HEAVY AND CHEMICAL INDUSTRIALIZATION AND ECONOMIC DEVELOPMENT IN THE REPUBLIC OF KOREA

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I. OBJECTIVES AND ISSUES

If we look at the foreign trade structure of the Republic of Korea (R.O.K.) during the 1960s, we see that among imports the relative weights of raw materials, intermediate and capital goods were high, while among exports there was a high relative weight of final consumer goods, and that in this sense it would be quite correct to typify that structure as a "processing trade pattern."[1] It is well known that the R.O.K.'s economic growth rate, pulled forward by the process of export-oriented industrialization, has achieved since the early 1960s a high level unmatched by other developing countries.

However, the economy's "processing trade pattern" structure, which gave rise to a great increase in imports together with the expansion in exports, has been considered to have contributed to the formation of a sort of organic state in which the growth capacity in the export industry sector could only to a small degree carry over to other sectors of the domestic economy. The export sector, centering around joint ventures with private American and Japanese enterprises, was dependent on the parent organizations for main input materials for tradable goods, and the destination of the manufactured exports was, for the most part, the countries where the parent enterprises were located. As a result of this situation, the R.O.K.'s export-oriented industrialization pattern has sometimes been labeled "international subcontracting" [13], and the export industry sector, having expanded and prospared in such a form, has been criticized as existing within a clear-cut "dual structure" of sharp contrast between itself and a stagnant small- and medium-sized industry sector oriented toward the domestic market [12, Chap. 1]. One could also say that the above structural aspects of the R.O.K. economy have been at the core of the once vociferously made argument (especially among Japanese opinion-makers) that the R.O.K. economy is characterized by "foreign subordination."

However, such a structural pattern in the R.O.K. economy was clearly undergoing a process of change under the influence of the rapidly advancing heavy and chemical industrialization during the Third Five-Year Plan period 1972–76. We may expect to see this tendency progresses with additional speed during the

[1] A detailed discussion of this type of structure in the R.O.K. economy of the 1960s is given in [7, Chap. 2].

Fourth Five-Year Plan beginning in 1977. In other words, after the beginning of the 1970s there has been an extremely rapid process of import substitution in the case of many raw materials, intermediate goods, machines and equipments; and there has even been a start, now rapidly expanding, of exports in the case of certain heavy industry and chemical products. In this connection, if we consider the so-called Hoffmann's ratio which is the ratio of the value added in the three branches of heavy industry (or production goods industry) sector represented by metallurgy, machinery, and chemicals, in comparison to value added in the light industry (or consumer goods industry) sector, we see that in the case of the R.O.K. the transition from the "first stage" of industrialization to the "second stage" was achieved during only eight years between 1960 and 1967, whereas the major industrially advanced countries, historically speaking, required from twenty to thirty years for the equivalent transition.

In 1973, the ratio of the value added in the heavy and chemical industry sector was 45.8 per cent. According to these figures, by that year the R.O.K. had entered the "third stage" of industrialization as represented by the Hoffmann's ratio, the transition from the "second stage" having required only six years. This was, again, approximately three times the speed with which the comparable transition was achieved in the historical experience of the major industrially developed countries.[2] Thus the rapid advance of heavy and chemical industrialization clearly constitutes the most important grounds for fundamentally dismantling the "traditional image" of the R.O.K. economy. The principal objective of this study is to search out those factors which are bringing about the rapid heavy and chemical industrialization presently being experienced by the Republic of Korea.

By one definition, heavy and chemical industrialization is a process by which, within the economy as a whole, the relative weight of the production goods industry sector increases with respect to that of the consumer goods industry sector. Seen from another angle, this process may be said to be a transition from a pattern in which a given country's industrialization is characterized by the import of input goods used for producing final consumer goods for the domestic market (i.e., the stage of import substitution of consumer goods) or for producing goods for export, to a pattern characterized by the domestic production of input goods themselves (i.e., stage of import substitution for production goods). This could also be expressed as a "deepening process" of the industrial structure. One might also call it the process by which the core activities of the production structure in a given country are transferred to an "upstream" from a "downstream" position.

The R.O.K. is recognized as being one of the very few developing countries that have succeeded in achieving, both skillfully and in a very short time period, a transition from an industrial pattern of import substitution to the still more highly developed pattern of export-oriented industrialization. The stage of import substitution may be said to have linked up with the export expansion stage with very little time lapse. The reason of the very rapid growth in total

[2] For a discussion of the rapid deepening process seen in the R.O.K.'s industrial structure, see [6, Chap. 5] [11, Chap. 6].

demand has been this "time compression" between industrial development stages which is a special characteristic of the R.O.K. case. The domestic production of final consumer goods could continuously expand at a very rapid pace due to the fact that it was pulled forward firstly, in the initial period, by domestic demand and then, in succeeding periods, by exports. This rapid expansion in the domestic production of final consumer goods brought about a backward linkage pressure to the production of input materials at each successive stage of economic development. The domestic production of the input materials rapidly commenced at a point when demand for a given product had come up to a certain minimum level of domestic production.

In other words, we may observe that the change-over in the R.O.K. to the domestic production of input materials has been the result of a backward linkage pressure brought about by expanded production of final consumer goods. The point I should like to emphasize is that in the case of demand for a number of final consumer goods, exports have played the decisive role. The road to domestic production of input materials was thus opened in response to export-oriented industrialization for the manufacture of final consumer goods.

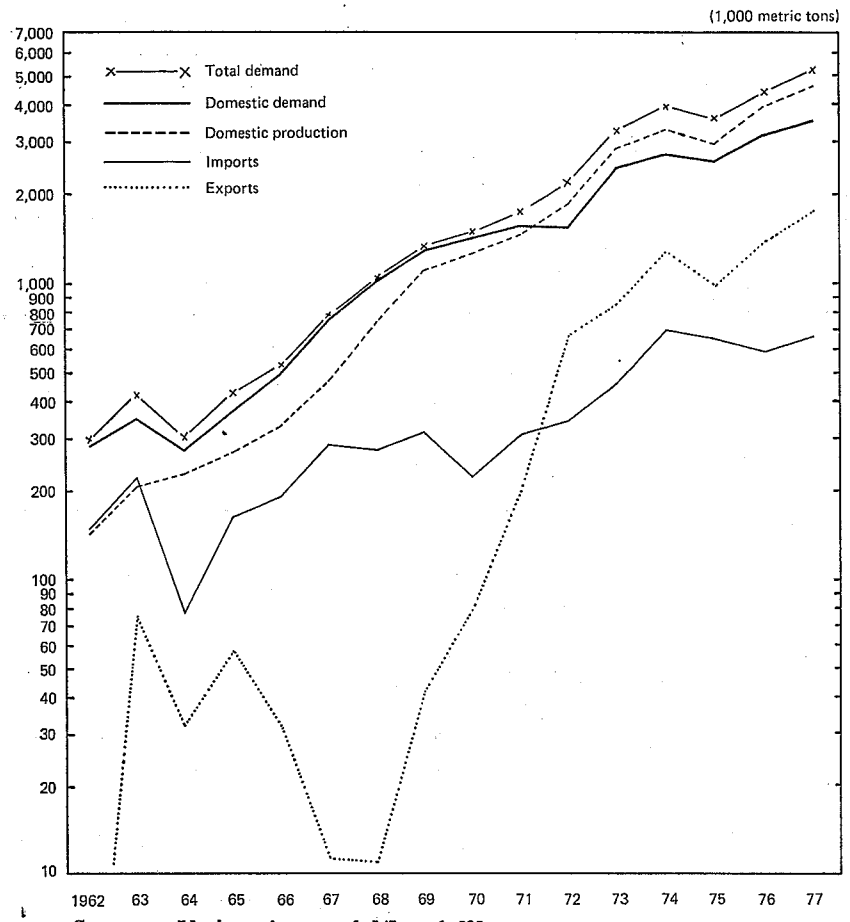
One reason for the success of heavy and chemical industrialization in the present-day R.O.K. may therefore be ascribed to the fact that it has taken place through progress toward import substitution of input materials via the route of export-oriented industrialization for the production of final consumer goods, and not according to the more general pattern of structural deepening, which a number of developing countries have tried to apply, of progressing to import substitution of input materials from import substitution of final consumer goods. And since the R.O.K.'s export-oriented industrialization has, as is widely known, proceeded at an extremely rapid pace, it may also be surmised that the accompanying process of structural deepening has taken place with unparalleled speed.

As case studies, we here propose to direct our attention to two chief industrial sectors, namely, (1) iron and steel, and (2) petrochemicals, in order to study the above pattern of the heavy and chemical industrialization process in the present-day R.O.K.

II. DEVELOPMENT PATTERN IN THE IRON AND STEEL INDUSTRY

The Republic of Korea's iron and steel industry can be characterized by the fact that it has been pulled forward by the noteworthy increase in total demand which is the sum of domestic demand plus exports. The development pattern in the R.O.K. iron and steel industry is shown in Figure 1. This figure traces the time series transition of domestic demand, domestic production, imports, and exports, in ton units of final products consisting primarily of rolled steel products, bars, plates and sheets, and iron castings. While domestic demand shows a continuous upward trend, domestic production is pulled forward by this domestic demand and expands at an even faster pace, with the result that the volume of the former overtakes that of the latter in 1971–72. According to the identical equation which states that domestic demand + exports ≡ domestic production + imports, the fact that domestic production has become greater than domestic demand means

Fig. 1. Development Pattern in Iron and Steel Industry: Rolled Steel Products, 1962–77



Sources: Various issues of [4] and [9].

that exports have come to exceed imports. This is clearly shown in the figure. We may interpret the above-mentioned trend as showing that growth in domestic demand pulled forward steel production until 1971, and that after 1972 exports, whose growth had come to surpass that of domestic demand, were a major impetus to increase steel production.[3]

The increase in demand for rolled steel products came about due to the very noteworthy growth in activity in the steel consumer industries (construction, and metal industry), and in the machinery industry (general machinery, transport machinery, and electrical machinery). As a result of the rapid growth in the

[3] It is of interest to compare this development pattern in the R.O.K.'s iron and steel industry with the long-range development pattern in Japan's iron and steel industry. One is struck by the much faster speed in the R.O.K. of the transfer from one industrial development stage to the next (from imports to import substitution to exports). For the case of Japan, see [15] [16].

electrical and transport machinery industries after the beginning of the 1970s, these industries have come to figure the most prominently, together with textiles, among the present-day R.O.K.'s manufactured exports.

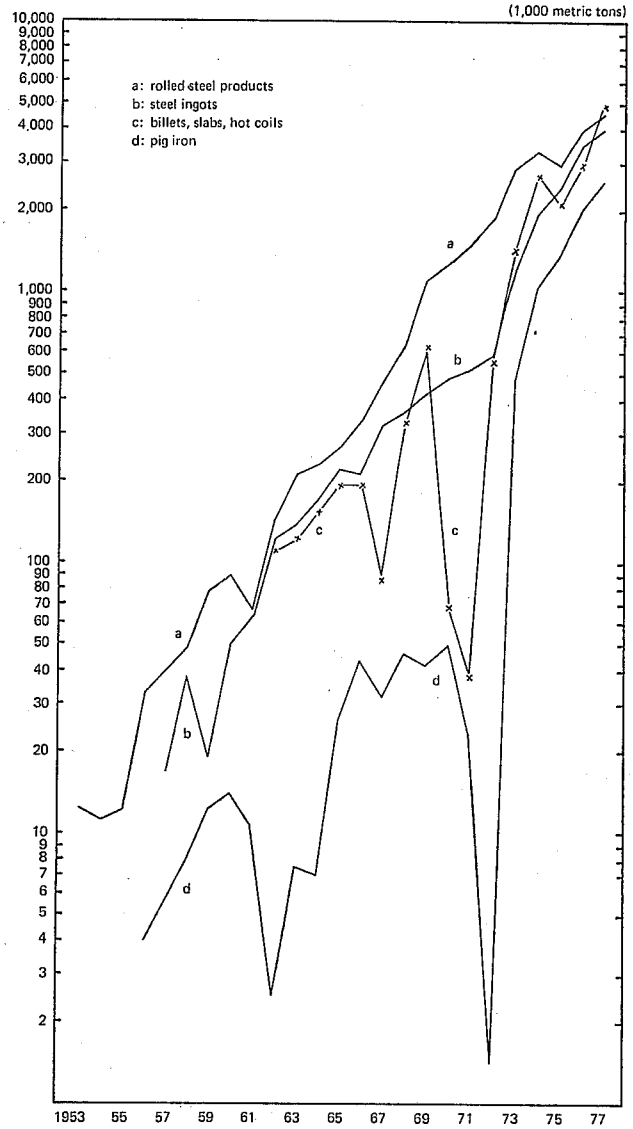
Let us here consider the case of shipbuilding. In 1976, the shipbuilding industry accounted for 4.3 per cent of the R.O.K.'s total exports, with ships representing seventh place among exported items. However, between January and June 1977, ships came to occupy third place among exports, following textiles and electrical machinery. In the case of ships, the rate of dependence on imports (imports/[domestic production + imports]) decreased from 82.4 per cent in 1972 to 36.9 per cent in 1976, while the rate of dependence on exports (exports/[domestic demand + exports]) steeply increased from 1.0 per cent to 58.4 per cent during the same period. In other words, the process of import substitution and the process of export expansion both made forward strides almost simultaneously during this very short time period. In the shipbuilding industry's development process we may see a good example of the "compressed pattern" at industrial development stage which we have already pointed out, whereby the process of supplying domestic demand by domestic production gives rise with very little time lag to a process of export expansion, and the expanding total demand acts consistently to pull forward domestic production.

The shipbuilding industry is the predominant user for thick steel plates. In 1975, the industry accounted for 80 per cent of all thick plates used. Before the beginning of the 1970s, however, the domestic demand for thick steel plates was almost negligible, and before 1967, domestic production of this item was zero. Domestic production showed a dramatic increase after 1972, following the start of a rapidly growing domestic production in the shipbuilding industry. The rate of dependence on imports for thick steel plates was 100 per cent up before 1966, and was 60.2 per cent in 1969, 25.1 per cent in 1972, and 26.9 per cent in 1976. These figures are clearly the result of demand-pull by the shipbuilding industry.

The iron and steel industry may be divided into the following three basic processes: (1) the iron-making process whereby pig iron is produced in giant blast furnaces which liquefy the iron ore and oxidize it with coke; (2) the steel-making process whereby such intermediate products as steel ingots, billets, slabs, and hot coils are produced in converters, electric furnaces, or open-hearth furnaces, using pig iron or scrap iron as starting materials; and (3) the rolling process, whereby billets, slabs, or hot coils are heated to incandescence and then extended and shaped under pressure by means of rollers to produce various types of steel manufactures.

The above discussion concerns steel products manufactured by the third of the above processes, namely, the rolling process. In this regard, however, we might well have predicted by inductive reasoning that expansion in the manufacture of rolled steel products as final goods would also stimulate the domestic production of such intermediate steel products as ingots, slabs, etc., and that in a further stage of development this would induce the domestic production of pig iron. Figure 2 indicates the process of expanding production of metal and steel at each manufacturing stage. We may see by this figure that there has been,

Fig. 2. Transition in Iron and Steel Production, 1953–77



Sources: Various issues of [1] and [4].

especially after the beginning of the 1970s, a deepening process in the iron and steel production structure, progressing from final goods to include intermediate products and then pig iron.

Table I shows that if rolling capacity is taken as the unit of reference, the unbalance with respect to iron- and steel-making capacity has gradually moved in the direction of rectifying itself. In other words, we can see that the production structure has deepened in an upstream direction, at an accelerating pace.

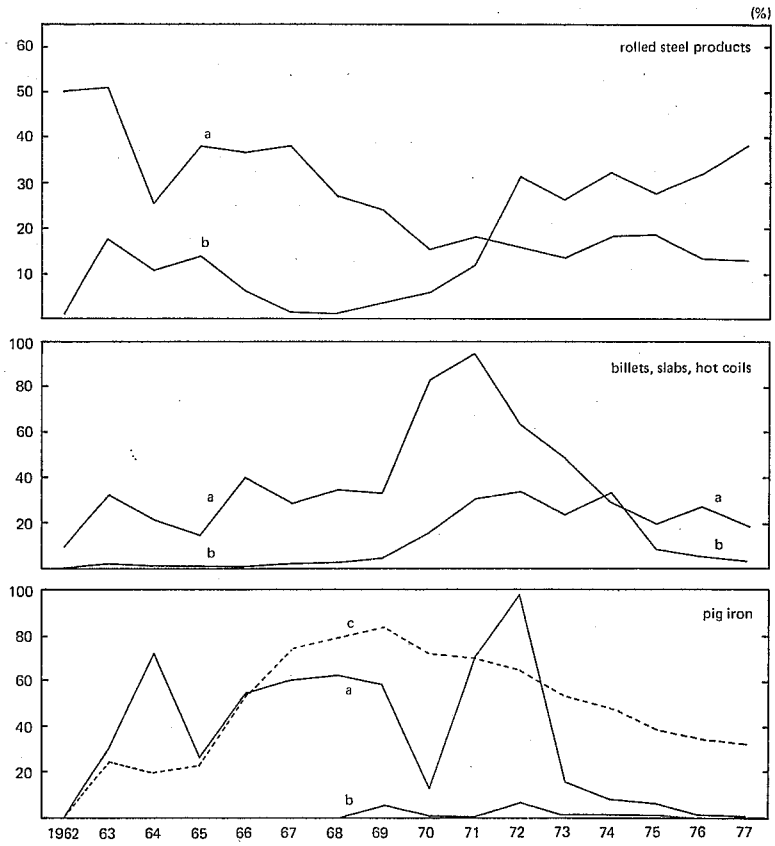
TABLE I

IRON- AND STEEL-MAKING CAPACITY

(Rolling capacity=1.000)

	1957	1960	1964	1969	1973	1976
Iron-making capacity	0.251	0.132	0.119	0.143	0.226	0.420
Steel-making capacity	0.304	0.392	0.402	0.533	0.427	0.725

Fig. 3. Transition in Import and Export Dependence of Iron and Steel Products, 1962–77



Sources: Various issues of [4] and [9].
Note: a=rate of dependence on imports; b=rate of dependence on exports; c=rate of dependence on imports for scrap plus pig iron.

It is of interest, also, to observe this type of structural deepening pattern in the iron and steel industry by looking at the degrees of dependence on imports and exports for each production stage. These are shown in Figure 3. Since 1962, the rate of dependence on imports of rolled steel products has, in accordance with the rapid expansion of domestic production, shown an almost continuous decline, and in recent years has fallen to a level of between 10–15 per cent.

In 1976–77, the rate of dependence on imports was zero in the case of reinforced bars, steel castings, cast iron pipes and tubes, and iron castings, and was around 5 per cent in the case of thin steel plates, steel sheets, and steel pipes and tubes. On the other hand, the rate of dependence on exports showed a steep increase after about 1970, and by 1977, had reached about 40 per cent. However, in the case of intermediate products,[4] the rate of dependence on imports increased through the 1960s, reaching a peak in 1971. In other words, we see that until 1971 the attempt was made to meet through imports the insufficiencies in domestic production brought about by the above-mentioned unbalance in production facilities, the imported intermediate products being used in the manufacture of final goods.

However, after 1971, as a result of the rapid increase in the domestic production of billets, slabs, and hot coils, the dependence on imports decreased and by 1976–77 this process of import substitution was virtually complete. After the beginning of the 1970s, dependence on exports of intermediate products showed a considerable increase. During the period 1971–74 it reached levels of approximately 30 per cent, but afterwards dropped off again.

In the case of pig iron, yearly fluctuations in the degree of dependence on imports have been very great, but until 1972 the general tendency was one of increase. In other words, until 1972 the process of increasing domestic production of steel materials not only stimulated imports of intermediate steel products (slabs, coils, etc.) but at the same time led to large-scale increases in the import of pig iron. After 1972 the decrease in the rate of dependence on imports has been truly remarkable. Exports of pig iron are, however, still negligible. If pig iron and scrap are together considered as complementary goods, the course of dependence on imports for these materials, taken together, is shown by the dotted line in the bottom section of Figure 3. In these terms, dependence on imports increased through the 1960s and began to decrease after the start of the 1970s.

A very notable rise in the R.O.K.'s domestic capacity to supply iron and steel products corresponds to the entry into production of the Pohang Iron and Steel Company, whose first stage of construction was begun in April 1970 and completed in June 1973, providing a yearly output equivalent to 1 million tons of crude steel. The same enterprise's second construction stage, providing for a yearly total capacity of 2.6 million tons, was completed in May 1976. The third construction stage, bringing the yearly capacity up to 5.5 million tons, is scheduled for completion in December 1978, while the fourth stage, bringing total capacity

[4] Intermediate products in the iron and steel industry include steel ingots as well as billets, slabs, hot coils, and the like. Ingots are produced by liquefying pig iron or scrap in converters or open-hearth furnaces and pouring the molten liquid into appropriate molds. In the R.O.K. there exist a fairly large number of open-hearth furnaces and cupolas (albeit these are often of small scale and poor efficiency), and at no time have imports of steel ingots reached a very great volume. However, there is a severe shortage of blooming mills which can convert ingots into billets, slabs, or hot coils suited for undergoing a rolling process in the manufacture of final products. In this study, "intermediate products" refer mainly to billets, slabs, and hot coils, whose import volumes have until very recent years been large.

up to 8.5 million tons, is scheduled for completion in 1981. The completion of the first stage in 1973 marked the birth of the R.O.K.'s first integrated steel mill turning out iron, steel, and rolled products. The rapid trend toward rectification of the unbalance in domestic capacity for rolled products, intermediate steel products, and pig iron has come about precisely in response to the entry into operation of the Pohang Iron and Steel Company.

We may say that prior to the completion of the first construction stage at the Pohang works in 1973, the R.O.K.'s iron and steel industry had centered around small-scale makers engaged in the rolling process.[5] We may consider that period I (1953–61) in the development of the R.O.K.'s modern iron and steel industry corresponds to the interval between the end of the Korean War and the beginning of the First Five-Year Plan, with period II (1962–72) corresponding to the interval between the beginning of the First Five-Year Plan and the completion of the first stage of the Pohang works, and period III beginning in mid-1973. According to this schematization, period I may be said to have been characterized by the use of scrap left over by the Korean War and by United Nations facilities, while period II was a period of the manufacture of rolled products using imported scrap and pig iron as input materials. During the postwar reconstruction of period I, one saw an enormous demand for reconstruction-related materials, especially steel bars, and there was as a result a proliferation of small- and medium-scale makers seeking to respond to this demand.

Even as late as 1962 (the beginning year of period II), steel bars accounted for 51 per cent of the total production of rolled products. In other words, the degree of diversification was still low. As seen in Figure 1, in 1962 the production of rolled steel products reached 141,000 tons, but this was not enough to meet domestic demand, and imports during the same year were 179,000 tons. In 1966, the end year of the First Five-Year Plan, domestic production of rolled products was 341,000 tons, the average annual rate of increase during the five-year period having been a high 24.6 per cent. At the end of the Second Five-Year Plan, domestic production was 1,699,000 tons, the average annual rate of increase during the period having been 37.8 per cent. By 1971, the end year of the Second Five-Year Plan, the rate of dependence on imports had dropped below the 20 per cent level. Since the degree of dependence on exports was in excess of 10 per cent during the same year, we see that by the end of the Second Five-Year Plan self-sufficiency in rolled steel products had been nearly achieved. With the transition from period I, which had focused on steel bars for construction use, to period II, production gradually became more diversified. By 1970, the relative weight of steel bars had declined to less than 40 per cent and in their place various types of steel plates were showing a rapid production growth. Needless to say, the expansion in the production of such consumer industries as electrical appliances, automobiles and ships became an important factor in providing the demand stimulus to pull forward the domestic production of steel plates.

[5] To further investigate the development of the R.O.K.'s iron and steel industry, see [9] [10].

However, during period II there was still no change in the pattern whereby small-scale rolled products makers were the main production units. For example, in 1970 there were fifty-five establishments engaged in the rolling process, but only ten of these had production capacities in excess of 20,000 tons. Nevertheless, through the efforts to expand production on the part of these small-scale makers which were far below international standards, not only was the process of import substitution for steel products nearly completed by the end of period II, but a considerable export expansion was realized as well. Thus, we can surely give a positive evaluation to these efforts during period II, recognizing that they provided the foundation for the sudden expansion in the R.O.K.'s iron and steel industry during period III.

As pointed out earlier, steel-making capacity was rather weak, and the insufficiency of iron-making capacity was more serious still. In 1970, there were three iron-making enterprises and fifteen enterprises equipped to produce steel. However, only one among the former, and three among the latter, had production capacities in excess of 100,000 tons. This insufficiency in production capacity at the more backward stages of production caused instability in the supply of input materials for the more forward stages and acted to depress rates of operation in general. This is reflected in the fact that around 1970 the rates of operation in the steel-making and rolling industries were approximately 60 per cent and 65 per cent, respectively. Not only in scale, but also in technical aspects, the production methods in the backward stage were quite inefficient. For instance, the yield percentage in the production of steel ingots (the ratio between the volume of the ingots to the volume of pig iron and scrap utilized) was in 1970 in the R.O.K. only 52.5 per cent compared to a rate of more than 90 per cent common in industrially advanced countries.

In spite of the fact that the R.O.K.'s iron and steel industries having got under way after the mid-1950s, large-scale production of rolled steel products, created a great demand pressure for such input materials as steel ingots, billets, slabs, hot coils, etc., and by extension for pig iron as well, until 1972 they could not induce backward stages of production. However, this unmet demand pressure for input materials for the rolled steel products sector caused the government to decide in 1970 to begin construction of the Pohang Iron and Steel Company, and following the completion of the first stage of construction in 1973, the iron and steel production structure at one stroke saw a great speed-up in its deepening process. As mentioned above, if the production capacity for rolled steel products in 1976 is taken as the unit of reference, production capacities for pig iron and for steel were in that year 0.420 and 0.725 respectively. Thus the unbalance of period II has been greatly improved, as have also rates of operation and levels of technical efficiency. In 1976, rates of operation in the steel-making and rolling sectors were 87.2 per cent and 74.1 per cent, respectively, and the yield percentage for the production of steel ingots had risen from the aforementioned figure of 52.5 per cent (in 1970) to 89.1 per cent, thus approximating the rates in industrially advanced countries. In view of the plans for expanding the capacity of the Pohang works, these trends may be expected to continue upward.

III. DEVELOPMENT PATTERN IN THE PETROCHEMICAL INDUSTRY

As in the case of the iron and steel industry, what stimulated the expansion of the petrochemical industry was likewise the expansion in demand for intermediate and basic materials brought about by the expansion in production of final goods. The expansion in total demand has proceeded extremely quickly, helped by the expansion in exports brought about immediately after the import substitution stage of final goods.

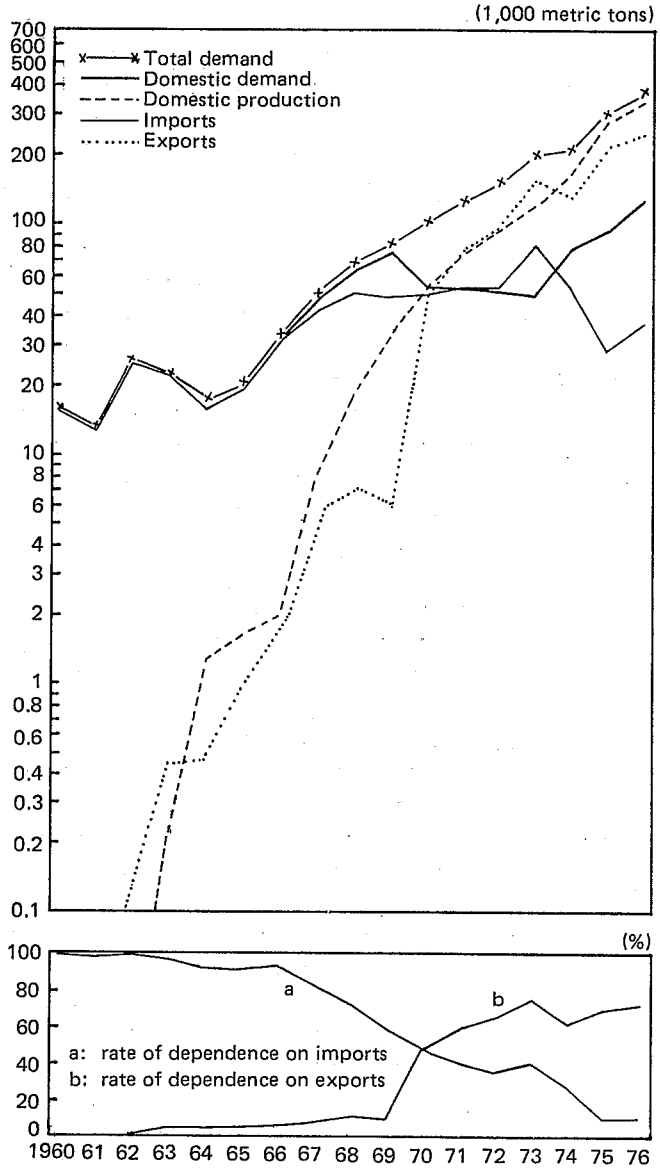
The petrochemical industry may in general be divided into three processes as follow: (1) process I, by which such basic materials as ethylene, propylene, benzene, and butadiene are produced by distilling or cracking petroleum; (2) process II, by which such secondary materials as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), acrylonitrile monomer (AN), and caprolactum are produced by polymerizing or combining the basic materials; and (3) process III, by which the secondary materials are processed into synthetic resins, synthetic fibers, synthetic rubber, etc. In the R.O.K., the most important products at the downstream are synthetic fibers and resins.

Figure 4 permits us to see the development pattern for synthetic fibers, showing changes over time with respect to domestic production, imports, domestic demand, and exports. It also indicates the degrees of dependence on exports and imports. We see that after the beginning of the latter half of the 1960s, import substitution proceeded very rapidly and that especially after the beginning of the 1970s, the relative weight of exports became extremely great. The figure gives us a graphic representation of the expansion of domestic production having been pulled forward by mainly domestic demand during the 1960s, and then in the 1970s by rapid growth in total demand corresponding to increase in exports.

The degree of import dependence in the case of synthetic fibers, which was 94 per cent in 1966, had declined to less than 10 per cent by 1975, while on the other hand the degree of export dependence reached 75 per cent in 1973. As may be seen in the figure, the volume of imports has been declining, both in relative and absolute terms, since 1973. Again, the "time compression" between stages of industrial development is graphically shown in the case of the synthetic fiber industry, where the transition from import substitution to an export orientation was achieved in the short period of less than ten years.

The R.O.K.'s synthetic fiber industry began its first stages of expansion in 1962 with the production of polyvinyl alcohol (PVA) fibers and in 1963 nylon fibers. However, the most noteworthy process of expansion belongs to the period after 1966–67. Acrylic fibers were first produced in 1967 and polyester fibers were first produced in 1968, while the production capacity for nylon fibers also showed a remarkable expansion after 1968. These three types of fibers have since the latter part of the 1960s been chiefly responsible for leading the R.O.K.'s synthetic fiber industry, and since 1974 expansion in the production of the acrylic and polyester fibers has been especially rapid. Needless to say, it has also been these three types of fibers which have taken the lead in synthetic fiber exports.

Fig. 4. Development Pattern in the Synthetic Fiber Industry, 1960–76



Sources: Various issues of [5].

While the final products of the synthetic textile industry are taken to be synthetic fibers and textiles, if one thinks still further downstream, one must naturally give consideration to the various types of clothing which are the most representative textile manufactures. In the R.O.K., the relative weight of synthetic fibers and textiles among all textile manufactures has risen rapidly; in 1975 it represented 54 per cent of the total volume of textile consumption. The clothing

industry, as demonstrated most markedly in the sewing sector, is very labor-intensive, and it is well known that it was clothing goods which were, so to speak, the classic example of the labor-intensive products which carried forward the bulk of the R.O.K.'s export expansion after the early 1960s. In this connection we must as a natural premise bear in mind that the clothing industry has been the sector which has ultimately provided the stimulus whereby export demand in particular has brought a great expansion in the production of synthetic fibers and textiles.

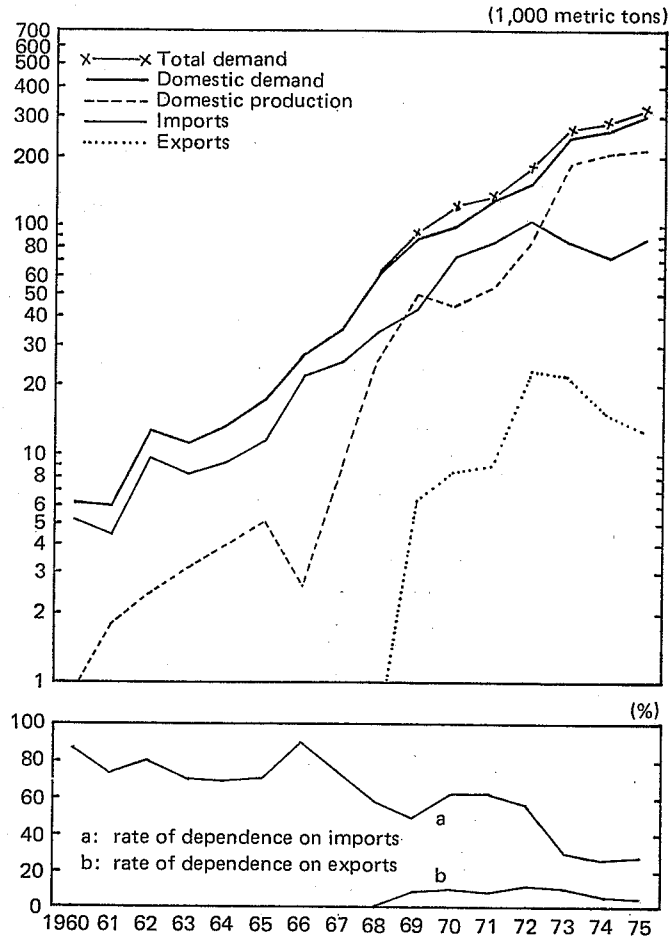
The other especially important industry forming the downstream of the petrochemical industry is the synthetic resin industry. Figure 5 traces the development pattern in this industry, using the same variables as in the case of synthetic fibers. We see that during the 1960s a rapidly growing domestic demand provided a stimulus to imports, but at the same time provided a stimulus to an even faster growth of domestic production. However, until around 1966, the volume of domestic production was still not large and the process of import substitution was barely progressing. But after 1967 the rate of increase in domestic production surpassed that of imports, and the rate of import dependence, which had been 90.8 per cent in 1966 dropped off rapidly until by 1975 it stood at only 28.2 per cent.

Part C of Figure 6 shows how, in the case of various representative resins, import dependence declined, within periods of two to three years, from levels of 100 per cent to 0–20 per cent, reflecting the truly remarkable rapidity of the process of import substitution. Exports began a rapid increase after 1968. During the five-year period up to 1972, an average annual growth rate of exports of 41.4 per cent was maintained, but after the cutback in demand which accompanied the oil shock, the growth rate switched to the negative side. Compared to the synthetic fiber industry, the synthetic resin industry is still in a young stage of development, and it may still be somewhat in the future before it becomes a full-fledged export industry.

In the case of both synthetic fibers and synthetic resins, the general pattern before 1972–73 was that of importing intermediate materials from industrially advanced countries and using these for producing final products for the domestic market and for export. However, as a result of the powerful backward linkage effect that had been built up during the earlier period in question, a rapid expansion in domestic production of intermediate and basic materials was induced after 1972–73 and import dependence for these input materials has plummeted.

Let us now examine the development patterns in the synthetic fiber and resin industries by looking more closely at the degrees of import and export dependence at each manufacturing stage. Keeping in mind that the principal intermediate materials for the production of nylon, acrylic, and polyester fibers are caprolactum, acrylonitrile monomer (AN), and ethylene glycol (EG), respectively, the degrees of dependence on imports for each of these products is given in Figure 6. Expansion in the domestic production of each type of final products of synthetic fiber may be said to have begun in 1963 for nylon, in 1967 for acrylic fibers, and in 1968 for polyester fibers. The very noticeable drops, beginning with

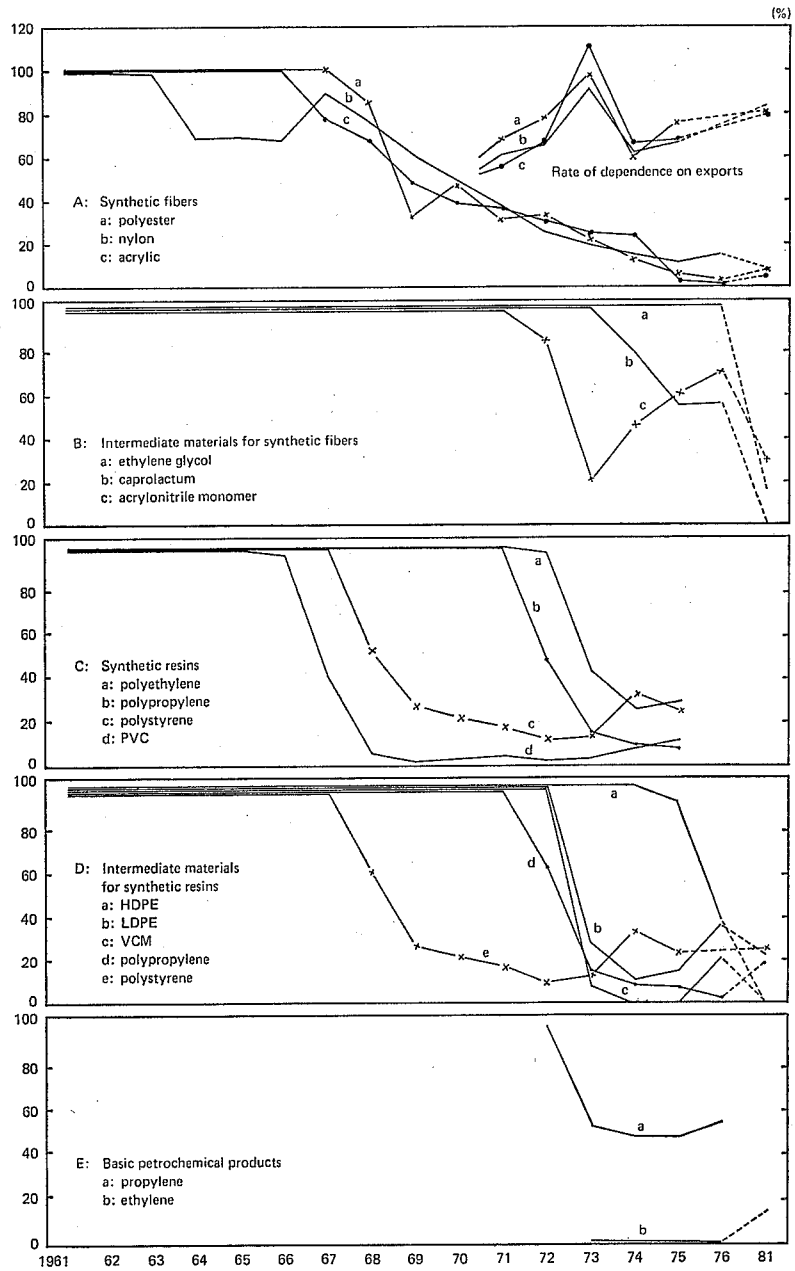
Fig. 5. Development Pattern in the Synthetic Resins Industry, 1960–75



Sources: Published materials of Hangug-hapseong-suji-hyeobdong-jōhab (Korea synthetic resins association).

these years, in the respective degrees of dependence on import are shown in part A of Figure 6, but in part B we see that in the case of intermediate materials, import dependence was 100 per cent, for AN until 1971, for caprolactum until 1973, and for EG up until the most recent year (1976) for which data was available. The drop in import dependence for AN and caprolactum was, however, rapid following the start of domestic production. In the case of AN, the degree of import dependence tended to rise again rather markedly in 1974 and the two subsequent years, and in the case of caprolactum the degree of import dependence has in recent years shown some tendency to rise. This phenomenon is the result of the fact that domestic supply of these intermediate materials has been unable to catch up with the rapid increase in demand for acrylic and nylon fibers which has been created especially through exports.

Fig. 6. Transition in the Rate of Dependence on Imports of Petrochemical Products, 1961–81



Sources: Published materials of Hangug-habseong-suji-hyeobdong-jōhab (Korea synthetic resins association), and Hangug-seogyu-hwahag-gongeob-hyeobhoe (Korea petrochemical industry association). Various issues of [2] and [5]. For estimate of 1981 figures, see [8].

With the completion of the new petrochemical complex which we shall presently discuss, supply capacity should greatly expand, and by 1981 (the end year of the Fourth Five-Year Plan) the aim is to reduce the degree of import dependence for caprolactum to virtually zero, thus completing the process of import substitution for this item. The same plan calls for reducing the levels of import dependence for AN and EG to 30.4 per cent and 12.8 per cent, respectively. By comparing parts A and B of Figure 6, we can in any case perceive a clear cause-and-effect relationship whereby a backward linkage effect brought about by the expansion in domestic production of final goods and exports in the R.O.K.'s synthetic fiber industry has acted to stimulate domestic production of intermediate materials.

This relationship is equally relevant to the case of the synthetic (plastic) resins industry. This industry is represented mainly by five plastic resin final products for widespread use. The trend toward decreasing levels of import dependence for each of these five items is shown in part C of Figure 6.

The production of thermoplastics in the R.O.K. began with the domestic production of polyvinyl chloride resin in 1966, expanded rapidly in 1967, and in 1968 saw the completion of the process of import substitution of this material. Large-scale domestic production of polystyrene, polypropylene, and polyethylene resin began in 1968, 1972, and 1973, respectively, and in each case the period of import substitution became virtually complete within two years after the start of production.

The backward linkage effect arising from this process of import substitution again induced in a very short time period the domestic production of intermediate materials. As mentioned above, among the synthetic resins, domestic production of polyvinyl chloride was carried out earliest, and although import substitution was completed in 1968, until 1971 imports were relied on for all supplies of the intermediate material, vinyl chloride monomer (VCM). However, during 1973, the newly begun domestic production of the latter showed such rapid growth that import dependence in that year dropped to below 10 per cent. In the case of the beginning of domestic production of polystyrene resin, domestic production of the intermediate material polystyrene was begun at the same time, and in the case of polyetylene and polypropylene resins, domestic production of the intermediate materials, namely, polypropylene and high- and low-density polyethylene, was also begun simultaneously. By 1973, the backward linkage pressure which accompanied the expansion in production of intermediate materials for synthetic fibers and resins had given rise to the start of domestic production of the basic materials ethylene and propylene. Ethylene had until 1972 been neither imported nor produced domestically, but saw the beginning of large-scale domestic production in 1973. Propylene had until 1972 been 100 per cent imported, but in 1973, with the beginning of domestic production, this import dependence dropped to around 50 per cent.

Thus, the rapid deepening process in the structure of the R.O.K.'s petrochemical industry, whereby the transition was made to include such upstream activities as the production of intermediate and basic materials, belongs to the

period after 1973. The expansion in the supply capacity of the petrochemical industry after 1973 was the result of the completion in October 1972 of the Ulsan petrochemical complex, which was a core project in the Second Five-Year Plan and whose construction was pushed forward by energetic government support. We may say that with the completion of this complex the R.O.K.'s petrochemical industry made its full-fledged debut. The precipitous drops after 1973 in the levels of import dependence for major intermediate and basic materials, as shown on the lines in the aforementioned Figure 6, are almost entirely due to the completion of the Ulsan complex.

The production of input materials is presently being carried out at full capacity, moreover, it is expected that total demand for synthetic fibers and resins will expand even further; the expansion in the former case centering around exports and that in the latter case centering around domestic demand. It is clear that the growth in total demand will outstrip, if it does not do so already, the production capacity of the present Ulsan complex. This is reflected in the already mentioned fact that the level of import dependence for AN (the main intermediate material for acrylic fibers), while dropping abruptly in 1973 to 20.2 per cent from the 86.4 per cent of the previous year, rose again to more than 60 per cent in 1975.

It should also be mentioned that as of 1975 the per capita volume of synthetic resin consumption in the R.O.K. was only 7.3 kilograms (total for the five major types of resin in general use). Although this figure represents a rapid expansion from earlier years, it is far from the levels in the industrially advanced countries and less than half that of Taiwan. But given the conditions of the large-scale rise in per capita income in the R.O.K. and of the rapid development of that country's heavy and chemical industries, it may naturally be expected that consumption volumes will greatly expand in a short period.

The insufficiency of the productive capacity for propylene, one of the main basic materials, is still a serious one. With a view to coping with this and the other considerations mentioned above, construction is presently under way both to expand the production capacity at the Ulsan complex and also to complete the R.O.K.'s second petrochemical complex. At the Ulsan complex, expansion is under way which will increase naphtha cracking capacity from the present 100,000 tons to 150,000 tons in ethylene equivalent. The new Yeocheon petrochemical complex, scheduled for completion in 1978, will center around a naphtha cracking plant producing 350,000 tons in ethylene equivalent and will include ten other related plants.

With the completion of these projects, the supply capacity of the R.O.K.'s petrochemical industry will take another big forward step and this process of raising the industry's productive structure to a higher level is expected to be complete by around 1980. Truly, it is sometimes hard to believe our eyes when we see that the process of deepening the production structure, by which very active downstream conditions have within a very short time period given rise to the domestic production of intermediate and basic materials, has been taking place so very rapidly.

IV. FACTORS PROPELLING THE HEAVY AND CHEMICAL INDUSTRIES

As described above, the process of heavy and chemical industrialization in the R.O.K.'s economy may be said to have been induced by a backward linkage effect brought about by the remarkably rapid expansion in the domestic production of final goods. However, unless we also direct our inquiry to the promoter of the heavy and chemical industries, and in particular to the resource base which has supported this industrialization process, we will not yet have provided an adequate explanation of the factors which have produced the heavy and chemical industrialization. Let us, then, here consider some of these factors.

Firstly, we should note the rapid appearance, during the process of rapid economic growth after the beginning of the 1960s, of national capitalists with management ability and capital sufficient to support the above-described industrialization process. The R.O.K.'s more influential capitalists for the most part had their early success during the reconstruction period following the Korean War in construction work or else in one or another of the so-called *sambaek* ("three white") industries, namely, spinning and textiles, flour milling, and sugar refining. During the subsequent period of rapid economic growth they extended their activities to the manufacture of parts and constituent materials for a wide variety of goods, and then to various types of processing and assembling, sales, and exports. At the present time the more important concentrations of capital are formed around managerial entities which are sometimes called "enterprise groups" or *chaebol* (a word copied from the Japanese term zaibatsu) and which may be considered as sets of companies dealing with the various stages of productive and marketing activity. These enterprise groups, known by such names as Samsung ("three stars"), Daewoo ("great universe"), Hyundai ("current age"), Ssangyong ("double dragon"), and Lucky have, during the period through the mid-1960s which was characterized by import substitution, and then during the following period of export-oriented industrialization, brought a succession of so-called "strategic" industries under their wings and thus succeeded in continuing to show rapid rates of growth. In this process they continued to accumulate notable results with respect to internal capital, capacity for technical development, managerial resources, and manpower, and beginning in the latter half of the 1960s, these enterprise groups began to advance into the field of the heavy and chemical industries. We can find a classic example in the Hyundai group which began with construction work and then in the 1970s continued to develop in such fields as general machinery, automobiles, and shipbuilding. In speaking of the R.O.K.'s heavy and chemical industrialization, we cannot ignore the rapid appearance of such groups of large-scale enterprises equipped with wide-ranging capacities to support this industrialization process.

However, we must not fail to give consideration to government efforts, which placed the heavy and chemical industrialization by above groups as a national project to strengthen a "self-supportive economy" and concentrated resources

in this process as a matter of national policy. Impressive examples of this government-private enterprise cooperation are seen in the enactment of the Priority Industry Promotion Law and the project of heavy and chemical industrial bases.

In the Second Five-Year Plan, the government set guidelines for promoting and strengthening the following types of industry sectors: (1) sectors which bring a high rate of foreign exchange earnings and which can be developed relatively easily as export industries; (2) sectors which have effective linkages to other industries and which produce greater employment opportunity; and (3) basic sectors providing the foundation for the future achievement of a self-supportive economy. In keeping with these guidelines, the following legislation was adopted and promulgated: the Petrochemical Industry Promotion Act in 1966, the Machine Industry Promotion Act and the Shipbuilding Industry Promotion Act in 1967, the Electronics Industry Promotion Act in 1969, and the Iron and Steel Industry Promotion Act in 1970. These sectors designated by the government for strategic development were made the objects of government assistance. As types of industry covered by the Priority Industry Promotion Law, they were extended such preferential conditions as the following: facilities for priority use of introduced foreign capital at low interest and long-term repayment schedules; necessary administrative guidance and financial aid for the purchase of raw materials and machinery; discounts in rail freight rates, harbor use fees, water, electricity and gas rates. Those industries which were favored by the Priority Industry Promotion Law have without exception shown remarkable progress.

Another factor which characterizes the heavy and chemical industrialization policy is the attempt to plan for regional industrial groupings through the construction of industrial bases for one or another priority sector, and thus to gain economies of scale and other benefits of concentration. Among such industrial bases are the Pohang steel base, the Changwon machine industry base, the Ulsan petrochemical industry complex, the Pohang steel complex, the Okpo shipbuilding base, and the Onsan nonferrous metal industry complex. These industrial bases were all created by the government and enterprises were invited to locate there following the completion of such infra-structure as roads, harbors, water and electricity networks. Enterprises locating in these complexes not only enjoy special measures with respect to taxes and financing, moreover in the case of imports of capital goods such as machinery, these goods are exempt from customs and commodity taxes. In any event, it seems quite logical to see that an important factor which has enabled the heavy and chemical industrialization to proceed with such notable speed was the generous government policy of protecting the heavy and chemical industries as a national goal.

The investment resources which have supported heavy and chemical industrialization may be considered to have been rapidly formed after the middle of the 1960s. It goes without saying that industrialization in the heavy and chemical fields strengthens tendencies toward capital concentration and that it requires an enormous scale of investment. The incremental capital output ratio for all manufacturing sectors of the economy averaged 1.7 and 1.4 during the first and second five-year plans, respectively. This figure was 2.0 during the Third Five-

Year Plan, and is expected to exceed 2.0 during the Fourth Five-Year Plan. During the three already completed five-year plans, the incremental capital output ratios with respect to the R.O.K. economy as a whole were 1.9, 2.6, and 2.9, respectively. The ratio is estimated to average around 3.5 during the Fourth Five-Year Plan [6, pp. 95–97].

Internal investment resources in the R.O.K. have become progressively more plentiful since the early 1960s and especially after the beginning of the 1970s. This phenomenon may be seen as having provided a start to the formation of the wide financial base which is needed for investment in the heavy and chemical industry, where the necessary scale of investment is so very large. At the beginning of the 1960s the domestic saving rate was less than 5 per cent, but this figure rapidly expanded to reach 21.4 per cent in 1976. The contribution to this expansion in domestic savings came from the private sector, and, we should note, most particularly from individual household savings. Needless to say, an important factor behind this heightened tendency toward individual savings was the rise in per capita income levels which accompanied a rapid process of economic growth [14, Chap. 5].

While the rate of overseas savings has in recent years shown considerable fluctuation, the general tendency has clearly been one of decrease. The overseas savings rate during the Third Five-Year Plan averaged 25.9 per cent, but this is less than the corresponding figure of 43.1 per cent during the Second Five-Year Plan. During the Fourth Five-Year Plan, it is projected that 92.4 per cent of total investments will come from domestic savings. The rapid rise in domestic savings may be considered to constitute the real backbone of support for the large-scale investments needed in the heavy and chemical industry sector.

As another factor which may be said to have fostered the R.O.K.'s heavy and chemical industry, we should give mention to some of the so-called "advantages of backwardness" which the R.O.K. has been able to enjoy in good measure in the course of its heavy and chemical industrialization process. In the case of iron and steel as well as in the case of petrochemicals, for the R.O.K. the initial choices were not what sort of technology to develop and how to get together within the country the needed investment funds, but were rather the choices of which capital and which already developed technology to introduce from which foreign countries.

In late-developing countries with rapid growth rates, such as the R.O.K., one can indeed see a concentration of capital from industrially advanced countries which are seeking better investment opportunities, once developing countries' projects come to be recognized as having sufficient credibility. Although, as already pointed out, a base of domestic funds for heavy and chemical industrialization is being formed in the R.O.K., there is no change in the fact that the R.O.K. is still a capital-short country. And interest rates for domestic funding are considerably higher than international levels. The fact that the R.O.K. has been able, at least during early stages of investment requiring the biggest outlays, to make plentiful use of low-interest capital has, needless to say, provided favorable conditions for industrial development.

In the case of the heavy and chemical industries, a very large part (though it

would be going too far to say all) of the necessary technology had already been "standardized," so to speak, in the industrially advanced countries, with the result that the difficulty and cost of introducing it can be considered not so very great, at least in comparison with the difficulty and costs involved at the time the same technology was introduced in the now industrially advanced countries. As is suggested by theories of product cycles, in the case of "vanguard industries" whose technologies are highly sophisticated and whose products as a result have a high tendency to be treated discriminatorily, the introduction or transfer of such technologies is not easy. However, in the case of those heavy and chemical industries whose technologies have to a considerable extent been standardized, technical assistance is relatively easy and the cost of introduction is relatively cheap. Thus it has become a rule of experience that there is an ample possibility that this situation can work to the advantage of late-developing countries.

For the second stage of construction at the Pohang integrated steel works, completed in 1976, total funding was 820 million dollars, out of which 520 million dollars was made available in the form of loans from foreign governments. Technical cooperation was also acquired from Japan, Australia, Germany, France, and the United States. In discussing the sort of integrated iron and steel works which now exists in the R.O.K., one can certainly not fail to take into due consideration the overseas cooperation in funding and, most especially, in technology. When we consider the Daehan Petroleum Company and the Honam Petrochemical Company, which occupy central positions in charge of petroleum refining and the naphtha cracking process at the Ulsan and Yeocheon petrochemical complexes, respectively, we see that both have access to very generous assistance in both capital and technology from industrially advanced countries, since the former enterprise is a joint venture with Gulf Oil and the latter with the Mitsui group in Japan. We may surmise that a considerable part of the reason why the R.O.K.'s heavy and chemical industries have advanced so quickly may be found in the fact that the R.O.K. has received some of the "advantages of relative backwardness"[6] and has prudently applied national policy to the task of using these advantages to the maximum extent.

V. CONCLUSION

Although I have given the above sort of positive valuation to the R.O.K.'s heavy and chemical industrialization process, I will not forecast optimistically that this industrialization process will continue to develop in the future without failures or shortcomings. With respect to the question of what sorts of biases and costs are imposed on the course of development in developing countries by heavy and chemical industrialization (by the process of import substitution of input materials), I believe that my views are somewhat severe, at least in comparison to many other development economists [14, Chaps. 3 and 4].

In general terms, we should be able to say the following with certainty. Namely, as a deepening process takes place in the import substitution structure, it becomes necessary to use capital-intensive production methods, backed up by relatively high

[6] This is a phrase first popularized by Gerschenkron. See [3, Chap. 1].

levels of technology, and the amounts of skilled labor and capital employed rapidly increase. Such production methods, as a result, are coming to be less and less suited to the given conditions of factor endowment in a given developing country. If such production methods should come to be relied upon exclusively, production costs will naturally become more and more influenced by economies of scale and advantages of specialization, to the point where they may quite possibly fail to correspond to market conditions in the developing country in question. Whether one looks at market conditions or factor endowments, there is no doubt that the structural deepening process which accompanies import substitution tends to widen the gap between domestic and international production costs.

However, if we limit our discussion to the heavy and chemical industrialization which is being attempted in the present-day R.O.K., we have little choice but to forecast that this will have achieved success in the not very distant future. As we have already pointed out, in the case of the R.O.K., the managerial base and the capital resources for the heavy and chemical industries were formed under the conditions of rapid economic growth prevailing since the mid-1960s. Also we have pointed out the fact that due to this high rate of growth it was relatively easy to introduce foreign capital and technology. We must indeed say that it is rare among developing countries for a skilled labor force to be formed so rapidly in such abundance as has been the case in the R.O.K.

In any heavy and chemical industrialization process the question of whether or not economies of scale can be displayed to full advantage is of decisive importance. Up to now the usual route of heavy and chemical industrialization in developing countries has been one whereby the process of import substitution (aiming at the "ready market" created by restrictions on imports of final goods) has sooner or later encountered stagnation due to the constraints of a domestic market of rather rigidly fixed scale and has given rise to the production of input materials searching for new substitution opportunities. Because the heavy and chemical industrialization process is not in these cases pulled forward by continuously expanding demand, there is indeed little room to give full play to the benefits of economies of scale.

In the case of heavy and chemical industrialization in the R.O.K., we must by all means not fail to take notice of the following point, which has already been mentioned several times in this paper. Namely, we can see a clear cause-and-effect relationship whereby as a result of the fact that the import substitution process for final goods was able to progress directly to the following stage of export-orientation, both the total demand for and the domestic production of final goods consistently expanded and induced the production of input materials under conditions of a backward linkage effect stemming from this expanding production of final goods. In the R.O.K.'s heavy and chemical industrialization process may be seen a model example of the cause-and-effect type of induction whereby export-oriented industrialization at a downstream position can expedite import substitution at upstream positions. In such a case, there is indeed room for giving full play to the benefits of economies of scale.

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