million, in a cement mill in Malaysia. About three-quarters of the investment in overseas manufacturing was in less developed countries in Asia; most of the rest was in Africa and the Middle East. Nearly all the investments were joint ventures with local partners. The chaebol did not dominate in this area as they did in plant exports.

The investments in manufacturing were dispersed over a number of sectors. Cement, textiles, metal products, and lumber and plywood each accounted for four or more ventures. Garments, printing, machinery, and rubber products (including tires) were each represented by two ventures. Single ventures characterized food processing, footwear, pulp and paper, and

31/ As of the end of 1981, investments totaling $14.8 million had been made in 12 projects.
### Table 5
Licensed Direct Investment in Manufacturing, by Sector and Region of Destination
(Cumulative, through the end of 1981)

<table>
<thead>
<tr>
<th>Sector</th>
<th>OECD countries</th>
<th>Asia, excl. Japan</th>
<th>Middle East</th>
<th>Latin America</th>
<th>Africa</th>
<th>Total</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, beverages, and tobacco</td>
<td>-</td>
<td>6,696</td>
<td>255</td>
<td>-</td>
<td>-</td>
<td>6,951</td>
<td>2</td>
</tr>
<tr>
<td>Textiles, apparel, and leather</td>
<td>450</td>
<td>1,288</td>
<td>263</td>
<td>450</td>
<td>-</td>
<td>2,451</td>
<td>7</td>
</tr>
<tr>
<td>Wood and wood products</td>
<td>1,348</td>
<td>6,735</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8,083</td>
<td>4</td>
</tr>
<tr>
<td>Paper products and printing</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>Chemicals, rubber and plastic products</td>
<td>-</td>
<td>1,276</td>
<td>541</td>
<td>-</td>
<td>7,000</td>
<td>8,817</td>
<td>4</td>
</tr>
<tr>
<td>Nonmetallic mineral products</td>
<td>-</td>
<td>28,743</td>
<td>1,520</td>
<td>-</td>
<td>-</td>
<td>30,263</td>
<td>4</td>
</tr>
<tr>
<td>Basic metals</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Metal products, machinery, and equipment</td>
<td>500</td>
<td>5,668</td>
<td>2,280</td>
<td>-</td>
<td>306</td>
<td>8,754</td>
<td>8</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>-</td>
<td>1,111</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,111</td>
<td>2</td>
</tr>
<tr>
<td>Total value</td>
<td>2,358</td>
<td>51,617</td>
<td>4,839</td>
<td>450</td>
<td>7,306</td>
<td>66,590</td>
<td>34</td>
</tr>
</tbody>
</table>

Total number of cases: 5 20 6 1 2 34

Source: Compiled by the authors on the basis of data made available by the Bank of Korea.
electronics. There were also several ventures in the miscellaneous category, to produce such things as fountain pens and costume jewelry. The largest ventures appeared in cement, chemicals, food processing, and pulp and paper.

Manufacturing investments in the OECD countries included a pulp-and-paper plant in New Zealand, a color television plant in the United States, and two printing establishments in Japan. The first of these was probably motivated more by the desire for access to natural resources, albeit in a processed form, than by anything else. The same motivation undoubtedly also played a part in some manufacturing investments in less developed countries, including perhaps those in the metal products and lumber and plywood sectors (Kumar undated, p. 13). Maintaining market access in the face of import restrictions was the key factor in the investment in the United States. Another force motivating some joint-venture investments has been the desire to gain access to foreign technology through collaboration with foreign companies. This objective apparently was dominant in establishing at least one of the joint-venture printing firms in Japan (Kumar and Kim 1981, p. 14). It has also been a factor underlying the formation of joint-venture construction firms (more generally, engineering firms) in conjunction with contractors from developed countries (Jo 1981b, p. 13). But perhaps the most outstanding instance of this motive was the acquisition of a U.S. firm that specialized in R, D, & E in electronics. From an interview with the Korean principal, Jo (1981b, p. 14) concluded that the basic motivation was to use this firm "as an overseas base for the development, and import, of appropriate technical knowledge, new process[es], and new product designs."
Disembodied technology exports

In Korean usage, licensing and technical agreements, which are licensed by the government under the Technological Development Promotion Act, are distinguished from technical consulting services, licensed under the Engineering Services Promotion Act. Licensing and technical agreements comprise transfers of codified technology and the provision of management and technical assistance in production engineering. Technical consulting services vary widely and in some cases appear to include management and technical assistance. Thus the dividing line between the two categories is not clear-cut. The only real distinction we know of is that no contracts involving royalties are licensed under consulting services.

Licensing and technical agreements. No licensing or technical agreements were recorded before 1978, when two contracts were licensed — we do not know their value. Thirty-nine contracts worth $161 million were licensed during 1979-81. Of these, 36 were with firms in less developed countries, mainly in the Middle East. Most licensing and technical agreements provided general technical assistance in production engineering and maintenance, many over several years or more. Nearly all these contracts provided assistance through the dispatch of personnel; but most of them also transferred some codified technical information, including some blueprints of equipment designs. Few provided project execution services (as distinct from codified information); none provided licensed proprietary technology in patents.

The sectors served by licensing and technical agreements were mainly in manufacturing, with a rather wide dispersion among these sectors. Production engineering know-how was transferred for steel, tires, cement,
plywood, garments, plate glass, rubber footwear, nonferrous metals, metal products, electrical equipment, and medical supplies. Several contracts transferred know-how only recently acquired through Korean efforts to assimilate foreign technology. For example, just three years after starting production, Korea's integrated steel mill entered a contract to provide technical assistance to an integrated steel mill being established in Taiwan. Some of the contracts were to plants in whose establishment Korean firms had participated through overseas construction or plant exports. These were sometimes formal elements of a "packaged" contract. Several of these involved assistance to startup and operations, with the contract calling for the local personnel to be trained gradually to take over all aspects of the plant's operations. But there were similar contracts with plants in whose establishment Korean firms had no role.

Consulting services. Exports of consulting services were far more numerous than those of licensing and technical agreements. The cumulative value of the 324 contracts licensed from 1973 through 1984 was $306 million, with more than three-quarters of the contracts (by number and value) having been licensed in 1979-81. Architectural and engineering design — and such things as feasibility studies, city and land-use planning, and computer software — accounted for about a fifth of the value of licensed exports of consulting services. The rest comprised technical services accomplished by the dispatch of personnel to oversee construction and plant erection, install machinery and equipment, inspect structures and equipment, trouble-shoot, train labor, and the like. Some contracts were short-term; others were long-term and involved participation in the day-to-day functioning of productive facilities.
The value of licensed contracts was split about evenly between manufacturing and social overhead sectors. Services to the chemical products sector dominated manufacturing; other sectors included cement, textiles, electrical products, and shipbuilding. In the social overhead sectors, there were contracts related to power generation and distribution as well as communications and a variety of other areas, such as water and sewage treatment. The destination for most consulting services was the Middle East, with OECD countries and African and Asian countries following in importance.

Many consulting services, particularly in the social overhead sectors, appear to have been related to Korea's construction exports. Some contracts for design services involved projects in which Korean firms also participated in construction. Consulting services in building construction, in turn, included some contracts to provide technical assistance and labor training to foreign construction companies -- with agreements, for example, with Malaysian and Indonesian firms. These contracts were construction-related in the sense that they were in part motivated on the Korean side by the hope that they would result in more favorable consideration to Korean firms bidding for construction (and other) projects in these countries. But they are also known to have reflected the desire of foreign firms to gain access to Korean construction expertise. Some of the contracts in manufacturing involved elements of project execution that were complementary to particular plant exports. Others served plants in which Korean firms had played a major role in project execution. A notable example here was a large contract for maintenance of a portland-cement plant in Saudi Arabia (one of the "outlier" plant-export projects discussed earlier). In general, the elements of production-engineering consulting services to manufacturing do not appear to be much different from those in licensing and technical agreements.
Firms specializing in engineering appear to have been responsible for most exports of both licensing and technical agreements and consulting services — not only exports related to project execution, but also those involving production engineering. These exports thus reflect the growing capability of Korea’s recently established engineering firms (see Lee 1981). The chaebol accounted for only a small share of the total licensed contract value, with many of their contracts related to projects in which they also participated through overseas construction or plant exports.

Revealed Technological Capability

This section concentrates on the two kinds of project-related exports for which we have comparatively more information about what is being exported. The focus is on how and to what extent these exports may have transferred idiosyncratic technologies. First, plant exports are discussed, then direct investments in manufacturing.

In plant exports

In continuing our discussion of plant exports, we try to answer two questions. What tasks of project execution are included? What are the characteristics of technologies embodied in those tasks? Our answers are tentative and in some respects speculative, for we do not have anything approaching a complete set of detailed case-by-case information. Nonetheless, some conclusions can be firmly drawn. One such conclusion is that only a few of Korea’s plant exports included all stages of project execution: that is,
only a few were Korean-managed turnkey projects.

Tasks of project execution. Amsden and Kim (1982) have tabulated the elements of 128 plant exports licensed in 1980 and 1981, exports that accounted for nearly half the value of plant exports licensed through 1981. The elements distinguished include the design of equipment (including fabricated structural elements), the manufacture (or fabrication) of equipment, its installation, after-sales service in the startup of operations, and a bundle of elements comprising the remaining activities involved in a turnkey project. Equipment alone was provided in 43 percent of the cases, accounting for 23 percent of the value of the sample; equipment and design were provided in 31 percent of the cases, accounting for 35 percent of the sample's value. Fifteen percent of the cases, accounting for 41 percent of the value, were turnkey projects. The remaining 11 percent of the projects, accounting for about 1 percent of the value, combined several elements including equipment but were not full turnkey projects. Both manufacturing and social overhead projects were included in all these categories.

The absence of design services from some of the manufacturing projects does not mean that the Korean contractor simply provided embodiment services in these cases. On the contrary, most of these projects appear to have supplied Korean-designed equipment. The absence of design services simply indicates that the designs were standard Korean designs rather than special designs tailored to the project being served. But circumstances appear to have been different in the social overhead projects: Korean contractors who provided equipment alone probably undertook only the embodiment activities. In turn, design in social overhead projects typically seems to refer to detailed engineering following basic engineering designs.
provided by the project sponsor. In manufacturing projects, design often appears to have included basic engineering as well.

Most of the turnkey projects were complete manufacturing plants. Many of the turnkey projects in social overhead sectors provided elements integrated with complex, multi-element projects. For example, projects in power and communications included such things as elements of power plants (a watergate for a hydroelectric plant), transformer substations, sets of transformers, transmission towers and cables, telephone switchboards, and communication cables.

Many social overhead projects appear to have been construction-related in that they included on-site construction or erection and installation as important elements. Many other social overhead projects seem to have been construction-related as well, but in a different way: they appear to have been tied -- either formally as subcontracts or more loosely through a joint marketing effort -- to Korea's overseas construction activity and to have consisted of supplying fabricated structural elements rather than complete structures.

Construction-related plant exports appearing in table 4 consisted of such items as loading docks, bridge structures, and oil storage tanks, in addition to elements of desalination, water treatment, and water distribution systems. In some cases, such as offshore drilling rigs, the fabricated structures were complete systems. We do not have the information needed to determine the division of construction-related plant exports into on-site construction services and the provision of equipment and fabricated structural elements produced in Korea. But it is apparent that several projects consisted primarily -- some perhaps exclusively -- of the latter, and it is
probable that all projects included capital goods produced in Korea.

We conclude that the driving force behind Korea's plant exports for social overhead projects was its rapidly advancing comparative advantage in embodiment activity, particularly in large-scale construction projects and capital goods production. The underlying technological capability appears to reside primarily in the organization, management, and execution of construction activity and in the production-engineering aspects of metalworking.

Additional forces seem to have been at work in the exports of manufacturing projects. Not only did many of these projects appear to include more sophisticated technical services, such as basic design engineering, they also appear typically to have transferred idiosyncratic process technologies. Moreover, several turnkey manufacturing projects called for considerable ability in the organization and management of complex overseas undertakings. In this respect the projects reflected a higher degree of entrepreneurial ability than was probably characteristic of most social overhead projects. Thus the technological capability underlying the manufacturing projects was more extensive in that a much wider range of elements was involved. The following examples illustrate this conclusion and point to several other interesting characteristics of these plant exports.

Characteristics of technology. Almost all our anecdotal evidence is for exports of turnkey projects. Some of these exports involved little, if any, direct foreign collaboration in their execution. This was true of Korea's first recorded plant export, a turnkey synthetic-and-silk-textile weaving mill in Afghanistan in 1973. This plant, with 155 looms, was entirely designed by the engineering staff of the leading Korean textile-machinery
producer, which was also responsible for training the Afghan labor. The looms were semiautomatic (that is, shuttles are manually changed when the yarn is exhausted), and they embodied idiosyncratic Korean adaptations that gave them a pronounced advantage over conventional semiautomatic and automatic looms.²²/

Some other such cases involved exports of paper-manufacturing plants by Yuhan-Kimberly, a Korean joint venture with Kimberly-Clark, a U.S. firm, to the latter's joint ventures in other developing countries.³³/ Here, as in many other sectors, Korean technology had been developed through experience using and then copying and adapting previously imported machines. The technology had progressed so much by the time of Yuhan-Kimberly's formation that much of its original machinery was Korean. This machinery, the precursor of that now exported, marked another step in the progression of Korean paper-making technology, a step by Korean engineers working with the assistance of Kimberly-Clark's technical staff to continue to adapt and improve the indigenous designs. Purchasers are said to favor Korean machines because they are cheaper and embody technology that is both simpler and more labor intensive than that available elsewhere.

Korean technological capability is similarly well established in cement and tires, both of which have also been exported in considerable volume.³⁴/ At least one of the cement projects -- a white-cement clinker plant in the Philippines -- was a turnkey project in which all stages of

²²/ For a discussion of Korean textile technology, see Rhee and Westphal (1977).

³³/ This discussion is based on Seoul National University (1980).

³⁴/ They respectively accounted for 1.3 and 2.7 percent of Korea's commodity exports in 1980, for example (Bank of Korea, Monthly Economic Statistics, April 1981, p. 94).
project execution were carried out by Koreans. The core process, said to be more fuel efficient than its competitors, embodied an energy-saving adaptation by the plant exporter. Seventy percent of the machinery and equipment were procured in Korea. The tire factory in the Sudan, referred to earlier as an outlier, was also a turnkey project involving no direct foreign collaboration. This project is interesting because the plant exporter (a trading company) had never produced tires and relied on a Korean tire manufacturer to obtain the process technology and to assist in the plant's operation and maintenance (Kumar undated, p. 15). Both the clinker plant and the tire factory were joint ventures between the project exporters and local partners, as were several other turnkey projects. Exports to third countries were involved in both deals; the tire plant was expected to export at least a quarter of its output.

Plywood plants have also been among Korea's turnkey projects. Korea has developed an idiosyncratic labor-intensive plywood technology (see Ranis 1974, pp. 76-77) and has been among the world's largest plywood exporters. In one plywood project for which detailed information is available, 85 percent of the machinery and equipment installed in the plant came from Korea (Kumar undated, p. 15). We suspect that other projects involved little foreign collaboration and transferred what was at least in part idiosyncratic Korean technology. Likely possibilities are rock-crushing plants and factories to make salt, asphalt, footwear, garments, fishing nets, food seasoning, and basic steel products.

Where foreigners have collaborated directly in Korean turnkey

35/ This statement and the preceding one are based on an interview reported in Amsden and Kim (1982).
projects, an infrequent case, though more often in large-scale projects than in the smaller ones, the collaboration appears typically to have been a means of transferring technologies for which Korea was unable to provide the basic engineering. But Korea clearly possessed capability in production engineering, having operated similar plants for some time. An example is an unsaturated-polyester-resin plant built by a Korean engineering-services firm in Saudi Arabia.\textsuperscript{36} The basic engineering for the core processes was provided by an American firm. All other stages of project execution -- including organization and management -- were accomplished by the Korean firm, whose affiliates erected the plant using Korean labor and provided roughly 90 percent of the machinery and equipment. Another example is the large portland-cement mill in Saudi Arabia, a turnkey project by a consortium consisting of the Fuller Company, an American machinery manufacturer, and an arm of the Hyundai Group, Korea's largest chaebol. Basic engineering and plant certification were provided by a Belgian company. The contract to the consortium was $235 million, and Hyundai's share was $209 million.\textsuperscript{37} Hyundai constructed the plant and supplied a large share of the machinery and equipment and much of the labor training (Export-Import Bank of Korea, \textit{Quarterly Exim Bulletin}, 1981, p. 3).

Most of Korea's manufacturing plant exports were not turnkey plants. Some consisted of supplying only machinery, but much of this machinery undoubtedly embodied idiosyncratic Korean technologies. Pursell and

\textsuperscript{36} The information for this example comes from an interview reported in Amsden and Kim (1982).

\textsuperscript{37} The clinker plant in the Philippines, referred to previously in the text, was much smaller; its contract value was $6 million. Moreover, it was to produce white cement, which is used as a finishing surface. The plant in Saudi Arabia produces portland cement.
Rhee (1978) provide evidence that Korean industry had the capacity to produce these capital goods. One of the questions asked in their survey of Korea's leading exporters concerned the share of domestically produced capital goods in their stock of machinery and equipment. Their responses are summarized in table 6. Though imported capital goods made up more than half the machinery and equipment used by most of these firms, many of them made much use of domestic capital goods. These figures doubtlessly understate Korea's capability to have supplied the capital goods required in its plant exports. The likelihood of such understatement is supported by a later government survey -- in 1978, for a different set of industries, but covering all firms in them -- which found that the share of domestically produced capital goods in local plants to produce polypropylene was 65 percent; cement, 55 percent; petroleum and synthetic rubber, 50 percent; zinc, 40 percent; steel and fertilizer, 38 percent; copper and polyester, 35 percent.

It is much harder to assemble corroborative evidence that the technologies were idiosyncratic, let alone that they were idiosyncratic in an appropriate direction -- say, more labor-intensive. The survey of leading

38/ The shares shown are based on replacement cost or market values for machinery and equipment. Shares based on book values, both before and after depreciation, were also obtained and are consistent with those shown.

39/ First, exporters were for various reasons likely to have relied far more heavily on imported capital goods than were firms producing similar products primarily for the domestic market. Second, these figures pertain to the capital stock in place in 1975; most plant exports came later, during a period of relatively rapid development in Korea's capital goods sector.

40/ The share for thermal electric power plants, also covered in the survey, was 20 percent. Korea Development Bank, *Monthly Economic Review*, April 1978, p. 19.
### Table 6

Use of Domestic Capital Goods by Exporting Firms

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of firms responding</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food processing</td>
<td>3</td>
<td>57.7</td>
<td>40.2</td>
</tr>
<tr>
<td>Garments</td>
<td>7</td>
<td>28.3</td>
<td>31.1</td>
</tr>
<tr>
<td>Footwear</td>
<td>3</td>
<td>58.3</td>
<td>25.2</td>
</tr>
<tr>
<td>Synthetic fiber and yarn</td>
<td>5</td>
<td>24.0</td>
<td>15.6</td>
</tr>
<tr>
<td>Textiles</td>
<td>17</td>
<td>39.8</td>
<td>30.5</td>
</tr>
<tr>
<td>Cement</td>
<td>1</td>
<td>9.0</td>
<td>.0</td>
</tr>
<tr>
<td>Plywood</td>
<td>2</td>
<td>6.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Paper products</td>
<td>1</td>
<td>20.0</td>
<td>n.a</td>
</tr>
<tr>
<td>Tires</td>
<td>3</td>
<td>18.3</td>
<td>2.9</td>
</tr>
<tr>
<td>Metal products</td>
<td>7</td>
<td>18.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Machinery</td>
<td>4</td>
<td>39.5</td>
<td>29.3</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>3</td>
<td>22.0</td>
<td>14.7</td>
</tr>
<tr>
<td>Miscellaneous:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tableware</td>
<td>2</td>
<td>55.0</td>
<td>49.5</td>
</tr>
<tr>
<td>Toys, handicrafts, and sporting goods</td>
<td>2</td>
<td>62.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

exporters did inquire about cost and productivity differences between domestic and imported capital goods. Comparable domestic machines were found to be from 8 percent cheaper (for footwear production) to 70 percent cheaper (for tires) than imported machines. This may simply indicate comparative advantage in producing machines of a standard design. But domestic machines were also said to be less productive than their imported counterparts, which is at least consistent with the supposition that they embodied idiosyncratically more labor-intensive technologies. To demonstrate that these technologies were more appropriate would require comparative benefit-cost evaluations. In the only such investigation known to us, Rhee and Westphal (1977) found that the technology embodied in Korean-made textile looms was both idiosyncratic and more appropriate (for many, but not all, varieties of cloth) to the circumstances of a less developed economy. But the generality of this result across other industries remains to be demonstrated.

The foregoing attention to embodied technology does not mean that we think the transfer of disembodied technology — for example, through labor training or assistance in the startup of operations — is inconsequential, either in general or as a possibly important element of Korea's plant exports, particularly for manufacturing projects. Quite the contrary. As is indicated in the next section, there is some partial evidence on this question in regard to Korea's direct overseas investments, but we lack even sketchy case-study information of the kind required to draw inferences in regard to Korea's plant exports.

In about half of the cases reported, the productivity difference was indicated to be more than enough to wipe out the cost difference. But the comparison of productivity with cost differences is crude and does not constitute a careful comparative benefit-cost evaluation like that called for in the text below.
In summary: Korea's plant exports do not conform to a single set of characteristics. Individual cases span the spectrum -- from turnkey projects with no foreign collaboration to subcontracts for providing fabricated structural elements. The former are fewer in number, and the latter are predominant, even more so in value. Differing degrees of organizational and managerial ability are exhibited, ranging from entrepreneurship in identifying and implementing rather large projects to the direction of construction and metal-working activities, including on-site erection and installation. Many of the manufacturing projects appear to have transferred idiosyncratic technology, embodied in Korean-made machinery. At the opposite extreme, many of the construction-related subcontracts appear to have consisted only of embodiment activity.

In direct investment

From interviews with the Korean firms engaged in overseas manufacturing ventures, both Jo (1981a, 1981b) and Kumar (undated) found that nearly all of them involved exports of idiosyncratic process technology.

Among 18 ventures covered in Kumar's survey, Korean firms provided:42/

- All the process or product-design technology in 13 cases and at least some of this technology in four more cases; in six of these cases, licenses, patents, and other proprietary know-how were involved.

- Technical assistance with respect to production engineering and other aspects of the firms' operation in all cases.

42/ In a few cases -- for example, the tire factory in the Sudan -- the Korean firms supplying the technology were not the same as the investing firms, though they may subsequently have merged.
Much of the machinery and equipment required for production, ranging from 85 percent for a plywood plant to 20 percent for a plant producing tractors and diesel engines.

Management expertise in 15 cases and overseas marketing services in 12 cases (Kumar undated, pp. 14 ff. and tables 3 to 5).

The exported technologies differed somewhat from those used in Korea. In particular, overseas ventures tended to be at a lower scale and to exhibit greater labor intensity (Kumar undated, p. 16).

Kumar (undated, pp. 17 and 18) concludes that "the over-all picture of technological diffusion which emerges ... is more or less similar to that suggested by the growing literature on south to south technology transfer." According to this literature a semi-industrial technology exporter, such as Korea, plays an intermediary role, exporting a technology that it originally imported from an industrially more advanced country and then adapted through experience to better suit its circumstances and, by extension, the circumstances of countries less industrially advanced than itself.\textsuperscript{43/} Jo (1981b, p. 14) indicates the nature of these adaptations in some detail: in addition to modifications to suit a smaller scale of operations, they mostly consisted of "labor-using innovations peripheral to the machine or core processes, including handling, packaging, storing, and so on, together with greater manual quality control (e.g., plywood production), more intensive machine

\textsuperscript{43/} In some cases the intermediary role was rather explicit, in that the investment was either arranged by or otherwise involved a firm from an industrially more advanced country and from which the Korean firm had secured technology. Kumar and Kim (1981, p. 12) cite a joint-venture costume jewelry firm in the Philippines that falls in this category; Kumar (undated, p. 18) refers to a joint-venture electrical equipment firm in Thailand that also fits this model.
maintenance, and the upgrading of lower-quality raw materials into quality inputs via manual sorting (e.g., wool and cotton yarn). Jo's findings are particularly notable in that they give clear evidence that transfers of idiosyncratic disembodied technology were a very important part of at least some of Korea's exports of capital goods and related services.

Korea's overseas manufacturing investments thus appear to reflect a technological advantage. But it still is unclear how much this advantage was grounded in the idiosyncrasy of the technologies transferred as opposed to the lower cost of transfer. For only seven of the 18 ventures in Kumar's survey did the Korean partners consider that their advantage over firms from other countries was in part that of being able to supply a more suitable technology. The "ability to establish and start overseas manufacturing projects at costs lower than those cited by their competitors" was considered important for 12 ventures. Whatever the technological advantage, there was a considerable overlap between Korea's overseas manufacturing ventures and its manufacturing plant exports. Indeed, in some cases an equity position was taken to facilitate the export of a plant. This appears to be true, for example, of the white-cement clinker plant exported to the Philippines, where the joint-venture form was not subject to a tax imposed on turnkey contracts between otherwise unrelated parties. It is also true of a steel-pipe manufacturing venture in Saudi Arabia, where the local sponsor requested the plant exporter's equity participation as a way of insuring satisfactory

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44/ Kumar (undated, p. 7 and table 2). Other self-perceived advantages that were mentioned included lower cost of expatriate staff for four ventures; more suitable product, three ventures; and greater marketing skills in relation to the domestic market, two ventures.
In other cases the plant exporter may have found it either necessary or attractive to take an equity position to secure the project's financing.\footnote{This and the foregoing example are based on interviews reported in Amsden and Kim (1982).}

But it would be wrong to conclude that technological advantages were the sole motivating force behind Korean manufacturing ventures overseas. Perhaps even more important to the investing firms in many cases were the desires to defend overseas markets previously served by exports and to increase exports to third countries. Kumar (undated, p. 12) indicates that the Korean partners had been exporting to the host countries before undertaking at least half the ventures he surveyed. He surmises for most of these ventures that investment was a defensive measure, albeit one that also offered prospects for expanded sales. Consider the tire plant in the Sudan: undertaken at the initiative of a Korean firm that had been exporting tires to the Sudan, the joint venture was given protection against imports, which had the hoped-for result of removing stiff competition from OECD exporters (Kumar and Kim 1981, pp. 11 and 12).

Many of Korea's overseas manufacturing ventures were either exporting to third countries or planning to do so; a third of these ventures were in export-processing zones (Kumar undated, pp. 9 and 13). Korean investors appear to have been taking advantage of lower labor costs in industrially less-advanced countries — a motive likely to take on increasing

\footnote{In some of these cases, and in others as well, it appears that plant exporters entered into long-term contracts to purchase part of the future output of the plants they were to construct — probably to facilitate their plant exports.}
importance as Korea loses its comparative advantage in low-skill, labor-intensive activities -- and of the less severe restrictions these countries faced on their exports to OECD countries. Leaving aside precisely what motivated their investments, the Korean firms in these ventures appear to have earned more than satisfactory profits on them (Kumar undated, pp. 20ff.). We unfortunately have no direct evidence about the motives of their local partners or about the benefits received by them. But it is reasonable to think that the technological capability and marketing savvy evidenced by Korea's outstanding export performance were major factors in attracting them to join with Korean partners.

Revealed Comparative Advantage

Early on, we identified five kinds of project-related exports: overseas construction, plant exports, direct investment, licensing and technical agreements, and consulting services. These exports and those of non-project-related capital goods constitute the sum total of exports of capital goods and related services. Overseas construction and plant exports for social overhead projects have predominated. They account for more than 95 percent of the cumulative value of licensed project-related exports at the end of 1981 and around half to three-quarters of total exports of capital goods and related services during 1977-81.\(^{47/}\) The bulk of this export activity

\(^{47/}\) The imprecision here results from the fact that actual values are less than licensed values by an amount that is not known. The value of licensed overseas construction and plant exports for social overhead
appears to have been performed in accord with detailed specifications provided by the purchaser.\textsuperscript{48/} We may thus conclude that Korea's revealed comparative advantage in exports of capital goods and related services is in project execution, mostly in embodiment activities in the form of construction and metal-working (including erection and fabrication).\textsuperscript{49/}

These embodiment activities are moderately intensive in human capital. They require reasonably skilled workers and technicians as well as competent engineers, factors of which Korea has a comparative abundance (see Dahlman and Sercovich 1983). But more than this, they require the ability to organize and manage undertakings that are often quite complex, even in subcontracts. Here Korean firms appear to have an advantage that permits them, for example, to complete projects in far less time than is considered average or normal. Precise information about this is lacking, but anecdotes abound. Moreover, much of the marketing of these exports is by Korean firms, acting without foreign agents. This is one area where Korean know-how

\textsuperscript{48/} This statement applies equally to Korea's exports of ships and railway vehicles, which accounted for much of the rest of exports of capital goods and related services.

\textsuperscript{49/} We are constrained to assessing revealed comparative advantage by the composition of Korea's exports. But we doubt that the use of more sophisticated methods would change the conclusion. For example, studies of so-called "technology exports" from India, Brazil, Taiwan, Hong Kong, Mexico, and Argentina suggest that their exports are much less concentrated in project execution and embodiment activity. Korea also appears to have invested comparatively little overseas, and Wells (1981) generalizes that idiosyncratic technologies have been at the heart of most overseas manufacturing investments by the semi-industrial economies. For comparative information, see Dahlman and Sercovich (1983); on India, see Lall (1981) and Agrawal (1981); on Brazil, work in progress by Sercovich; on Taiwan, Amsden (1981) and Ting and Schive (1981); on Hong Kong, Chen (1981); on Mexico, work in progress by Dahlman; and on Argentina, Ablin and Katz (1978).
relating to transactions is second to none.

We follow Johnson (1970, pp. 17-19) in defining technology as capital in the form of the productive knowledge used to combine other inputs, including human capital, into want-satisfying goods and services. Such capital is not accumulated solely through investments to create new knowledge through research and development. It is also accumulated through investments to acquire and assimilate existing knowledge. Indeed, the second form of investment predominates in Korea's acquisition of technological capability. That is why we say that the main technology factor underlying Korea's revealed comparative advantage in embodiment activity is its mastery of production engineering in construction and metal-working. Korea enjoys a cost advantage in these activities owing both to its mastery and to its comparatively low wages and salaries — adjusted for skill and productivity differences — for semi-skilled and skilled workers, technicians, and managers.⁵⁰/

In most of its exports of capital goods and related services, Korea is not exporting technology. This is true because the element of technology in these exports is mastery of certain project execution activities, not newly created technological knowledge. But as we have tried to establish, a small

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⁵⁰/ It could be objected, particularly with regard to overseas construction, that we attach too little importance to the low wages and willingness to endure hard work in difficult circumstances that have characterized Korean laborers — and too much importance to the technological capability that is involved. This objection overlooks the fact that Korea's overseas construction involves more than merely the provision of labor services. Or, if not that, the objection neglects the technical, managerial, and "logistical" complexities entailed in the sophisticated, large-scale construction projects in which Korean firms have been involved. In this connection it is pertinent to observe that as Korean wage rates have risen over time, non-Koreans have increasingly replaced Koreans in tasks requiring lower-level skills, and the composition of overseas construction has shifted toward increasingly complex activities.
part of Korea's exports do appear to transfer idiosyncratic manufacturing technologies created through experience-based adaptive engineering. Whether these technologies are peculiarly Korean is not known. Nor should too much importance be ascribed to their idiosyncrasy, since all technologies in use are to some degree idiosyncratic. Moreover, the dividing line between acquiring and assimilating technologies and adapting them is not clear-cut: effective assimilation appears almost always to involve adaptation (Dahlman and Westphal 1982, pp. 113-17). Nonetheless, discrete Korean technological knowledge underlies a small but significant part of Korea's exports of capital goods and related services.

Technological idiosyncrasies may be an element of Korea's revealed comparative advantage in project execution. That is, the technologies used to carry out these activities might be idiosyncratic. Differences in technology related to organizational modes and procedural methods might, for example, be what underlies the ability of Korean firms to complete projects in record time. This possibility is certainly consistent with our conception of the elements of investment capability. But we lack information to assess the existence and importance of such idiosyncrasies.

The technology factor that underlies most of Korea's exports of capital goods and related services is much the same as that which underlies most of its (other) manufactured exports. In an earlier, more general examination of Korea's industrial competence, Westphal, Rhee, and Pursell (1981, pp. 51 and 72) concluded that: "Relative to world standards, Korea's proficiency in plant operation far surpasses that in product and plant design... [so that ] 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." The new evidence presented here about Korea's exports of capital goods and related services does not change our basic perception of Korea's industrial competence. The rapid growth of these exports largely reflects the rapid accumulation of proficiency in construction and metalworking.

This emphasis on proficiency in production should not imply that Korea lacks a design capability. Exports of idiosyncratic manufacturing technology indicate that there is some capability in the design of machinery. And Korea does export detailed project-engineering services. But these exports are only a small fraction of the total. What is more significant, Korea does not appear to possess much capability in basic project engineering.

In discussing Korea's evolving strategy for promoting exports, we emphasized two distinct objectives: exploiting the country's existing comparative advantage, and dynamically changing its comparative advantage. There can be little question, especially in the light of the foregoing discussion, that Korea's exports of capital goods and related services exploit its existing comparative advantage, in terms of both its endowment of human capital and its mastery of what might be termed the production-engineering aspects of project execution. What, then, of their role in dynamically changing Korea's comparative advantage?

51/ An exception should be noted. Korea appears to have a relatively small volume of overseas investment and other forms of participation in production overseas that would exploit its superior industrial competence in sectors in which has been an active exporter. Why? We would argue thus: the human resources required to exploit this advantage further (through increased participation in production overseas) have a much higher return in the uses to which they are put.
Owing to their highly specialized nature, many activities of project execution are characterized by extreme economies of scale.\(^52/\) Korean firms could not be internationally competitive in these activities if they served only the domestic market. Export activity has thus made it possible to establish investment capabilities that could not otherwise have been realized without tremendous sacrifice of scale economies. Moreover, the accumulation of experience is a critical input in acquiring most of these capabilities.\(^53/\) Export activity not only compresses the time for experience to be accumulated; it also affords a wider variety of experience in more diverse circumstances. It can thus be expected to accelerate cost reductions from learning and to deepen existing capabilities.

These benefits appear to be reflected in changes over time in the composition of Korea's exports of capital goods and related services toward increasingly more complex and sophisticated activities, something which we do not document here owing to space limitations. Managers of exporting firms have also confirmed, in interviews with Amsden and Kim (1982), that these benefits are realized. But these managers have indicated another benefit as being even more significant: participation in project execution with foreign firms from third countries has been an important vehicle for acquiring additional capabilities and new technologies. These gains have occurred through a process akin to apprenticeship — a process also observed in Korean participation in local projects. This broadening of Korean technological


\(^{53/}\) See the sources cited in the preceding note.
capability occurs even in overseas construction. For example, one Korean firm assimilated a complete system of solar energy technology through its participation with a U.S. firm in a project involving this technology in Saudi Arabia.

The broadening and deepening of Korea's industrial competence, particularly of investment capability, appears to be an important motive in the government's promotion of exports of capital goods and related services. In the short run, the gains from exploiting existing comparative advantage in these exports are considerable. But in the long run, the gains from further developing Korea's technological capability may be even more considerable.
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