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PROBLEMS OF HEAVY INDUSTRIALIZATION IN ASIAN DEVELOPMENT

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1. Theories of Heavy Industrialization

The establishment of heavy industries has caught the interest of high officials and planning authorities in Southeast Asia and elsewhere, as exports of light industrial products taper off and protective measures increase. Various justifications for establishing heavy industries have been advanced, some of them *ad hoc* and others based on economic theories. This paper discusses briefly these arguments.

More basic than the problem of limited market size and scale economies is that of technological complexity and dynamism in the successful establishment of heavy industries. Also, their enormous costs mean that developmental funds must be taken away from agriculture and light industries. Hence, economists cannot ignore the capital-intensive industries which have important ramifications for the other sectors.

The paper first summarizes the various arguments put forward for heavy industrialization and in the second section defines and delineates the characteristics of heavy industries in an effort to examine the arguments. It then goes on to examine the postwar record and experience of heavy industries in Asia.

The most influential model of heavy industrialization asserts that in the early stages of industrialization, secular growth is maximized by increasing the share of investment at the expense of consumption, and raising the share of investment in the capital-goods industries relative to the share of investment in consumer-

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goods industries. The proponent is the Soviet economist, G. A. Fel'dman, whose model influenced Professor Mahalanobis to work out a similar model for India (see Domar, 1957).

The U.S.S.R. in the prewar decades and the East European bloc, China, North Korea and (through the Mahalanobis version) India in the 1950s, adopted the Fel'dman model and started their industrialization drive with the capital-goods industries which in practice translate into heavy and capital-intensive industries . The rationale of the model is that in the early stages of industrialization, the establishment initially of capital-goods industries will enable the country to produce machines and industrial materials for the consumer goods industries, and equipment and modern inputs (like chemical fertilizers) for agriculture, instead of relying on insufficient foreign exchange to import machines from foreign countries.[1] This will in turn enable the GNP to accelerate as productivity rises in the consumer industries and in the capital-goods industries with scale-economies as time goes by.

Another important theory is that of Hirschman (1958) which influenced developing private enterprise countries, particularly in Latin America to promote the establishment of heavy industries. The heart of the arguments presented is that the growth of developing countries must be induced and the trick to development is to provide as many inducing mechanisms as possible. The most important among such mechanisms is to give priority to industries which have the most and strongest linkages (both backward and forward interdependencies as in the input-output tables) in the early stages of industrialization. Hirschman finds the linkage-intensive industries to be iron and steel, nonferrous metals, paper and pulp, petroleum, and chemicals; and the low linkage-industries to be trade, services, fishing, electric power, agriculture, transport, mining, etc.

Finally, the infant industry concept advocates that given sufficient time, heavy industries can acquire scale economies, skills and experience, enough capital and so on to catch up and become inter-

[1]"In the long run, the rate of industrialization and the growth of the national economy would depend on the increasing production . . . . . heavy chemicals and heavy industries in general, which would increase the capacity of capital formation. Our important aim is to make India independent as quickly as possible of foreign import or producer goods so that the accumulation of capital would not be hampered by difficulties in securing supplies of essential goods from other countries." From the Second Five-Year Plan, quoted in A.M. Choki, *State Intervention in the Industrialization of Developing Countries: Selected Issues,* 1979.

nationally competitive. Other arguments by the advocates in Southeast Asia are more specific to the present period and conditions: that with increasing protectionism in the developed countries on labor-intensive, light industry exports, developing countries have no alternative but to shift to capital-intensive manufactures; that the NICs (the newly industrializing countries such as Taiwan and South Korea) have achieved rapid growth via heavy industries, and that if developing countries were to wait too long, the costs of construction of these large-scale projects will multiply with the rising costs of fuel and other items; and that when the world economy picks up in the near future, the present over-capacity in steel, petrochemicals, aluminum, copper and other basic industries will disappear and LDCs will again be at the mercy of the more developed countries. These issues will be examined in the next section.

2. The Structure of Heavy Industries: the Growing Complexity and Dynamism of Industrial Technology

There is a need to clarify the term *heavy industries*. In the foregoing section, we mentioned terms such as capital-intensive, capital-goods, and others used by engineers like upstream and downstream, process and assembly (or machinery), and high and low technology. These terms have been introduced at various stages in the development of industrial technologies and they need to be clarified. Probably the first to appear was the capital (or producer) – consumer good dichotomy which Marx used in Das Kapital.[2] As the industries became more and more mechanized and with larger machinery and factory, heavy industries began to be separated from the light ones. The heavy ones dealt with bulky, metallic products which required larger, more powerful machinery to process, convey and handle. Thus, the heavy-light dichotomy came to refer to the weight of the product and manufacturing process (including factory, machinery and other equipment) while the consumer-producer (or capital) goods designation referred to the buyers of the goods – whether they were the final or intermediate purchasers. But problems arose with both pairs of concepts, as manufacturing became much more varied and complicated.

[2] W.G. Hoffman (1958) in his classic study, *The Growth of Industrial Economies,* (a translation by W.O. Henderson and W.H. Chaloner of the 1931 German volume), found that the first stage industrialization was dominated by consumer-goods industries; in the second stage, capital-goods grew more rapidly until the third stage where there was a balance between the two. One might add that in the fourth stage, the capital-goods industries (on Hoffman's definition)dominate manufacturing, with the rapid growth of the machinery and equipment industries (see discussion in the next section).

The rise of fairly bulky products made out of chemicals, petrochemicals, rubber, wood and ceramics began to require large and heavy machines and other equipment. Some of these factories even required as much capital as some of the metal-working factories, especially those producing the smaller machines. The latter began to become increasingly important as electric/gas-driven technologies in the 20th century succeeded in mechanizing nearly all of the hand- and tool-operations in the factory. Economists began to use the terms, capital-intensive industries, instead of heavy industries, and labor-intensive instead of light industries, to measure the extent to which fixed capital was used by each worker.

Then, there arose many varieties of intermediate producers of semi-processed and finished materials as manufacturing became a much more roundabout process in the 20th century, making the producer-consumer goods dichotomy tenuous. Increasingly, the terms *upstream* and *downstream* industries came to be used. The former referred to industries located closer to the sources of raw materials (such as in mining, forestry, farming, animal husbandry) and the latter to the final consumers.

Moreover, the accelerating use of more complex machines in manufacturing gave rise to other terms: process versus engineering or assembly and high versus low technology industries. Industries using equipment, processes, and techniques embodying a great deal of complex scientific knowledge began to be known as high technology industries and these were found mainly in the heavy industries. Thus, the science-intensive industries were the technology-intensive industries and they tended to be technologically dynamic because of the rapidity of change in scientific knowledge (Foregoing based on T. K. Derry & T. I. Williams, 1960).

Process industries deal with the processing of raw materials into various types of finished materials which are shaped by engineering industries into components, accessories, parts and put together into machines and equipment. The main function of process industries is to change the form and shape of the original raw materials rather than to fabricate the latter into components and parts. Their operations are dominated by processes such as sintering, smelting, refining, casting, forging, rolling, squeezing, shearing, spinning, stretching, molding, and the like. By contrast, the operations of the assembly industries comprise boring, grinding, milling, joining, planing, broaching, drilling, turning, reaming, sawing, routing, welding, soldering, brazing and the like (De Garmo, 1977).

The process industries tend to be found upstream and their output tend to be unfinished, intermediate products sold to downstream engineering industries which in turn sell their output to other engineering firms or as finished products to final users, whether consumers or producers. Because the engineering industries do more fabricating than forming, they tend to use more labor per unit value of output while the process industries tend to be more energy-, material- and capital-using per unit value of output. The engineering industries are made up of establishments producing machinery and secondarily tools, fixtures and other equipment while the process industries comprise the manufacture of food, clothing, wood, paper, chemical, mineral and primarily metal products.

Following UNIDO's usage, heavy and light industries will be taken in this paper to be capital-intensive, including under heavy industry: paper and paper products (ISIC:341), industrial chemicals (351), other chemical products (352), petroleum refineries (353), miscellaneous products of petroleum and coal (354), non-metallic products (36), basic metals (37) and fabricated metal products, machinery and equipment (38) (UNIDO, 1979). This is contrary to traditional use but if the heavy-light dichotomy is to be retained, there is no other choice.[3] The concept of heavy industries is important as it brings in one group, the most capital-intensive and predominantly technology-intensive industries, producing hard, durable, expensive goods, with their processing operations typically located upstream and their fabricating and assembling operations downstream.[4] In terms of this definition, the traditional concept of heavy industries will comprise the hard-goods portion which in turn may be divided into processing and engineering.

The justifications set forth in the theories of Fel'dman and Hirschman and in the infant industry concept may have been relevant to the 19th century technology of the heavy industries but they are no longer valid to the technology in the 20th century, particularly in the second half of the century. This was implicit in the foregoing discussion of the changes in industrial terminologies. The machines of the First Industrial Revolution of the 19th century brought into the factory a relatively small number of simple, low-technology, labor-intensive equipment driven by water

[3]It may be convenient to use the terminologies, soft-goods and hard-goods within the heavy industries, the latter to refer to the last three ISIC groups, 36, 37, and 38.

[4]In *Structure and Change in European Industry,* p. 70, 1977, it is shown that European capital-intensive industries tend to be both skill-intensive and research-intensive. Because of the combination of the three, total factor productivity levels tend to be low.

and steam power. With the invention of electricity and internal combustion engines in the latter decades of the 19th century, and with shortages of unskilled workers in the United States in the early decades of this century, the Second Industrial Revolution ushered in a much more sophisticated technology largely based on science and powered by electricity and gas, together with the rise of the chemical industry in Germany. The mechanization of farms and factories accelerated as hand- and tool-operated operations became mechanized. In the second half of this century, machines became larger, faster, and fuel efficient, and in the 1970s much more automatic and versatile with the increasing use of microcomputers and robotics. With the wide application of science-based technologies, especially in the complex heavy industries, the pace of technological change increased.[5]

The rapid changes are difficult to measure directly. Indirect evidence however shows that the growth of energy use per worker (measured in horsepower) in U.S. industries rose from an average of 2 per cent per year in the period 1869 to 1919 to 5 per cent in the period 1920 to 1970. The engineering (or machinery) industries grew faster than the rest of the manufacturing or process industries (food, textile, wood, ceramic, chemical, rubber, primary metal and non-ferrous metal industries). The engineering industries employed 17 per cent of the manufacturing labor force in 1899 in the U.S. but by 1978 the share rose to 42 per cent. The rise of the machinery industries reflects not only the widespread use of machines but also the dynamic character of technological change since these industries are the chief source of new technologies. A more direct evidence of accelerating technological advance is perhaps the number of inventions patented which rose from a cumulated total of 1.3 million in the half-century, 1870 to 1920, to 2.2 million in the following half-century.[6]

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[5]The foregoing is a summary of my paper, "The Growth of Factor Productivity in the U.S.: The Significance of New Technologies in the Early Decades of the 20th Century" (*Journal of Economic History*, forthcoming.) The displacement of skilled workers and technicians by microcomputers is ushering in the Third Industrial Revolution. It seems to me preferable to relate the stages of industrial technology development to its impact on labor. See my note in the *Malayan Economic Review* on dualistic theories of growth (October 1981) on the impact on unskilled workers of the First Industrial Revolution and the impact on skilled workers in the Second Industrial Revolution.

[6]Horsepower statistics computed from *Historical Statistics of the United States,* combined for later years with kilowatt hours from *Statistical Abstract of the U.S.* and OECD, *Labor Force Statistics, 1967-1978;* patent statistics from *Historical Statistics, ibid.*

The dynamic nature of technological change is also evident in the growth of technical literature. It is reported that "50,000 scientific journals containing some 2,000,000 articles appear annually, and it is estimated that the volume of technical literature published more than doubles every ten years" (UNIDO, 1969, p. 1).

These patent statistics may understate the acceleration of technological change if one assumes that science-based inventions are more substantial than other types and that there were more science-based inventions in the later decades. One rough indication of this assumption is the rise in the number of engineers per invention patent issued, i.e., from 2.5 in 1900-1920 to 5.2 in 1920-1940, to 12.9 in 1940-1960, and to 18.9 in 1960-1970. If data were available for natural scientists for the early decades of this century, the number of engineers and scientists per patent may indicate an even faster growth. For the postwar decades, data on the number of scientists and engineers employed in R and D work are available; their share in the total number of scientists and engineers increased from 28 per cent in the 1950s to 35 per cent in the 1960s and declined to 25 per cent in the 1970s (the last reflecting the sharp fall in R and D expenditures in the United States.)[7]

The rapidity of industrial technological changes has produced complications in at least three directions. First, the primary (or basic) process heavy industries located upstream became not only capital-intensive and scale-economic but also technology-intensive. Instead of a few, simple machines, the mechanical process became an interconnected complex of varied fixtures, machines, conveyors, and equipment running more or less automatically with electronic guidance and a large force of technicians. For example, the 19th-century iron and steel industry looked more like a combination of large construction and mining industry with droves of unskilled workers shovelling coke ore, etc. into the blast and open-hearth furnaces and so on. Today, the industry is an integrated system of a half-dozen huge complexes of plants, automatically run by technicians and engineers from control rooms with only a small force of skilled and unskilled workers on the plant floor. The whole system is comprised of continuous, syn-

[7]Data on engineers and scientists from *Historical Statistics of the United States Colonial Times to 1970* and *Statistical Abstract of the United States, 1970.* A-M M' Bow head of UNESCO, noted that there were 5000 research scientists and engineers in the U.S.S.R., 3500 in Japan, 2700 in the U.S. (per million population) compared to 99 fo Asia (other than Japan, China and India), reported in *Business Day*, Manila, March 23 1982.

chronized processes, beginning with the smelting of iron ore into pig iron in the blast furnaces, the conversion of pig iron into steel in other furnaces, and then the continuous casting of liquid steel into bars, slabs, billets, and blooms. These complexes are too large to be housed in factories, which are increasingly replaced by plants in the industrial technology of the 20th century. They require expensive spare parts and readily available repair work by experienced technicians to keep the complexes functioning smoothly and at a high capacity.

The growth in technological complexity can be measured only roughly. The available data on KWH of electric power used per worker in the primary metal industries rose by about seven times between 1931 and 1962 and eight times in the paper and chemical industries between 1912 and 1954. Much of this rise may be interpreted to mean that more and more hand- and tool-operated processes were mechanized and faster, more powerful machines replaced older ones.[8]

Secondly, beyond the primary stage, many of the semi-finishing process industries mid-stream have become complex. In the iron and steel industry, large amounts of capital must be invested in hundreds of establishments manufacturing many different types and sizes of semi-finished steel products using complex rolling mills and foundries.[9] Similarly, the lower stream industries using the smelted copper, aluminum, nickel, and the petrochemical feedstocks have become large and complex industries. For the other primary process industries such as cement, glass, and oil refining, there are fewer large and complex middle-stream industries. These may be called simple, primary process industries in contrast to the more complex primary process industries such as steel, aluminum, copper, and petrochemicals. In the simple ones, most of the output goes directly to the final business users, be it the construction industry in the case of cement or the gasoline stations in oil refining.

In the complex processing industries, most of the domestic demand for the metal smelters and naptha crackers must come

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[8]Computed from *Historical Statistics of the United States, Colonial Times to 1970*, Part 2, pp. 828, 673-677; and *National Income and Product Accounts of the United States, 1929-74*.

[9]In Japan, in 1978 nearly 10,000 establishments were reported in the basic iron and steel industry, and in the small Korean industry, about 500 in 1980.

from the middle-stream industries. If many of the latter industries do not exist, the demand will be small, no matter how much a large country (such as India) consumes yearly of finished steel products (UNIDO, 1981, p. 145). The quality of the steel and other metal products (in the form of blooms, slabs, bars, and billets) must be good if they are to be purchased by the middle-stream industries. The metallurgy is extremely complex. For quality to be good, there must be competition among the producers of each type of semi-finished products but the markets are small and capital scarce for more than one or two firms in many of these industries in the LDCs. And where there are many, the sole possession of a license to use the most advanced technology may confer monopolistic power to one or two firms over the rest.

The problem of establishing good-sized, competitive, middle-stream industries producing quality semi-finished products is not an easy one. This is because these industries in turn depend on the demand of a wide range of the downstream industries producing final or nearly final products, namely the assembly and the construction industries and a host of miscellaneous manufactures ranging from textiles, plastics, metals, machinery, construction and other industries.

This leads to the third complication imposed by 20th century technology. The users of the output of the middle-stream industries in both the metal and petrochemical industries are scattered among enormous types and numbers of small, medium and large firms both in the engineering (in the case of metals) and processing (in the case of petrochemicals) industries. For example, the input-output tables of Japan for 1975 show that three-fourths of the total output of primary or basic iron and steel and other metals were sold to the metal-fabricating industries producing machinery, appliances, transport equipment and precision instruments. In comparison, non-metallic mineral industries (like cement) sold three-fourths of their output to construction and public utilities. In the paper and pulp and petroleum product industries, about one-half was sold to wholesale and retail outlets *(Statistical Yearbook of Japan,* 1981).

The users of most of the output of the middle-stream, metal industries are not only the large-scale manufacturers of such products as automobiles, ships, heavy machinery and so on, but also hundreds of thousands of small and medium producers (about 300,000 in Japan in 1978) of components, parts, and accessories. Without these producers, the large-scale assemblers cannot operate.[10] The high quality of these subcontractors is vital not only to the quality of the small, and large downstream assemblers of cars, ships and machines but also to the efficiency and quality of the middle stream industries. However, the quality of subcontractors is low in LDCs as it takes extensive experience to upgrade their performance, a process which requires external assistance over a long period of time. The coordination between assemblers and subcontractors is vital but the institutions for this are weak in developing countries.

Therefore, in the establishment of these complex process industries, not just the industries upstream but those in the middle stream and downstream, should be taken into account. Furthermore, not only the material, energy, capital and domestic demand requirements but also the technological (including higher level manpower) requirement need to be considered. Otherwise, the domestic demand for the output of the costly metal smelters and naptha crackers will be short of full capacity and export markets must be sought. But because the smelters and crackers built are likely to be of minimal scale, they will not be able to compete internationally. Developing countries may be forced to subsidize exports, and even then may have difficulties if quality problems are not solved.

All three problems – insufficient demand from downstream industries, too costly subsidies, and poor quality of the product–together with the inability to solve day-to-day technological problems of repair and maintenance, may combine to produce low rates of capacity utilization, making this the major obstacle (in the short run) in the growth of heavy industries in the developing countries. For, with low rates of utilization, earnings will be insufficient to meet high overhead costs, leaving little for undertaking expensive R & D efforts and providing costly replacements for obsolete parts and units. Thus, instead of growing and catching up, the "infants" may fall behind as the superior and larger R & D efforts in developed countries bring about rapid technological change. The foregoing appears to me the major mechanism by which the heavy process industries in developing countries fall behind those in the developed

[10]Toyota Motors alone is said to have more than 30,000 subcontractors.

countries. The reason for the rapid progress of these industries in developed countries is as follows.

For the larger developed countries, the iron and steel stream of industries (including the heavy machinery industries) is important in their status as economic and military powers. Despite the great costs of R & D and maintenance of the industries in competitive shape, this stream of industries has to be kept economically viable during peacetime to be able to switch quickly to a war economy which can produce the tanks, planes, ships, and other military hardware.[11] Thus, no effort is spared to keep them technologically in the forefront.[12] Thus, it is well-nigh impossible even for large developing countries like Brazil, India, and China to spend the amounts needed in R & D and to purchase the technologies to keep their iron and steel and other industries abreast of the leading steel makers in the developed countries.

R and D expenditures in Argentina, Brazil, Mexico, Colombia and Venezuela in the early1970s averaged 0.2 per cent of GNP an in India, Korea, and Philippines 0.3 per cent compared to 2.0 pe cent in the United States, Japan, France, Germany and the Unite Kingdom. Moreover, the expenditures in the latter countries wer concentrated in the high-technology sectors of machinery, chemical basic metals, transport and aerospace which accounted for 85 per cent of the total R & D expenditures in 1975. In developing coun tries, a major part must go into agriculture, physical infrastructure mining, health, education, and so on.[13]

Then, too, even if the funds were available, the developin countries may not have the large, experienced staff of R & D man power to keep them technologically in the forefront. A broad arra of specialized scientists and engineers with long experience in field such as electronics and metallurgy may not be available if the othe industries in non-ferrous metals, chemistry, lower-stream processin

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[11]This explains the large subsidies given to the shipping industry to keep a minimu number of ships afloat in case of war.

[12]And the recent emergence of electronically-guided technologies has made th iron and steel stream of industries much more complex. The attraction of heavy industrie for military reasons even in developing countries such as India and South Korea will b subsequently shown.

[13]Computations based on the UN *Statistical Yearbook*, 1976, pp. 867-868, an GNP data from IBRD *World Development Report,* 1980. Sector expenditures taken fro OECD *Industrial R & D in Selected Member Countries, 1967 to 1975,* pp. 114-140, 197

and engineering industries are not well developed. The research externalities may be large in 20th century technologies which must provide for highly interconnected, integrated, synchronized manufacturing processes throughout a stream of industries. This is in addition to the problems of scale economies in research.Therefore, if we are to point to any single factor, it is technological capability (even more than markets, capital and labor supplies) that is becoming the strategic resource in the development of nations.[14]

If the foregoing is valid, the infant industry arguments take on a new light. They may apply in the long run to the simpler process industries such as cement, textiles, rubber, glass, pottery, food, wood, fertilizers and others,which do not mainly depend for their demand on a large group of fairly capital- and technology-intensive industries lower stream. In these industries, the opportunity to catch up may be good if other conditions are satisfied, such as raw material availability, cheap power, sufficient consumer demand, and skilled labor supply.

For the complex process industries, on the other hand, some infants may succeed only if exceptional conditions are satisfied. In iron and steel, aluminum and copper smelting, chemicals and petrochemicals, paper and pulp, the need extends beyond cheap raw materials and power. Here, the technological complexities in the upstream industries will require a highly experienced staff of engineers and managers to supervise the operations of the facilities, and the complexities lower-stream will require that the demand over and above local lower stream demand, be assured of a market abroad. If these conditions are not satisfied, the "infant" may take too long to "grow up" and in the meantime the effort to nurture it along in the form of protective tariffs and subsidies may stunt the growth of the lower-stream industries and the simpler process industries listed above (via "cost- and quality-cascading").

The heavy assembly industries such as automotive, shipbuilding, and heavy machinery need a large and varied group of small and medium industries to supply the parts and components for the

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[14]We should'nt neglect the institutional aspects. These are very important as shown in the rapid strides made by Japan in new production (or applied) technologies. Much more than in scientific and basic technology R & D, applied technology R & D requires the close cooperation of large groups of highly specialized technical manpower. See my article "Reinterpreting Japan's Postwar Growth" in the *Economic Development and Cultural Change*, October 1982, pp. 1-43.

assembling establishments. It takes some time to develop the efficiency and reliability of these latter industries which must meet the exacting demands of time and specifications for the more complex parts and components of the heavy assembly industries. If a major portion of the more important parts and components has to be imported, the costs of the assembled products will be too high such that they must all be sold domestically. Consequently, the size of the domestic market will restrict the scale of the plant as in the case of automobile assemblies in developing countries. In the case of large-value products such as in shipbuilding where the engine forms a small part of the total cost, the import of complex components will not push the total price beyond world market prices, and being labor intensive, the shipbuilding industry can grow up to be a competitive adult.[15]

Howard Pack points out that "a principal requirement of the entire mechanical-engineering sector is the development of a subcontracting network. In the machinery sector of the advanced countries, subcontracting has proved to be important in reducing costs . . . . the subcontractors must be efficient and reliable. The evidence in the country studies surveyed in this paper suggests that subcontracting, although extant in some countries and in some sectors, is limited. This results partly from the unreliability of existing subcontractors in meeting delivery dates and quality specifications, partly from their relatively high costs." Pack goes on to cite the case of the largest Indian machine-tool producer purchasing only 10 per cent of its inputs externally compared to a counterpart Western European firm's 40 per cent, and that among 250 suppliers of components to the Indian textile-machinery industry, only 10 produced high quality components.[16] The low quality of subcontracting firms inhibits Taiwan's automotive industries and Korea's heavy machinery industry despite the fact that small industries are extensively found in these countries and account for a large portion of manufacturing output and exports.[17] Pack notes the high costs

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[15]This is true of South Korea which still imports the large engines needed for the bigger ships.

[16]Howard Pack, *Fostering the Capital-Goods Sector in LDCs: A Survey of Evidence and Requirements*, pp. 16-18, 1980. See also forthcoming study on ancillary firms in Asian automotive industries by the Council for Asian Manpower Studies, edited by S. Ishikawa and K. Odaka.

[17]See Jack Baranson, *The Automotive Industry in the Republic of China: An Appraisal*, 1970.

of coordination between assemblers and subcontractors as an obstacle to efficiency.

However, the major obstacle in most of the heavy machinery industries is the lack of sufficient capability in research personnel and facilities and of funding for large-scale R & D efforts to be able to match those of industries in the developed countries. Again, the speed of technological changes in the latter is likely to leave the industries in developing countries far behind. It must be remembered that these heavy engineering industries are part of the iron and steel stream, which is so important in the economic-military power of leading countries. Even a powerful president as Eisenhower complained of the power of the military-industrial complex of corporations in Washington.

The chances of the "infant" growing up is small in fields where design changes are rapid, where the technology involves competence in complex areas of chemistry, physics, metallurgy and electronics, and where much subcontracting of complex components is necessary (Pack, 1980, p. 56). But there are many areas in the vast sector of the engineering industries where these conditions are not found and where the abundance of labor relative to capital can have its full play.Therefore, heavy industries and "big projects" are not the only alternative to increasing protection in light industry products. One outstanding characteristic of 20th century industrialization is that most of the industries are located not upstream or downstream but at the upper, middle or lower stream where a wide choice of industries not requiring too much capital, scale economies, externalities, and above all, high level manpower for production and research is found.[18]

As to the Hirschman's linkage theory, it is not sufficient just to add up linkages as found in the input-output tables. Some linkages require too much capital, scale economies and above all high technological skills which are scarce in developing countries;

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[18]Even in mining where technology is relatively simple, the "infant industry" argument is difficult to realize, and the Philippine mining industry starting strong in the 1950s appears to be falling behind in the 1970s and in the 1980s according to Jaime V. Ongpin, head of Benguet Corporation. "With few exceptions Philippine professionals have not been able to keep up with major recent advances in many aspects of mining technology . . . . the technology gap will widen further . . . . ." *(Asian Wall Street Journal,* November 9, 1982).

industries can only be developed therefore over very long periods of time and with enormous costs. It is better to start with industries whose linkages are within the endowment, capabilities, and, in general, comparative advantages of developing countries. If there are not enough such industries, why not even enclave industries like cement and chemical fertilizer which may be badly needed in construction and agriculture instead of iron and steel, petrochemicals, and aluminum? The enclave heavy industries can supply opportunities for learning and experience.

The Fel'dman-Mahalanobis model may have been appropriate for the 19th century when the technology of the capital-goods industries relative to that of the consumer-goods industries was fairly simple and slow-changing. This is unfortunately no longer the case with most of the big, heavy industries–both processing and assembly–in the latter half of the 20th century. In these, the demand for the output of the primary or upstream industries is largely dependent on the intermediate or middle-stream industries and the demand of the latter dependent on the final or downstream industries. But in the technological learning process, in the heavy *process* industries it is easier to start with the simpler downstream industries and go on to the middle-stream and then to the upstream where the most complex ones are found, both for operation and research. In the heavy engineering industries, it is better to start with the simpler, labor-intensive making of components and parts (most of which can be exported without tariff obstacles) and then go on to the sub-assembling industries and finally to the main assemblies.

The Fel'dman-Mahalanobis model starts with the primary process industries and the downstream engineering assemblies, and this nearly always means that the output of these industries is both high-cost, and low-quality at the outset. In the heavy engineering assemblies, product design becomes obsolete with time since R & D capabilities are inadequate in LDCs, especially compared to DCs. This , in turn, slows down the technological progress of the heavy process industries, which, together with problems of maintenance and management, keeps the costs of their output high. High costs and poor quality in both types of heavy industries inevitably bring about extreme protective measures to keep out imports. There is then "cost- and quality-cascading" on the light industries which are forced to buy obsolete machines and high cost semi-finished materials. With cost-cascading, the labor-intensive light industries are unable to export. The foreign exchange saved from secondary import-substitution is offset and even cancelled by the inability of the light industries to export. And the high cost of manufactures domestically tends to reduce domestic consumption and therefore the industrial growth rate.

Moreover, because of the great costs of establishing a wide range of heavy industries, most of the financing must come from the central government in the developing countries where other manufacturing industries are not well developed and cannot invest. After establishment costs are sunk, the maintenance, replacement, subsidies, and deficits must be borne by the government. All this must be at the expense of the government's assistance to agriculture, light industries, to infrastructure construction, social development, all of which fall behind those of other LDCs with a different strategy of development. All these, together with the high cost of manufactures, tend to reduce the savings rate. The growth not only of industries but of other sectors tends to slow down in the long run. The end result is an insufficiency in the growth of aggregate domestic demand for manufacture in general, which together with technological and management problems on the supply side in the heavy industries, underlies the slow growth of industry.

Furthermore, income distribution will tend to be unequal since the available capital is spread to only a few highly paid workers. If it were instead made available to labor-intensive, light industries, the number of firms and workers affected would be greater. For example, if one billion dollars, instead of being used to construct an iron/steel complex, were to be spent to produce textiles, food processing, wood products, small and medium machinery shops, of an average investment of $100,000, the number of firms created will be 10,000 and the number of jobs, one or two million instead of one or two thousand.

Incidentally, the argument that heavy industries must be established now to avoid higher costs in the future overlooks the possibility of higher costs of future construction of physical infrastructure such as dams and irrigation works in agriculture, and a wide range of public utilities whose priorities may be higher. This is particularly so because such infrastructures are not subject to as rapid a rate of obsolescence as the plants in the heavy industries, nor likely to generate external diseconomies as in the case of cost- and quality-cascading.[19]

Southeast Asian public authorities also argue that after a few years when the world economy picks up, there will again be shortages of primary heavy industrial materials and developing countries will be at the mercy of the suppliers. But the main question economists are now asking is: when the world economy picks up, how vigorous will the recovery be? If we are in for a slow-down as in the 1930s, the recovery is not likely to create a seller's market in most of the heavy industries where excess capabilities are reported to be enormous. Even with a recovery that puts the industrialized countries back on the historical trend line of a growth of 2 per cent per capita GNP instead of 3-4 per cent, the excesses may not disappear. The period of gestation of heavy industry complexes from the planning stage is three to five years, and during the high growth years of the mid-1970s, many projects were started not only in the developed countries but also in the NICs and LDCs and these have come on stream during the recent years. Moreover, the developed countries may have entered the downward phase of the long swings which have interacted with trends and cycles during the past century or so in nearly all the industrialized countries.[20]

3. Postwar Asian Experience in Industrialization

How well did the various Asian countries industrialize their economies? In particular, how was the performance of less developed countries emphasizing heavy industries in their development strategy? In looking at these issues, it would have been instructive to refer briefly to Latin American countries such as Mexico, Brazil,

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[19]The high risks due to technological obsolescence can be illustrated as follows: in the petrochemical industry, the rise of natural gas technology to produce the raw materials for plastics, etc.; recently, the use of blast furnace technology to replace the electrolytic processes in aluminum; the elimination of reheating, by linking continuous casting with hot rolling mills and attempts to reduce the thickness of plates by one-half in iron/steel. Risks occur also because of raw materials/energy depletion (in the case of the Malyawata in Malaysia with the exhaustion of iron ore and cheap wood to make charcoal for the blast furnace).

[20]See my article "Perspective on the Prospects for Southeast Asian Growth in the 1980s," *Journal of Philippine Development,* 1980 for a brief review of the nature of long swings as given by Moses Abramovitz of Stanford in the Appendix Note, pp. 110-116.

Venezuela and Argentina who have adopted the heavy industrialization strategy, but time and resource constraints did not make this possible. (But note the problems they are facing today in their repayment of debts much of which was contracted for big projects).

Table 1 uses value added per worker, kilowatt hours per worker and capital stock per worker to measure capital intensity. The best measure is probably value added per worker, partly because it includes not only material capital but also human capital and thereby takes into account technology intensity. This can be a disadvantage if one is interested only in material capital intensity and not in either skill intensity or technology intensity. But because the degree of competition and the extent of labor union power vary from industry to industry, value added per worker may include more than capital intensity. Also, this is probably biased upward since the larger the firms in an industry, the lower the degree of competition and the higher degree of union power, assuming that the large firms tend to be more capital- and technology-intensive. But there are exceptions as in the traditional printing trades which have strong labor union traditions though labor-intensive, and in various light engineering industries which are skill-intensive but not necessarily technology-intensive. Increasingly, modern technology using electronics is separating skill intensity from technology intensity by replacing highly-skilled occupations with electronic technology, as in the most recent machines in the printing industry. Also, there are many other forces distorting relative prices such as protection, subsidies, and so on for developing countries.

Kilowatt hours per worker has an advantage over the other two measures for inter-country comparisons because there is no need to convert various currencies to a common currency. Recent studies of purchasing power parities show how greatly undervalued the currencies of less developed countries are, and therefore over-deflating occurs when exchange rates are used in converting to a U.S. dollar basis. But purchasing power parities do not take into account large quality differences in the products between less and more developed countries, so that it is difficult to know what the true basis of conversion should be. The major limitation of using energy per worker is that energy requirements vary among industries; some, as in the technology of alumina smelting require much more than, say, light engineering. Aside from energy requirements dictated by technology, the industries dealing with bulky and heavy products need more energy for moving and hauling their inputs and outputs.

Capital stock directly measures capital intensity and, is therefore, the best from a conceptual point of view. However, difficulties are encountered in collecting good data, particularly in times of rapidly changing prices, and in allowing for depreciation and obsolescence in periods of rapidly changing technologies. Moreover, it is often not the stock of capital but the flow of services from the stock of capital which is of interest. In this case, there is an upward bias for industries like iron and steel and petrochemicals with large, expensive plants and structures. Both value added and capital stock per worker must be deflated overtime by prices and the longer the period covered, the more difficult it is to take into account quality changes. These comments on the limitations of the various measures of capital intensity partly show that small differences in comparisons both overtime and between countries should not be taken seriously. This is, of course, true also of data from the national accounts, input-output tables, and other sources of macro measures.

Table 1 shows a summary of the overall record of postwar industrialization of Asian countries (and for comparison with industrialized countries). The industrial growth of East and Southeast Asian countries is impressive whether compared with Western countries or with India.[21] The growth rates of Japan and Hong Kong in East Asia are low primarily because they were early starters in the postwar years and South Korea the late starter. And the surprisingly high rates of Malaysia, Thailand and Singapore are partly due to the low base of manufacturing with which these countries started out in the early 1960s, especially as compared with India and the Philippines which initiated substantial industrialization in the 1950s. Indonesia began its industrialization in the mid-1970s.

[21] Strictly speaking, the term industrial is broader than manufacturing, including mining, construction, transport and communication, and public utilities but the growth of these sectors parallels those of manufacturing which is overwhelmingly the largest and the most dynamic segment of the sector.

TABLE 1 – Postwar Growth and Levels of Industrialization In Selected Countries of Asia and the West

	MANUFACTURING			Average Annual Growth Rate of GNP Per Capita (1960 to 1980)
	Average Annual Growth Rate (1960-80)	KWH Per Worker (1978)	Product Per Worker in US $ (1979)	
	1	2	3	4
Western Industrialized Countries	3.9%	21,357	23,605	2.9%
United States	4.1%	38,470	26,778	2.3%
Germany, Federal Republic	3.8%	20,734	32,126	3.3%
United Kingdom	1.7%	13,323	13,798	2.2%
France	5.1%	18,295	27,184	3.9%
Australia	4.9%	–	18,137	2.7%
East Asia	12.9%	13,003	9,137	7.2%
Japan	8.7%	23,479	21,921	7.1%
Taiwan	15.1%	10,300 (1)	6,270	7.4%
South Korea	17.1%	8,922	5,239	7.0%
Hong Kong	12.4%	–	3,700	6.8%
Singapore	11.3%	9,309	8,553	7.5%
Southeast Asia	9.5%	6,393	3,027	4.0%
Malaysia	11.8% (2)	7,125	4,310	4.3%
Philippines	7.0%	7,438 (3)	3,680	2.8%
Thailand	11.0%	6,548	2,969	4.7%
Indonesia	8.1%	5,348	1,149	4.0%
India	4.9%	–	3,446	1.4%
China	10.0% (4)	6,232	2,220 (6)	2.7% (5)

Footnotes:

(1) 1977
(2) 1970-80
(3) 1975
(4) Average annual growth rates of industry
(5) 1957-79
(6) Value added per worker of industry

Notes: Group average are simple averages. Column 1 represents compound rates measures by value added in manufacturing (constant prices). Columns 2 for Germany, Singapore, Thailand, and Philippines cover only those establishments with 10 or more workers, for Australia (4 or more), for Malaysia and South Korea (5 or more), and for Thailand (10 or more). Growth rates of manufacturing in the 1950s were high in Japan (18.3%), Philippines (10.0%) and probably Hong Kong. Malaysia's value added per worker like that of Singapore may be overstated compared to other Southeast Asian countries because of the higher proportion of output traded internationally. See Kravis et al., *op. cit.*, p. 9.

Sources: Columns 1 and 4 from *IBRD World Development Report 1982* except column 4 for China from IBRD Report on China (Main Report, p. 47); column 2 computed from *UN Yearbook of Industrial Statistics, 1978,* Volume 1 and pertains to manufacturing; column 3 computed from *IBRD World Development Report 1981* (for dollar product in manufacturing) and *ADB Key Indicators* and *ILO Yearbook of Labour Statistics* (for data on manufacturing employment). Thailand data in col. 2 computed from *Report of 1978 Industrial Census.*

In attempting to measure the capital intensity of manufacturing industries as a whole and the heavy industries in particular, we ran into some difficult problems because of the uneven coverage of very small enterprises (less than 5 or 10 employees) in the censuses of industries of various countries. These differences must be adjusted in the future, as value added or KWH per worker is significantly affected by the large number of very small firms in some countries. Fixed capital data are probably too unreliable for most countries due to the rapid changes in prices. The (US dollar) value added per worker shown in Table 1 probably understates the capital intensity of Taiwan and South Korea because the foreign exchange rate used overdeflates value added in local currencies, compared to purchasing power parities noted above.

For these countries, KWH per worker may give a better notion of capital intensity. As noted in the footnote to Table 1, because Singapore and Philippine data exclude firms with less than 10 workers, capital intensity is overstated, although not as much in Singapore where the smaller firms are not proportionately as important as in the Philippines. But the value added per worker in U.S. dollars may be understated for the Philippines and Malaysia due to the use of foreign exchange rates, as noted above for Taiwan and Korea. This is probably true also for India, where the purchasing parity gives a per capita GDP three times that of the exchange rate deflation in 1973, as in the case of the Philippines (double for Malaysia and South Korea).[22] With these adjustments in mind, we may conclude that capital-intensity by the latter 1970s was high for both Taiwan and South Korea in East Asia, as high as Singapore, and all three higher than Hong Kong. In Southeast Asia, the Philippines probably has the highest capital intensity, followed closely by West Malaysia, then Thailand and Indonesia. We turn now to a brief review of industrialization in some of the countries in Asia.

City-States: Hong Kong has substantially lower capital intensity than Singapore. The textile industry and the labor-intensive engineering industry such as watch-making predominate in Hong Kong manufacturing while Singapore, lacking an industrial enterpreneurs class, had to depend on foreign investment which tended to be on the capital-intensive side, even in the engineering industries.

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[22]See Kravis, Heston, and Summers, *International Comparisons of Real Product and Purchasing Power*, p. 10, 1978.

Remarkably, without any assistance from the government which pursued laissez-faire in 19th century British tradition, Hong Kong has been able to maintain high and stable rates of growth. This is because of the labor intensity of manufacturing which requires very little government intervention and the presence of an experienced industrial class from China. In this respect, Hong Kong and Singapore are very much like Switzerland. Being tiny city-states without agriculture of any significance, both countries had to import most of their food requirements, the most important commodity in the basic needs of any country. To be able to import food, they had to export manufactures and services, traditionally in the form of entrepot trading. In the postwar decades, with the rise of independent China (and Indonesia in the case of Singapore), entrepot trading ceased in Hong Kong and declined substantially in Singapore. Without natural resources (either mineral or energy), these countries had to depend on manufacturing which had to be exported immediately without a period of protection for "growing up" (since food must be imported each year). Thus, efficiency in manufacturing was a matter of life and death. Hong Kong was fortunate to witness the influx of a large number of entrepreneurs and technicians from China, especially from the textile center, Shanghai, but Singapore had to open its door wide, improve its public infrastructure and human resources to attract investment, entrepreneurs and technicians from everywhere. Singapore's successes with a relatively more capital-intensive industrialization was due to its ability to attract not only the capital but also the managers/technicians and technology, indeed the entire enterprise from the advanced countries. There was a brief interlude with import substitution in the early period in Singapore, but it was dropped when full employment was reached. And recently the last remnant of it was abolished with the closing down of the car assembly industry. One major mistake was Singapore's decision to build a huge petrochemical complex with Japan's multinationals, which today is a source of great worries for all concerned.

South Korea and Taiwan: Both did well with exports from their labor-intensive industries but with full employment, they began to move into heavy industries in the 1970s, Taiwan somewhat earlier and more gradually than South Korea. The continuing success of labor-intensive exports during most of the 1970s, together with the construction of heavy industries in the 1970s made for rapid growth of manufacturing. But as these heavy industries came on stream in the late 1970s, plans for further extensions have been dropped or postponed, until the mid-1980s.[23] Due to the substantially cheaper production of olefin from natural gas in the United States and the Middle East, Taiwan and South Korea's petrochemical industry (and also that of Japan) faces a bleak future while the output of their iron and steel industry must be subsidized to compete with Japan. (Similarly with Taiwan's aluminum smelter against United States and Canadian smelters and South Korea's copper smelter). In the near future as Japan's iron/steel industries develop new technologies, the subsidy will have to be increased.[24] These and other heavy industries of both Taiwan and South Korea, meeting head-on the competition from those of developed countries, are likely to contribute to the slowdown of the growth of the overall economy in the 1980s. Particularly serious is the situation in South Korea which moved too rapidly and massively into heavy industries in the latter 1970s. With large interest payments incurred in the massive borrowing required and with its agriculture and light industries not developed as well as in Taiwan (partly due to the Korean War which retarded South Korea's development efforts and the shift of funding to heavy industries from agriculture and light industry), Korea's inflation problem became serious in the late 1970s as labor and food shortages became severe.[25] (See Appendix Table 3.) The haste with which South Korea moved into heavy industries suggests that military requirements may have been partly in the minds of the military rulers and it is reported that Korea plans to put the unused capacities in the heavy industries in heavy machinery and shipbuilding to the production of tanks and destroyers, and in the petrochemicals into munition production, fo internal use and exports.

[23]See *Ten-Year Economic Development Plan for Taiwan, Republic of China (198 1989)*, 1930 and revisions in latter 1981; *A Summary Draft of the Fifth Five-Year Econo mic and Social Development Plan, 1982-1986*, Economic Planning Board, Republic o Korea, 1981; *Industry in Korea, 1980*, and long-term plan documents for the earlier perio for a listing of heavy industrial projects.

[24]Korean steel is about 10 to 20% higher in costs. See *Comparative Advantage o Manufacturing Industries in Asian Countries*, 1982, pp. 224, 232-233. Another troubl some industry is the heavy engineering complex built recently at Changwon which is bei operated at less than 25% capacity. It is unable to sell the electric generators and tran formers abroad as their designs are five years behind. More fundamentally, the small a medium subcontracting firms are not able to produce quality parts and components.

[25]The debt problem faced by South Korea is similar to that of the Latin Americ countries such as Mexico, Brazil, Argentina and Venezuela which have gone in heav for capital-intensive industrialization.

Despite its difficulties with the blast furnaces, petrochemical crackers and aluminum smelters, Taiwan may be somewhat better off in the 1980s compared to South Korea. Besides a more developed agriculture and textile industry, Taiwan's "backward integration" strategy called for moving from downstream to middle stream (intermediate industries) instead of from upstream to downstream industries. In 1980, Taiwan's labor force in agriculture was 20 per cent of the total compared to Korea's 34 per cent.

The immediate problem for Taiwan and South Korea is more the lack of energy and raw materials resources in the heavy processing industries and the lack of resources for innovative R & D needed to develop heavy engineering industries such as automobiles and heavy machinery. In the long run, R & D will be a problem for both types of heavy industries besides institutional problems. Fortunately, the main focus of their latest plans has shifted to more labor-intensive and technology-intensive sectors in engineering. After a decade or so of trying to develop their own auto industry, they are now in the process of going into joint ventures with the Japanese auto industry.

India: Instead of developing light industries for exporting and agriculture to cut down food imports (as was the case in Japan in the 1950s, Taiwan in the 1950s and 1960s, and South Korea in the 1960s), India plunged in the latter 1950s into the construction of a wide range of upstream heavy industries (iron and steel, aluminum, copper, heavy engineering, chemicals, cement, paper and pulp, and "necessary auxiliaries like transport").[26] Once this fateful decision was made, India has been compelled to spend enormous amounts of its budget to keep afloat this broad range of heavy industries which with few exceptions after two decades have not been able to meet international standards of competition. The costs incurred by the heavy industries have left insufficient funding for agriculture and light industries both of which were unable to export sufficiently to finance the imports of heavy products. Hence, India is forced to depend on its own heavy industries for heavy products. And the original goal of accelerating the growth of the overall economy by establishing heavy industries has been thwarted by the poor quality of the machines and equipment of India's

[26] See *Second Five-Year Plan*, p. 51, Government of India, 1956; also *Third Five-Year Plan and Fourth Five-Year Plan.*

engineering industries, and the high cost of the basic, primary industrial materials of its heavy processing industries. Poor quality and high cost "cascading" in downstream industries, especially light industries, restricted sales at home and abroad.

The goal of self-reliance and freedom from the technology of the developed countries appears to have been virtually abandoned as one industry after another continue to depend on licensing from abroad for its new technologies, the most recent being the state automobile, steel, aluminum, and petrochemical industries. After valiant attempts to develop an indigenous automobile, negotiations are now underway for a joint venture with a Japanese automobile company. The steel industry, after setting up "elaborate facilities for the manufacture of equipment, and for the design and consulting services that would permit it to dispense with foreign expertise in the construction of future steel plants," has now awarded a British company a $2.8 billion contract to build a new steel mill which will incorporate recent Western technologies.Similar arrangements were previously concluded for an aluminum smelter and a petrochemical complex (International Herald Tribune, 1981). As one reporter puts it: "Self-reliance involves a large and efficient research and development base and an ability to transform the results of that R & D into economically viable industrial mass production. Twenty-five years after the Second Five-Year Plan the Indian economy (industrial) is largely a licensed one. . . While it has the third largest reservoir of trained scientific manpower in the world, the R & D does not meet the needs of the country" (International Herald Tribune, 1981, p. 6s).

But more than insufficient R & D is involved in postwar India's poor industrial record – only about one-half of the industrial growth rate of Southeast Asia and one-fifth of the growth rate of GNP per capita of East Asia. (See Table 1). Most of the heavy industries have been unable to operate at high capacity, most often at no more than one-half to two-thirds capacity. Such low capacities in capital-intensive industries with huge overhead costs mean very low rates of return and hence inadequate rates of rehabilitation and replacement, thereby causing the technological gap to widen. Poor infrastructural services (shortages of power, fuel, transport), inadequate planning, strained industrial relations and inefficient management are cited by India's planners for low capacity utilization (*Draft Five-Year Plan, 1978-83*, p. 84).

In the steel industry, the problem of "balancing dimensions" or the fuller utilization of all machines and equipment in the integrated complex is something which management has found difficult to solve. In heavy engineering, besides the problems of balanced dimensions, the problems of improving quality underlie low capacity utilization. Both problems are rooted in the inadequate development of small and medium enterprises for producing components, parts, and accessories–enterprises which could have been adequately developed only with the growth of lower stream processing industries and light and medium engineering industries.[27]

In the First Plan (see Appendix Table 1), government expenditures for agriculture and rural development (including irrigation) were 33 per cent in the planning budget, for social services (education, health and family planning) 21 per cent (a total of 54 per cent), and for industry 5 per cent. In the Second Plan when the heavy industry strategy was adopted, agriculture, etc., got only 15 per cent and social services 16 per cent (a total of 31 per cent) while the share of industry was raised to 23 per cent (of which heavy industries were allocated 16 per cent). The industrial share continued to be large thereafter, averaging about 20 per cent (1961 to 1980) with a constant 7 per cent for small industries. The share for agriculture remained the same throughout the 1960s (about 15 per cent) then rose to 21 per cent in the 1970s. The share for social services remained unchanged at around 16 per cent throughout the 1960s and 1970s. (See Appendix Table 2.) The costs to the other sectors (agriculture, light industry, education, health, and family planning) were enormous and the question emerges whether some other strategy, perhaps closer to that of a mix of Taiwan (emphasis on agriculture in the 1950s), of South Korea (emphasis on light industry in the 1960s) and of Japan (highly selective heavy industrialization with emphasis on engineering throughout all the postwar decades) might not have produced better results for India. In the latter 1970s, India was compelled to develop its agriculture and light industries, especially engineering, to internationally competitive levels since there was little possibility for any of its heavy processing industries to be competitive in the 1980s or in 1990s. Wouldn't it have been better to have built the irrigation works, extensions, and so on in the 1950s and 1960s and attain self-sufficiency in rice, and other food items, and thereby cut down imports?

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[27]For a discussion of these and other problems, see *Draft Five Year Plan, 1978-1983; Sixth Five Year Plan,* Chapter 16, 1981; also A.N. Agrawal, *Indian Economy,* Chapter 25, 1980.

This would have permitted the experienced textile manufacturers in Bombay and elsewhere to import the best spinning and weaving machines from abroad so that India could have become the largest textile exporter in the world, foregoing the establishment of textile machinery industry until later when the latter had expanded substantially. Is there much point in blaming the system of protection and the clumsiness of government administration and management for the poor performance of the heavy industries? It would seem unavoidable that once Nehru decided on heavy industries, only the government with the requisite finances could establish big industries, and that extensive protection was (and is still) absolutely necessary if these expensive enterprises were to survive.

China: During one of my talks on the Indian experience at the Chinese Academy of the Social Sciences (September 1982), I was surprised to hear that the industrial strategy of the Chinese economists was similar to that of India.[28] But compared to the Indian experience, the Chinese, as in other socialist economies,started to emphasize heavy industries (strictly speaking the Marxian capital-goods industries in the Fel'dman theory) from the very beginning of their planning. As shown in Appendix Table 2, the state capital construction funds allocated to the heavy industries in the First Plan (1951-1956) was 46.5 per cent compared to India's 16.4 per cent in the Second Plan (1956-1961). The funds allocated to agriculture were only 4.5 per cent compared to India's 15.0 per cent (including irrigation). Even if we allow for the possibility that the provincial and local governments may have contributed more than in India to agricultural development, the amount allocated to heavy industry relative to agriculture was many times greater in China than in India, although the definitions of capital construction of China in Appendix Table 2 and of outlays of India in Appendix Table 1 are not the same.

Consequently, it is easy to agree with Liang Wensen's (1982, p. 63) conclusions: "Contrary to expectations, however, this bias towards heavy industry and iron and steel did not stimulate the anticipated growth in other spheres of the economy. Instead, it resulted in an imbalance between industry and agriculture, an irrational economic structure, a blind search for higher output value and not

[28]See also Xu Dixin and others, *Chinese Search for Economic Growth: The Chinese Economy Since 1949,* pp. 55-62, 1982. This volume contains chapters written by some of China's leading economists and is noteworthy for their nonideological, flexible approach to the problems of development. The translations were by Andrew Watson of the University of Adelaide.

for better quality, and a decline in living standards." Parts of the various essays in the Xu Dixin volume pieced together lead one to the view that the outcomes indicated in the Fel'dman model did not materialize, and as in the case of India, agriculture and light industry failed to develop, leaving China with a growth rate of GNP per worker of only 2 per cent (1960-1979), lower than India's 2.5 per cent, than the 5 per cent for Japan, Taiwan, South Korea, Hong Kong, and Singapore, and 3.5 per cent for Philippines, Thailand, Indonesia and Malaysia.[29] And like India's heavy industries, those of China have fallen far behind those of the West and Japan technologically, with machines and equipment mostly of 1950 vintage. Cost and quality "cascading" to the lower stream industries was also serious as in India. Liang Wensen (1982, pp. 69-72) notes one type of cost cascading which is worthy of mention: high machinery, fertilizer, and pesticide costs raised production costs in agriculture which, because they were not passed on in higher prices to urban consumers, restricted production of agricultural raw materials which in turn affected the growth of light industries.

As in India, shortages of facilities such as transport, communication, electric power, and so on obstructed the smooth operation of heavy industries. Surprisingly, these two giants with widely-differing socioeconomic systems experienced the same difficulties in their efforts to develop heavy industries prematurely. As in India, not one dissented to my suggestion in one of my talks that it would have been far better that China had concentrated its efforts on agriculture and light industries in the 1950s and 1960s, and then accelerated heavy industrialization in the 1970s. The present leaders of China are fully aware of the backwardness and inefficiencies of their heavy industries and the constraints these have imposed on downstream industries. Unfortunately for heavy industries, it is not easy to correct the mistakes of the past, as rehabilitation and renovation are expensive and slow. Too much has been sunk in infrastructure and machines and they cannot be scrapped. They will continue to cascade their poor quality and/or high costs products to lower stream industries.

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[29]Data shown on Table 1 are from my paper "Postwar Philippine Economic Growth" (mimeo). China's growth rate of per capita product, however, is double that of India, the explanation being that because housewives were sent out from homes to the fields, shops, and offices in increasing numbers, the labor force increased much faster than the population – a phenomenon quite common in socialist countries.

From the welfare point of view, China has done far better than India—in education, health, sanitation, nutrition, social justice and above all, in the distribution of household income. China's socialism, strongly obsessed with egalitarian goals, has during the Cultural Revolution attempted to equalize wages of unskilled, skilled and white-collar workers with amazingly small differential among the three groups. (I was told in Beijing that the basic pay differential between unskilled and intellectual labor was no more than 25 per cent even today.) It does not seem possible for China to modernize its economy by keeping wages of very scarce intellectual workers so low, since the latter must play the key role in the development of science, modern technologies, and management.

The greatest source of income inequality of households in China is the discrepancy of incomes in peasant and workers households (the "between variances"), and the inequality among peasant households (the "within variances"). Our calculation shows that in 1981, the average annual income of peasant households was 1262 yuan compared to 1814 yuan for worker's households, or a 50 per cent differential.[30] The low figure for the peasants is due to the uneven development of agriculture in different regions of the country, mainly the result of inadequate attention paid to agriculture in the past three decades. An emphasis on agricultural development can substantially bring down China's household income inequalities even though wages to intellectuals are doubled or tripled. Thus, the heavy industry strategy has had adverse consequences for income distribution. If one billion dollars of development funds, instead of invested in one more iron/steel or petrochemical complex, were to be spent on dams and other irrigation infrastructure, it could benefit hundreds of thousands of peasants by increasing yields, multiple-cropping and rural industry (using hydro-electricity) instead of a few thousand workers. It would also probably save more foreign exchange by reducing food imports and by increasing the export of labor-intensive light industrial products.

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[30] Annual wages are taken from *China Daily*, Sept. 17, 1982 and other data from *Almanac of China's Economy, 1981* (in Chinese) pp. 6-25. China apparently conducts household income and expenditure surveys annually. Because of the differential of wages between white and blue collar worker (one issue of *China Daily* pointed out that because of large bonuses for blue collar workers in 1981, the latter's incomes were higher than white collar workers), the "within variances" are likely to be small.

Fortunately, the political leadership in both India and China has now begun to shift to agriculture and light industry development. But in my view of the development process, the shifts have not been sufficient. Agriculture and light industries need to be supported to the point where agricultural farm family incomes (through higher yields, multiple-cropping and off-farm employment) begin to rise faster than the labor force, and then sustained at this pace until full employment is reached. After this point is reached, accelerated mechanization can take place in both agriculture and industry.[31]

Japan: All the heavy industries (except petrochemicals) existed long before World War II, so that the Japanese had extensive experience in the technology of heavy industrialization. During the 1930s when Japan began to militarize its economy, the heavy industries grew rapidly. Nevertheless, horsepower per worker in manufacturing (as an indication of capital-intensity) in 1939 was no higher than Taiwan in 1961 (1.9) and the U.S. in 1899.[32] The heavy processing industries, especially iron and steel, were inefficient and could not compete internationally. It was in the 1950s that the prewar heavy processing industries, particularly iron/steel and chemicals, were rehabilitated, renovated and brought up to world standards, and only toward the late 1950s that plans for the accelerated expansion (via new plants) were begun. The petrochemical industries (being new industries) were built in the early 1960s. The real strength of prewar Japanese industrialization was in the engineering industries, particularly in light and medium machines and equipment, in the system of subcontracting by small firms, and in shipbuilding.[33]

In the immediate postwar decade starting with the late 1940s and into the 1950s, top priority in planning was given to the development of agriculture, small and medium industries, transportation and key industries. The latter comprised industries servicing and

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[31] See for details my study, *The Transition to an Industrial Economy in Monsoon Asia,* Asian Development Bank, Manila: 1983.

[32] Computed from *Historical Statistics of the U.S., Census of Commerce and Industry of Taiwan 1961,* and from the *Long-Term Economic Statistics of Japan,* Vol. 12.

[33] G. C. Allen, *Japan's Economic Expansion,* 1965, Chapter IX on steel and chemicals and Chapter X on engineering industries.

supporting a wide range of the economy with high social returns such as coal mining, shipbuilding, electric-power, and iron/steel. In 1953-56, the government spent 30 per cent of its economic development assistance on agriculture and rural development, 25 per cent on transport and communication, 22 per cent on key industries, and 14 per cent on small and medium industries. Production levels in iron/steel and other metals reached prewar levels toward the end of the 1950s, and basic chemicals (excluding petrochemicals) and light and medium machinery reached prewar levels around mid-1950s. The latter and textile exports were the leading industrial exports all throughout the 1950s and it was only during the 1960s that textile exports were replaced by machinery and metal exports.[34] With the coming of the 1970s, heavy industrial exports, both processing and assembly, became the leading export sectors. (See Appendix Chart.) Thus, capital-intensification was a gradual one and was accelerated only after full employment was approached toward the turn of the decade into the 1960s, as capital funding became available, as supporting infrastructure (electricity, transport, communication, etc.) became efficient, and as technological capabilities approached Western levels. Hundreds of young engineers and scientists were sent abroad to U.S. enterprises with the best technologies to master quickly the best practices in every industry.

Even more important, the Japanese overhauled their industrial institutions for the efficient operation of large enterprises, seeing that the prewar institutions were not appropriate. Management was professionalized doing away with familial connections, and authoritarian labor-management relations were transformed into one emphasizing humaneness, participation, consensus, and cooperation. An innovative system of industrial relations (long-term employment, seniority remuneration, profit-sharing bonuses, extensive welfare benefits and in-service training, quality control circles, and so on) emerged, which succeeded in motivating both labor and management to work wholeheartedly for the long-term success of the enterprises.[35] To maximize the effectiveness and efficiency

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[34] Computed from *Hundred-Year Statistics of the Japanese Economy*, Bank of Japan, and *Japan Statistical Yearbook*, various issues.

[35] For details on institutions in postwar Japan, see my article "Reinterpreting Postwar Japanese Economic Growth," *Economic Development and Cultural Change*, October 1982. Japanese management and union leaders saw that the technology of the 20th century unlike that of the 19th century called for the need not only to train their workers well but to motivate them to the highest level.

with which scarce capital and technological resources were allocated, a unique system of formulating and executing industrial policies and planning was put into effect by the government. An important element in this system was the establishment of close, cooperative research bringing together fiercely competing firms for innovating new technologies, and thereby overcoming the relatively small supply of research manpower for advanced technologies.[36] Japanese heavy processing industrial firms are also tied in closely with large machinery firms (in what is known as keiretsu in Japanese) so that close cooperation in R & D for new technologies is continuously carried out. And in the case of "innovations in the small" on the factory floor, the quality control circles are a rich source of innumerable improvements.

Moreover, from this unique system of industrial policy institutions emerged the view that no one nation can possibly monopolize the innovation of all technologies (so varied and multitudinous are the products, processes, and materials of modern industry in the latter half of the 20th century), and that the different technologies are intimately interconnected. Thus, instead of striving for self-reliance and self-sufficiency in technology, the goal of international cooperation and exposure was adopted.

It seemed also to have been recognized early in the postwar decades that the real strength of the Japanese economy inhered in the machinery/engineering sectors rather than the raw materials- and energy-intensive heavy processing industries. The former can capitalize on the superb quality of Japanese workers, both in skills and work ethics. Extensive efforts were made to develop the efficiency and technology of the small and medium industries, particularly as subcontractors for heavy engineering. Today with raw materials and energy costs rising, Japan's primary petrochemical, aluminum, and pulp/paper industries are in trouble but

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[36]In this way, for example, the Japanese electronic industry, much smaller than that of the U.S., was able to surpass IBM in computer hardware, and won the race in microchips to mass produce the 64 and 256 K. RAM. See M. Nakama, in *Asian Wall Street Journal*, Oct. 7, 1982. Also H.I. Fusfeld and C.S. Haklisch, ed., *Industrial Productivity and International Technical Cooperation*, 1982. The 16 or so microchip companies in the U.S. were forced to organize a joint venture to do R & D in the future instead of each duplicating and overlapping in their R & D efforts. On the Japanese system of industrial policy, see Merton J. Peck in *Asia's New Giant*, edited by H. Rosovsky and H. Patrick, 1976; Chalmers Johnson, *MITI and the Japanese Miracle*, 1982; also Shinohara, *Industrial Growth, Trade and Dynamic Patterns in the Japanese Economy*, 1982.

unlike Taiwan and South Korea, Japan can fall back on its strength in the machinery industries.[37]

4. Summary and Suggestions: Regional Joint Ventures for Heavy Industries

The complexity and dynamism of basic technology in the 20th century have made the heavy industries extremely risky for developing economies whose R & D resources are scarce. (It is even risky for developed countries as witness the difficulties of iron and steel in the U.S., U.K., and France.) Their costliness can retard even the growth of large countries such as India and China. Accordingly, great caution must be exercised in the decision to establish them, especially in LDCs such as in Southeast Asia with their very limited R & D capabilities, despite their wealth of resources such as petroleum and natural gas. It is hazardous to depend on the infant industry argument which is based on the simpler technology of the 19th century. In Latin America and Asia, the heavy industries established in the postwar decades have not "grown up" but have fallen behind. Even the recently established iron/steel industries of Taiwan and South Korea are falling behind as Japan's industry comes up with improvements and new technologies. It is safer to start with the lower-stream heavy processing industries and learn first of all to operate them efficiently before going on to the primary, basic industries.[38] If one starts with the more difficult and costly basic industries, cost (and poor quality) cascading is likely to constrain the growth of the lower-stream industries and their ability to export.

If the basic industries must be established for one reason or another, it is best to do so as a cooperative, regional joint venture (including multinationals) which will spread the risks

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[37]Shinohara (1982, p. 223) computes total factor productivity growth for Japan's manufacturing industries, for 1960-1971. Using his computation for individual industries, we have grouped them and found that the engineering industries had the highest growth rate of 5.8% per year, followed by light industries, 4.1%, and heavy processing industries the lowest at 3.6%.

[38]The operation of direct reduction plants for iron-making is said to be even more difficult than blast furnaces even with the help of technicians from developed countries. I would suggest that before a country starts to build direct reduction plants, a group of experts should visit Krakatau in Java, also New Zealand and the blast furnace at Malyawata near Penang to study the problems facing these enterprises.

of failure and obsolescence. Even in a country as rich in petroleum, natural gas and raw materials as Indonesia, it is best to start the highly scale-economic petrochemical industry as a regional joint venture with substantial equity participation by leading multinational companies. This is intended mainly to spread the risks over as many countries by insuring that the markets will be sufficient and that enough technicians and new technologies will be made easily available.[39] Government participation and guarantees should be minimal, if any, and private interests should be made to shoulder nearly all the risks, at least up to the later years of the present decade. It is better to use public resources to strengthen the lower-stream industries, particularly in light and medium machinery /engineering industries, where the learning effect, employment creation and export generation are greater (without depleting valuable natural resources).

One of the reasons given for heavy industries is their need in time of war. Nehru is said to have gone all-out for heavy industries in the latter 1950s because of the fear of China's heavy industrialization in the early 1950s. And this was reportedly the reason (June 1982) for Park Chung Hee's haste in building the steel, chemical, and heavy machinery (including shipbuilding) industries. Recently, it is said that Korea will be using the excess capacities in its heavy industries to produce tanks, destroyers, and munitions for domestic and foreign sale. It is difficult for economists to judge this matter but such decisions should not be made surreptitiously and in the name of economic development. If it is on valid grounds, there is all the more reason to construct heavy industries as a regional, cooperative joint venture, not only to spread the risks and costs but to insure that they will not be used offensively against each other, as Japan did in the 1930s and 1940s. For sure, once an economy begins to plan its growth by establishing costly heavy industries with an eye for military purposes and not for economic development, its long-term growth is likely to be unfavorably affected. One of the strengths of postwar Japanese development planning was that it was intended exclusively for peacetime purposes, not for war as in the prewar decades. The diversion of resources from the agricultural sector in the prewar decades starting from the Mejii era left the peasantry in extreme poverty; the eventual rise in tensions and unrest in the rural areas

[39] And as Professor Romeo Bautista suggests, the joint venture can go beyond regional grouping such as ASEAN.

led to wars and more military expenditures, and Japan ended up with a prewar growth that was no higher than those of its colonies, as Professor Mizoguchi has shown.[40]

Another suggestion is the need to study the Japanese type of industrial policy formulation and execution, which many observers feel played one of the key roles in the postwar growth of heavy industries in Japan. Policy formulations, especially identifying and selecting industries for concentrated efforts, coordinated by the Industrial Structure Council of MITI, were undertaken carefully and participated in by a large number of varied groups including experts from the academic community, leaders of labor unions and consumer groups, besides the business and government sectors (unlike in Southeast Asia where it is somewhat surreptitiously carried out by a small group of politicians, bankers, engineers, and government officials).[41] The execution of industrial policies was coordinated skillfully through a system of "administrative guidance" which was more effective than regulations of the Western type. The transfer of foreign institutions requires modifications even more than the transfer of new technologies, so that there is a need to study Japanese institutions such as industrial policy formulation and execution before adjustments and modifications can be made.[42] But if heavy industries have extensive ramifications on trade policy, agriculture, employment, light and lower-stream industries, the financial health of the nation, and indeed on the future growth and distribution of national income, as I have argued in this paper, then the decision to establish them cannot be left to a small group of bankers, engineers, politicians and officials.

Postscript: Since writing the paper, various countries of Southeast Asia have announced plans for a number of heavy industries,

[40] See my paper, "Mejii Government Fiscal Policy and Economic Development," in *State and Enterprise in Japanese Development,* 1965; and Toshiyuki Mizoguchi, *The Economic Growth of Taiwan and Korea,* 1975, p. 150.

[41] The use of consulting firms from developed countries has its dangers. Those from countries which export the heavy industrial products into Southeast Asia may be biased against the project but those from countries which do not export are biased for it, especially because of the fat fees they can receive for assistance in operating the project and for supplying the equipment. Their reports have to be evaluated carefully if mistakes are to be avoided.

[42] See Peck (1976) and Johnson (1982).

notably the Philippines, Thailand, Malaysia and Indonesia. The Philippines has postponed or abandoned plans for aluminum smelters and petrochemical complexes but is going ahead with plans for an iron and steel complex and is in the process of completing a copper smelter. Thailand is reconsidering the petrochemical complex, seeing that its natural gas is about one-third more expensive than can be bought in the international market. Malaysian leaders are determined to go ahead with their plans for a petrochemical complex, iron/steel, aluminum smelters, paper/pulp, automobiles, and so on. It is indeed puzzling that a small country like Malaysia should be thinking in terms of such expensive projects when very few countries in the world are contemplating the establishment of such industries given so much excess capacities in the heavy industries, and when countries such as Japan, South Korea and Taiwan are willing to sell their petrochemical, aluminum, and paper/pulp industries. I hope that these countries undertake good cost/benefit studies of these projects involving academic economists in their own country. Above all, a careful examination of the difficult problems encountered by Indonesia's iron/steel complex at Cirebon, the petrochemical complex in the process of completion in Singapore, the copper smelters in the Philippines and South Korea, the heavy machinery complex in South Korea, aluminum smelters in Taiwan and Japan, shipbuilding in Singapore and South Korea, the automobile industry in South Korea and Taiwan may be sobering, besides the study of the overall experience of India, China, Mexico, Argentina, and Brazil in heavy industrialization.

It is well to consider carefully the probability that the new pattern of industrialization emerging in the DCs in the closing decades of the 20th century may be quite different from that which developed in the opening decades with the iron/steel industry establishing itself as the sinew of modern industry and then later joined by other heavy processing industries, most importantly the petrochemicals after World War II. Today the iron/steel, like the railroads in the 19th century, is getting to be a "sick" industry as more and more DCs turn to subsidizing it and as new materials are found to replace steel. The petrochemical industry is rapidly moving out to the Middle East. In the emerging pattern, it is not the heavy processing industries but the machinery/engineering industries, particularly the bellwether of the new technology, electronics, which dominate manufacturing, with nearly half of manufacturing employment. These are the industries that are expected to be the leading growth industries in the coming decades, as technology becomes more and more dependent on electronics. Here is where resource poor Asia with its "teeming millions" is likely to benefit, and in this shift of technology lies the hope of a shift in the center of modern economic growth from the Atlantic to the Pacific.[43]

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[43]See my paper, "On the Coming Pacific Century, "*Malayan Economic Review*, October 1983.

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Appendix Table 1 – Percentage Distribution of Outlays in Indian Development Plans, 1951 to 1979

	1st Plan 1951–1956	2nd Plan 1956 – 1961	3rd Plan 1961 – 1966	4th Plan 1969–1974	5th Plan 1974–1979	6th Plan (Estimate) 1980–1985
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture and Rural Development	10.5%	5.9%	8.5%	16.7%	11.0%	12.6%
Irrigation	22.1%	9.1%	7.6%	3.9%	10.7%	13.9%
Energy	7.6%	9.7%	14.6%	14.6%	24.9%	30.3%
Industry	4.9%	23.4%	22.7%	22.2%	18.7%	17.2%
Heavy	–	16.4%	15.9%	14.4%	11.9%	10.9%
Light	–	7.0%	6.8%	7.8%	6.8%	6.3%
Transport and Communication	26.4%	28.3%	24.5%	23.2%	17.6%	6.4%
Social Services	21.0%	15.9%	16.5%	14.7%	15.8%	16.0%
Education	–	–	6.9%	5.1%	3.3%	2.9%
Health and Family Planning	–	–	–	4.5%	3.0%	3.2%
Others	7.4%	7.8%	5.6%	4.6%	1.1%	3.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Sources: (1) and (2) from pp. 738-739 of *Third Five Year Plan,* (3) from pp. 72-74 of *Fourth Five Year Plan (A Draft Outline)*, (4) from p. 83 of *Draft Fifth Five Year Plan (1974-79) Vol. 1,* (5) from pp 17-18 of *Draft Five Year Plan 1978-83,* and (6) from pp. 57-58 of *Sixth Five Year Plan 1980-85.*

Appendix Table 2 – Industrial Growth and Structure of China

	1950–52	1st Plan 1953–57	2nd Plan 1958–62	Adjust-ment Period 1963–65	3rd Plan 1966–70	4th Plan 1971–75	1976–80	1950–80
I. *Average Annual Growth Rate of Gross Output (in %)*								
Agriculture	14.1	4.5	–4.3	11.1	3.9	4.0	4.9	4.2
Industry	34.8	18.0	3.8	17.9	11.7	9.1	9.3	12.8
Heavy	48.8	25.4	6.6	14.9	14.7	10.2	7.9	15.5
Light	29.0	12.9	1.1	21.2	8.4	7.7	11.1	10.9
National Income	19.3	8.9	–3.1	14.5	8.4	5.6	6.3	7.1
II. *Distribution of Capital Construction Funds (in %)*								
Agriculture		7.8	12.3	18.8	11.8	11.3	11.0	
Industry		52.4	61.3	53.7	61.4	60.2	54.9	
Light		5.9	5.2	3.9	4.0	5.4	6.9	
Heavy (including metallurgy)		46.5	56.1	49.8	57.4	54.8	48.0	
[Metallurgy]		(10.5)	(14.8)	(9.3)	(11.8)	(10.6)	(8.5)	
Other Sectors		39.8	26.4	27.5	26.8	28.5	34.1	
Total		100.0	100.0	100.0	100.0	100.0	100.0	
III. *Composition of Gross Output of Agriculture and Industry (in %)*								
		1949	1952	1957	1965	1975	1979	
Agriculture		70.0	58.5	43.3	29.7	28.5	25.7	
Industry		30.0	41.5	56.7	70.3	71.5	74.3	
Light		(22.1)	(26.7)	(30.1)	(35.4)	(30.9)	(32.1)	
Heavy		(7.9)	(14.8)	(26.6)	(34.8)	(40.5)	(42.2)	

Sources: Panels I & II from Table 9 and Table 4, respectively, of Xu Dixin and others, *China's Search for Economic Growth, the Chinese Economy Since 1949* and *Statistical Yearbook of China 1981* compiled by the State Statistical Bureau, PROC; panel III computed from Part IV, page 4 of

Appendix Table 3 – Industrial Growth and Structure of South Korea

	1953–56	1957–61	1st Plan 1962–66	2nd Plan 1967–71	3rd Plan 1972–76	4th Plan 1977–81
I. *Average Annual Growth Rate of GNP by Sectors (in %)*						
GNP	2.7	4.0	7.8	9.7	10.1	5.6
Agriculture	0.7	4.1	5.6	1.5	6.1	–0.7
Manufacturing	15.0	8.6	15.0	21.8	18.7	9.4
Heavy	20.5	16.3	25.5	26.0	22.5	10.5
Light	14.2	5.8	10.8	19.2	15.6	8.2
Social overhead capital & other services	3.1	2.9	8.4	12.6	8.4	6.0
II. *Distribution of Loans and Investments of Central Government and Banking Institutions (in %)*						
Agriculture			21.0	15.2	12.0	10.0*
Manufacturing			40.0	40.6	48.4	48.3*
Heavy			21.2	20.0	23.6	28.5*
Light			18.8	20.6	24.8	19.8*
Other Sectors			39.0	44.2	39.6	41.7*
Total			100.0	100.0	100.0	100.0*
III. *Industrial Distribution of GNP at 1975 Prices (in %)*						
	1953	1961	1966	1971	1976	1979
Agriculture Sector	48.9	47.1	42.5	28.4	22.5	18.8
Industrial Sector	8.4	14.4	20.2	32.2	43.1	49.0
Manufacturing	4.8	8.3	11.5	19.6	28.8	32.7
Heavy	0.7	1.9	4.2	8.4	14.4	18.6
Light	4.1	6.4	7.3	11.2	14.4	14.1
Service Sector	42.7	38.5	37.3	39.4	34.4	32.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

*1977-79

Sources: Panel (I) from "*The Fifth Five Year Economic and Social Development Plan, 1982-86*. Panel (II) computed from *Korea Statistical Yearbook*, various years. Panel (III) computed from *National Income in Korea 1978* and updated by *Korea Statistical Yearbook 1980*.