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2012 Modularization of Korea's Development Experience:

Small and Medium Enterprise Promotion Policy

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Preface

The study of Korea's economic and social transformation offers a unique opportunity to better understand the factors that drive development. Within one generation, Korea has transformed itself from a poor agrarian society to a modern industrial nation, a feat never seen before. What makes Korea's experience so unique is that its rapid economic development was relatively broad-based, meaning that the fruits of Korea's rapid growth were shared by many. The challenge of course is unlocking the secrets behind Korea's rapid and broad-based development, which can offer invaluable insights and lessons and knowledge that can be shared with the rest of the international community.

Recognizing this, the Korean Ministry of Strategy and Finance (MOSF) and the Korea Development Institute (KDI) launched the Knowledge Sharing Program (KSP) in 2004 to share Korea's development experience and to assist its developing country partners. The body of work presented in this volume is part of a greater initiative launched in 2010 to systematically research and document Korea's development experience and to deliver standardized content as case studies. The goal of this undertaking is to offer a deeper and wider understanding of Korea's development experience with the hope that Korea's past can offer lessons for developing countries in search of sustainable and broad-based development. This is a continuation of a multi-year undertaking to study and document Korea's development experience, and it builds on the 40 case studies completed in 2011. Here, we present 41 new studies that explore various development-oriented themes such as industrialization, energy, human resource development, government administration, Information and Communication Technology (ICT), agricultural development, land development, and environment.

In presenting these new studies, I would like to take this opportunity to express my gratitude to all those involved in this great undertaking. It was through their hard work and commitment that made this possible. Foremost, I would like to thank the Ministry of Strategy and Finance for their encouragement and full support of this project. I especially would like to thank the KSP Executive Committee, composed of related ministries/departments, and the various Korean research institutes, for their involvement and the invaluable role they played in bringing this project together. I would also like to thank all the former public officials and senior practitioners for lending their time, keen insights and expertise in preparation of the case studies.

Indeed, the successful completion of the case studies was made possible by the dedication of the researchers from the public sector and academia involved in conducting the studies, which I believe will go a long way in advancing knowledge on not only Korea's own development but also development in general. Lastly, I would like to express my gratitude to Professor Joon-Kyung Kim and Professor Dong-Young Kim for his stewardship of this enterprise, and to the Development Research Team for their hard work and dedication in successfully managing and completing this project.

As always, the views and opinions expressed by the authors in the body of work presented here do not necessary represent those of the KDI School of Public Policy and Management.

May 2013

Joohoon Kim

Acting President

KDI School of Public Policy and Management

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Summary

For almost four decades, the Korean economy had sustained high growth, which had been associated with rapid industrialization. There had been qualitative improvement in industrial structure, technological sophistication, and entrepreneurial capability. Many factors had contributed to sustained high growth: the abundant supply of a high quality labor force, relatively low wages, and vigorous private investment. A favorable world trade environment such as GATT-guaranteed free trade, unrestricted capital inflows, and technology transfers had also contributed to the expansion of the Korean economy. But it should be noted that such remarkable performance would not be possible without an outward-looking strategy effectively utilizing the latecomer's advantage and industrial policies successfully managing the industrial transition. Facing difficult structural problems at each phase of the industrialization process, Korea had been successful in facilitating the industrial transition needed to sustain high growth.

Korea's industrial policy history can be roughly divided into four phases: (1) the takeoff phase between 1961 and 1972, (2) the heavy-chemical industry promotion phase between 1973 and 1979, (3) the liberalization, restructuring and technological development phase between 1979 and 1991, and (4) scientific and technological development phase after 1992.

In the 1960s, the government had control over trade, foreign exchange, finance, and even aspects of industrial decision-making. The policy measures to promote export were highly discretionary. A state-controlled banking system provided financial support for export; and with protectionist policies in place, exporters enjoyed advantages in importing machinery and intermediate inputs. Exporters were supported with multiple exchange rates, direct cash payments, permission to retain foreign exchange earnings for private use or resale, and the benefit of borrowing in foreign currencies. These measures, however, were used in an integrated fashion to pursue the primary objective of export growth. Industrial policy

during this period involved neither functional intervention nor selective intervention, but rather a comprehensive incentive system designed to channel resources into export-oriented activities. This complex policy regime succeeded in part because intervention was guided by clear criteria regarding export performance. Export as a criterion for resource allocation resolved the ambiguities that lead to corruption and waste. At the same time, the more bureaucratic market-steering intervention was slowly replaced with market-enhancing incentive schemes.

The heavy-chemical industry (HCI) drive promoted a higher capital- and skill-intensive export industry that replaced the traditional labor-intensive export industries. This shift can be seen as a logical response to the rapid increase in domestic wages and increased global competition in traditional export industries. HCI required large-scale, risky investments that would not be undertaken by private firms without decisive government leadership. It was a shift from general export promotion to sector-specific import substitution. A broad range of policy instruments supported the promotion of the heavy-chemical industry. Bank credits and foreign loans were allocated to the heavy industry at substantially subsidized rates. The import of heavy-industry products was prohibited even if used for export production, translating into a higher level of protection for the heavy industry and lower level of protection for other industries. The HCI drive significantly deepened the industrial structure. And while some of the production and export objectives of the plan were eventually realized, they were accompanied by over-capacity, inflation, financial market distortion and external imbalances. By the early 1980s, the export structure shifted from labor-intensive to capital- and skill-intensive products. The share of the heavy industry in exports also rose substantially. The dependence on imported intermediate inputs in the heavy industry declined. The heavy industry surpassed the light industry in its share of total output. But the allocation of financial resources led to significant market distortions. Moreover, many of the heavy industries suffered from overcapacity. Investments exceeded levels consistent with the market size, technological capability and financing capacity. Monetary expansion to finance heavy industry investment led to rapid inflation which, when combined with a fixed exchange rate, caused a sharp appreciation of the Korean currency. The competitiveness of other export industries was significantly eroded. The current account deficit as a share of GNP increased from 1.1 percent in 1976 to 6.7 percent in 1979.

Investment in the heavy-chemical industry was not sufficiently conditioned on export performance. The adverse effects were primarily due to overly ambitious investments, which outgrew the technological and financial capacities of the economy. While large enterprises with their economies of scale were critical to the heavy industrialization process, their role led to the concentration of economic power in the hands of a few big conglomerates. Moreover, the development of assembly industries without the concomitant development

of specialized suppliers—of materials, parts and production machineries—deepened the import dependency of the major export industries. The policy was distinctly different from inward-looking import substitution policy in that it aimed to promote export industries with higher capital- and skill-intensity. The heavy industry was promoted in such a way that it was highly integrated with the world economy. The strategy was effective in some industries, but ineffective in others. The variance in outcomes was inevitable in view of the inherent risk assumed by the heavy industry promotion program. The structural transformation effected by the heavy industry promotion policy was consistent with emerging changes in comparative advantage, but occurred too rapidly at excessive costs.

Since 1979, the government had pursued a slow but deliberate policy of liberalization—trade liberalization, financial liberalization and realignment of the industrial incentive system. In contrast to the liberalization experience in South America, there was little urgency or drama to the effort in Korea. The government was withdrawing slowly in the policy areas of domestic finance, import barriers, and direct export promotion. The government reduced its role in credit allocation and terminated policies that granted the heavy industry large-scale preferences. Financial reform began with the alleviation of restrictions on bank management and divesting government equity shares in five commercial banks to transfer the ownership to private shareholders. Interest rate subsidies were eliminated; and the size of special funds decreased. Further financial liberalization has actually since been hindered by the legacy of heavy intervention in private resource allocation during the 1970s. The government would not let troubled firms go bankrupt, resulting in continued financial problems. The government committed itself to increasing the import liberalization ratio, from 69 percent in 1980 to 95 percent in 1988. The system of controls over foreign direct investment was also somewhat liberalized. Investments in science and technology (S&T) were encouraged to promote industrial restructuring from capital-intensive to technology- and skill-intensive industries.

Despite the government's increasingly neutral positioning, the government continued to take an active role in restructuring distressed industries, supporting the development of technology, and promoting competition. An active role in these functional areas was regarded as consistent with the liberalization effort. As a way to streamline the industrial incentive system, the Industrial Development Law replaced seven individual industry promotion laws in 1986. The law stipulates that the government intervenes for industrial rationalization in areas where market failure occurs. In industries where competitiveness was vital to the economy but not expected to be competitive when left to the market, specialization was encouraged through incentives designed to promote technological advancement. In declining industries, the government intervened in the phasing-out process. A national R&D program was established in 1982 to fund public as well as public-private joint R&D

projects in high-technology fields. Private R&D expenditures expanded rapidly, increasing the number of private R&D centers. R&D expenditures increased from 0.8 percent of GNP in 1980 to 1.9 percent of GNP in 1990.

By the early 1990s, the Korean economy had successfully transformed into a newly industrializing economy (NIE). Of the Asian NIEs, Korea had perhaps the best prospects for developing a competitive advantage in a range of technology-intensive industries. Major Korean corporations had invested more heavily in upgrading their technological capability compared to companies in other Asian NIEs. High R&D/sales was a typical business model. By aggressively pursuing licenses and other agreements in order to acquire foreign technology, Korean corporations had been unique among firms in Asian NIEs in their commitment to developing their own product models, and to invest in state-of-the-art process technology. In the 1990s, major corporations intensified indigenous R&D to strengthen their competitive advantage through creative imitation of sophisticated foreign technologies. As an increasing number of Korean firms found themselves in defensive market positions, it became increasingly critical that they assimilate R&D-intensive and system-oriented technologies. Defensive innovators often lack the capacity for original innovation, especially the link with fundamental research. Yet they must design models as good as those of the early innovators, as well as incorporate technical advancements to differentiate their products at lower costs. Major corporations established overseas R&D laboratories in advanced countries, and used M&As to gain access to frontier technologies. In some technology areas, Korean multinational corporations (MNCs) grew sophisticated enough to enter into strategic alliances with world leaders. In 1997, 15 Korean companies owned 32 R&D facilities in the U.S. Korean firms registered 1,567 U.S. patents in 1996, which is the seventh largest number of U.S. patents registered by a foreign country.

In the 1990s, however, imports increased at a faster rate than exports, primarily because of imports of technology-intensive intermediate goods and capital goods. In these areas, Korea's technological capability still lagged far behind advanced countries, especially in product design and basic project engineering. The Korean capital goods industry had developed rapidly in the 1980s, but its level of development lagged compared to advanced countries, showing a low share of locally made machinery in major industries. As for the automobile and petrochemical industries, machinery was localized at around 50 percent and 60 percent, respectively. In many activities related to the production of intermediate and capital goods with significant economies of scale, technological acquisition had been restricted by the relatively small size of the domestic market. Investments in such areas had been delayed until the size of the domestic market, together with export production, grew large enough to allow a minimally efficient scale of operation.

The government implemented a Five-Year Plan for Localizing Production of Machinery, Parts and Materials, and also initiated the Highly-Advanced National Project (1992-2001), which was an inter-ministerial R&D program to develop strategic industrial technologies needed for more self-reliance in science and technology. Key innovations were to be developed with the systematic involvement of industry from the early stages and to commercialization and diffusion. This program had created a considerable number of innovation networks by forcing enterprises, universities and GRIs to work together. It exposed many people to challenging research and thus provided some form of research training in basic technology areas. After the financial crisis in 1997, the emphasis on R&D grew even stronger with globalization. Overnight, globalization brought fierce competition even to domestic markets and accelerated the diffusion of new technologies to wider areas. Relentless global competition facilitated a network collaboration effort to catch up to world technology leaders.

Table S-1 | Evolution of Indigenous Technological Capability

	Technological Capability
1971-1980 Operational	• Establishment of Public research institute • Ability to manage and to operate production facility supplied by foreign partners
1981-1990 Duplicative	• Increase in private R&D investment • Ability to expand production facility without foreign assistance
1991-2001 Adaptive	• Increase in commercialization research • Technological self-reliance • Ability to adapt product design • Ability to re-engineer production processes
2001-2010 Innovative	• Increase in applied research • Advanced design • Ability to develop next generation systems

SME policies were carried out with a legal foundation from the early 1960s but not fully initiated until the mid-1970s. During the first three five-year plan period, most of the SMEs manufactured daily necessities and became well-established in light industries, which was in line with policies to promote export of light industry products. From the latter half of the 1970s, SME policies were designed to promote the modernization of production facilities and strengthen the technological capabilities of SMEs, in particular the specialized suppliers of parts and components for large assemblers. In 1993, SME policy shifted from providing protection and assistance toward laying the groundwork for autonomy and competition. Until the early 1990s, policies for SMEs had supported cartelization on the whole. SMEs were also administered subsidies on account of political pressures. The policy

gradually shifted to self-sufficiency and a transformation toward a new type of industrial policy aimed at fostering technology development and technology transfer. The government had supported start-ups since the mid-1980s, but the venture promoting policy began to take effect only after the financial crisis in 1997.

In the 1960s, SMEs contributed significantly to the production of export commodities, and hence to earning foreign exchanges. Between 1962 and 1976, however, the share of SMEs in manufacturing employment and value added had decreased along with an increasing share of industry segments with economies of scale. Between 1978 and 1991, the share of SMEs in manufacturing employment and value added increased from 44.1 percent and 30.0 percent, respectively, in 1976 to 63.5 percent and 45.8 percent in 1991. This reflected the increasing proportion of subcontracting SMEs among the total manufacturing SMEs, from 20.4 percent in 1976 to 73.6 percent in 1991.

Table S-2 | SME Promotion Policies

	Policy Targets and Main Support Measures
1962-1977	• Export SMEs • Comprehensive incentive scheme for exports • Financial support for modernizing the production facilities of SMEs • Technical and management guidance • Established industrial estates for SMEs
1978-1995	• Subcontracting SMEs and specialized suppliers • Financial Support for modernizing production facilities of SMEs • Technical and management guidance • Assist technological development
1996-2002	• Innovative SMEs • Support for Start-ups • Assist Technological development • Building infrastructure for technology diffusion • Cluster approach to the promotion of regional SMEs

Rapid industrialization reflects a cumulative sequential learning process. Outward-looking strategy and government policies had been effective to facilitate the learning process. This was also the case for the small and medium-scale industry (SMI). Asian NIEs exhibited the same pattern of structural change. They were in the convergence process, during which the lagging countries were catching up to the industry leaders. There were strong reasons to expect a convergence of productivity levels, and the convergence process lasted for several decades. If the lagging countries follow an appropriate policy mix, they would be able to increase productivity gains at a faster pace than the leader countries. But they enjoy certain benefits for their backwardness, in that over a considerable range of

technology, they can emulate the leaders and obtain a given amount of growth with less expenditure on R&D. Without running into diminishing returns, they could push the rate of capital formation per worker faster, resulting in rapid structural change. Manufactured goods produced in Asian NIEs thus could compete in world markets in price and quality. This increased competitiveness resulted from learning new technologies and upgrading the industrial structure year after year to achieve a higher level of technological content.

Trade in the elements of technology enabled the lagging countries to develop industries through any possible combination of local and foreign technological capabilities. Trade in the elements of technology takes many transactional modes, including turnkey project contracts, trade in capital goods, licensing, foreign direct investment (FDI), international subcontracting, and technical agreements. However, any transactional mode transfers only the elements of technology, not the technological capabilities. The development of local technological capabilities can occur only as a result of purposive indigenous efforts to assimilate transferred technology. Technological capabilities can be employed not only in import substitution but also in adaptation and can be the base from which additional capabilities are acquired.

Since the early 1990s, transnational corporations (TNCs) have penetrated global markets and integrated their world-wide operations, broadening and deepening national economic interdependence. Trade and technology transaction take place more and more within TNCs rather than in the market. TNCs have been responsive to differences in regional conditions, and relocations are becoming more strategically motivated. Governments have competed with each other to attract and retain the higher value-added activities of TNCs. An increasing number of developing countries have been actively participating in globalization. But not all countries are benefiting equally. Sustainable development requires the ability to conform to high standards for domestic policies and institutional practices, as well as the ability to progress from labor-based FDI to skill-and-technology-based FDI by building technological capabilities.

What may be learned from Korea's experiences is not the highly discretionary industrial policies of the 1960s and 1970s, which are simply not feasible under the WTO regime, but the institution building that took place through indigenous efforts to develop technological capabilities, including the Korea Institute of Science and Technology (KIST), Korea Advanced Institute of Science (KAIS), Small and Medium Business Corporation (SBC), national R&D programs such as Industry-based Technology Development Projects, Korea Institute of Industrial Technology (KITECH), University Technology Forces (UNITEF), Regional Consortium for Technology Development Among Industry, Academia and Research Centers, regional innovation centers such as Technology Innovation Centers (TIC) and Techno-Parks, and the Small and Medium Business Administration (SMBA).

We are concerned with understanding the complex evolutionary processes in which the dynamic technological behavior of firms interacted with change in their economic environment. At the same time, we are concerned with the ways in which industrial technology infrastructure changed their roles and structures over time in response to changing pressures and incentives in their environment. And our concerns about the effects of policy require understanding of how firms responded to policy change over time, and how policy itself shifted in response to changes in political structures and processes. Understanding what did not work is just as important as understanding what did work. Transferring good practice requires distinguishing the general from the specific. Practices and methods need to be understood and mapped within their institutional contexts: what works in one context may do so as part of a broader set of explicit and implicit arrangements and may not easily be transferred to other countries. Adaptation and interpretation is generally necessary, which requires learning and sunk costs on the part of the adopters.

Chapter 1

Industrial Policies and Structural Changes

1. Managing the Take-off: Export-Led Industrialization (1962-72)
2. Promotion of Heavy-Chemical Industry
3. Liberalization, Restructuring and Technological Development
4. Scientific and Technological Development

Industrial Policies and Structural Changes

1. Managing the Take-off: Export-Led Industrialization (1962-72)

Liberation from Japanese rule and the unexpected partition of the Korean peninsula in 1945 created extreme disorganization for the Korean economy. Moreover, the Korean War (1950-53) destroyed almost half of the manufacturing plants that existed in 1949. The shortage of goods and rapid wartime expansion of the money supply combined to create rampant inflation. By the time of the cease-fire in 1953, the Korean economy could function only with a massive inflow of foreign aid. The urgent programs for the reconstruction of infrastructure and industrial facilities were completed by 1957, and the government gradually shifted its policy emphasis from reconstruction to price stabilization. Price stability was attained in 1958 and 1959. The social instability caused by the Student Revolution in 1960, however, brought back high inflation. The reconstruction and stabilization programs were financed largely through U.S. and U.N. assistance. Interest rates were controlled at a low level with the implicit objective of accelerating private long-term investment. Industrial policy was mainly inward-looking. High tariffs and quantitative restrictions encouraged import substitution in non-durable consumer goods industries. Some export-promotion measures were undertaken, and export grew – and maintained negligible levels throughout the 1950s.

The Chang regime that came into power immediately following the Student Revolution was itself overthrown by a military coup in 1961. Beginning with the military government, development strategy shifted to export-oriented industrialization. This shift in development strategy reflected the economic conditions of the early 1960s. The early stage of import-substitution industrialization was completed by 1960. The previous imports of non-durable consumer goods and intermediate goods used in their manufacturing plants were replaced

largely by domestic production. As opportunities for easy import substitution rapidly diminished, industrial growth slowed. At the same time, U.S. aid was also coming to an end.

The First Five-Year Economic Development Plan was launched in 1962. High growth began in 1963 and has continued ever since. While each of the first three five-year plans contained unique goals and policy directions, there was one consistent, basic policy goal throughout – export-oriented industrialization and growth. Most other policy objectives were either in line with this basic goal or considered second to it. Industrial policy in this period involved neither functional intervention (addressing specific types of market failure) nor selective intervention (influencing an industry-specific composition of economic activities), but rather a comprehensive system designed to channel resources into export-oriented activities.

The key precondition to export-led growth was the reform of the exchange rate regime. In the late 1950s, the Korean currency was clearly overvalued. The elimination of this distortion became the logical priority of early reforms, and the major devaluation of 1961 and 1964, along with other supporting policies, provided a strong initial impetus for export growth. Since the effect of the 1961 devaluation was quickly eroded by domestic inflation, a sliding-peg system of continued adjustments was introduced in 1964. The exchange regime was critical to the success of the outward-looking strategy. The fluctuations in the real exchange rate between 1964 and 1973 were moderate in comparison to those experienced by most developing countries. Owing to aggressive export promotion policies, however, export industries faced less variation in incentives than occurred in the real exchange rate.

The policy measures to promote exports were highly discretionary. Exporters were supported with multiple exchange rates, direct cash payments, permission to retain foreign exchange earnings for private use or resale, and the privilege to borrow in foreign currencies and to import restricted commodities under the export-import link. The system granted exporters access not only to foreign machinery and intermediate inputs for their own use, but also to scarcity rents in the heavily protected domestic market. The export-import link was officially terminated in 1965, but companies still had to meet export performance requirements to qualify as an importer until 1975. Even as discretionary incentives were gradually replaced by more automatic measures, exporters received significant concessions: income taxes on earnings from exports were reduced by 50 percent (1961), exports and indirect exports (intermediate inputs to exports) were exempted from domestic indirect taxes and tariffs (1961), and exporters allowed accelerated depreciation (1966). A formal system of wastage allowances permitted exporters to import, on preferential terms, greater amounts of intermediate inputs than required in export production (1965). These interventions allowed exporters to avoid the distortions involved in the protection of domestic markets and thus curtailed the losses inherent to the array of import restrictions.

Elective import-liberalization emerged later as a component of the outward-looking strategy. Since high-cost or low-quality domestic inputs could injure the competitiveness of the export industry, tariff and import controls had to be rationalized. But liberalization played a secondary role. While protection could have sharply distorted domestic production incentives, the actual effects were negligible for exporters and indirect exporters. This is not to say that the trade regime was neutral. A highly protected market could have directed domestic resources to import substitution rather than export activities, but the government countered this tendency by developing a complex array of export promotion policies. Korea's trade policy was marked not by the absence of protection in general, but by its absence in those industries that had export potential and could best respond to export incentives. Protection of the domestic market was high in industries without strong export prospects, and low in industries with international competitiveness.

Support for exports was pervasively channeled through the state-controlled banking system. Government objectives were implemented through policy loans—bank loans explicitly earmarked for particular activities or industries, and lent passively by banks at interest rates below those charged for general lending purposes. Rates charged for export activities were particularly low. Special funds administered by commercial banks were established for financing the inputs of export industries (1961) and for export promotion (1964). Following the explicit priorities of the government, banks increasingly used export performance as a criterion for creditworthiness. Access to bank credit was extremely important since the bank lending rate was substantially below the cost of borrowing in the alternative curb market, with the average spreads being approximately 22-25 percent between 1963 and 1973.

Extensive government control over financial and other resources was not unique to Korea, but the way control was exercised is noteworthy. The government's overriding interest in export development was clearly communicated to the principal agents of the economy. Institutions such as trade promotion meetings, industry and firm-level export targets, close surveillance of export performance, and special awards for export achievements were legendary features of Korea's export promotion system. Support measures, backed by high priority lending to exporters, gave trade performance extraordinary visibility and undoubtedly helped to focus the efforts of all economic institutions—firms, banks, and the bureaucracy—on the implementation of the outward-looking strategy. What made the system work was the government's commitment to exports and its ability to act decisively. The government's focus on trade performance also explained why the discretionary components of the system achieved excellent results. Exporting was identified as the criterion for resource allocation, and the performance of firms, banks and the bureaucracy was closely monitored with this target in mind. The system was decidedly interventionist, but it resolved the ambiguities that typically create corruption and waste in other settings in favor of a criterion closely related to economic efficiency.

Throughout the 1960s, reforms aimed at greater neutrality were coupled with positive forms of intervention favoring exporters. When added together, these various subsidies apparently offset the protection afforded to domestic markets by high tariff and non-tariff barriers. As of the late 1960s, the principal features of the trade regime contained the following: (i) moderate overall protection of domestic markets offset by special subsidies to exports; (ii) approximate world market pricing of inputs and outputs across different export products; (iii) high protection of the domestic market in industries with poor export prospects; and (iv) high protection of final consumer goods, as well as modest protection of industrial raw materials and capital goods.

Export patterns also slowly diversified. However, labor-intensive light manufactured goods, such as textiles, garments, footwear, wigs, electronics, and plywood, still predominated and accounted for about 75 percent of total manufactured exports. The major shifts in the structure of industrial exports in 1965-72 were the decline in the relative importance of textiles and plywood and an increase in the share of clothing, electronics, and footwear. In addition, there was significant dependence on two principal markets, Japan and the U.S., which together accounted for 70 to 75 percent of Korean exports. Korea deliberately concentrated on developing exports in areas such as clothing and wigs where international demand in general and U.S. demand in particular had been growing very rapidly. An important aspect of Korea's industrial success had been its concentration on industries where capital requirements were low relative to output. Investment in manufacturing absorbed less than 20 percent of total fixed investment. The capital-output ratio in Korean manufacturing was not only low, but also showed potential for further decline, partly because of the expanding markets for electronics and clothing.

Korea's economic record during 1963-72 was one of the most impressive among developing countries.[1] However, the process of rapid growth had not been without problems. The heavy investment needed to sustain rapid growth was well beyond the country's domestic saving capabilities. During the latter half of the 1960s, the large saving-investment gap not only persisted but also widened considerably. In addition, the economic and financial cost of export incentives rose sharply during the late 1960s.[2]

1. GNP growth averaged 9.5 percent a year, and per capita income in 1972 was around US$310 – in real terms more than double the level of ten years before. The average manufacturing growth rate during the decade was about 18 percent. The share of manufacturing output to GNP rose from 11 percent in 1960 to 26 percent in 1972. Manufactured exports rose from less than US$10 million in 1962 to US$1,365 million in 1972. The ratio of exports to GNP rose to 21 percent in 1972.

2. The debt-equity ratio of corporations rose during the 1968-69 investment boom due to heavy reliance on borrowed capital, and the tight profit margins deteriorated sharply the financial structure of corporations during 1970-72. A presidential decree in 1972 instigated measures to improve the financial position and structure of business enterprises and showed increased determination to tackle the inflationary problem. Prime emphasis was laid on mandatory rescheduling of their short-term borrowing from the curb market and commercial banks. At the same time, the basic lending and time deposit rates of commercial banks were reduced from 19 percent to 15.5 percent, and from 16.8 percent to 12 percent, respectively.

The reliance on foreign savings increased from an average of 7.3 percent of GNP during 1964-66 to around 11 percent during 1968-70. The debt service ratio jumped from 3.7 percent in 1966 to 24.6 percent in 1971. The steep rise in the debt burden threatened to become a serious constraint on growth during 1970-71. The basic problem was that domestic savings was negligible. The mobilization of domestic resources created financial strains because of excessive reliance on credit expansion and an average inflation rate during 1965-72 of 13 percent a year. Corporate savings remained relatively small with high debt-equity ratios, and the financial position of business enterprises became extremely vulnerable towards the end of the 1960s.

During 1970-72, the government took measures to reduce the rate of increase of investment and further curb the expansion of foreign capital requirements. The exchange rate was steadily adjusted down from 300 won per U.S. dollar in the early 1970s to 400 won per U.S. dollar by the middle of 1972. Measures were also taken to limit expansion of domestic credit. When combined with a reduction in government investment and uncertainty about export prospects (after the U.S. took steps in 1971 to strengthen its balance of payments), these measures produced a definite slowdown in the economy. Real investment stagnated in 1970-72, and the ratio of fixed investment dropped sharply from 26.6 percent of GNP in 1969 to 20.2 percent in 1972. The general economic slowdown did not, however, result in an abatement of inflationary pressures, and price increases accelerated during 1970-72, partly because devaluation raised the prices of imported raw materials and the cost of debt service. An inflationary psychology also dampened savings.

The cost of promoting exports was another major concern. The rather complex system of incentives had been workable mainly because of the close alliance between government and business. The question was whether these export incentives were excessive. Increasing subsidies per dollar of exports resulted in a misleading impression of the competitiveness of exports. The increase in subsidies was necessitated by the fact that Korea's price level rose much faster than that of its major trading partners while the official exchange rate remained relatively stable during 1965-70. During 1970-73, the real exchange rate fell substantially to strengthen the competitive position. Combined with the reduction in import tariffs and the liberalization of imports, the decrease in the real exchange rate lessened the need for export subsidies. Wastage allowances were reduced; business income tax preference on export earnings was abolished; interest rate subsidies came down because interest on export credits rose and, more importantly, the general level of interest rates declined; and duty exemptions fell lower tariffs. Overall export subsidies fell to only 15 percent of total exports from over 30 percent in 1970.

The effective rate of subsidy on manufacturing exports in 1968, however, was estimated to be in the range of 9 to 12 percent, which was not excessive by international standards.

The average rate of effective protection in 1968 was estimated at around 10 percent, which was quite low by international standards. A unique feature of industrial development in the early years was the efficiency with which the economy utilized foreign markets, products, and resources to expand exports and income. The export take-off would not have been possible without decisive and innovative policies. Outward orientation was not limited to increased exports; the opening of the economy toward imports and capital inflows were included as well. Foreign capital helped to boost investment significantly above domestic savings. This complex policy regime succeeded in part because intervention was guided by clear criteria of economic efficiency. Korean policies established a direct link between profitability in world markets and domestic incentives.

Korea first adopted a strategy of export promotion with the expectation that it would accelerate growth by relaxing foreign exchange constraints and increase efficiency through resource allocation in line with comparative advantage. These expectations were more than fulfilled. Exports also led economic development in a more fundamental sense; that is, in the establishment of new industries and in the acquisition of added technological capability in existing industries.

In the early phase of industrialization, the prominent feature of technological development was the importance of informal transfers of technology including imitation and apprenticeship and the limited extent of reliance on proprietary transfer of technology such as FDI and licensing agreements. The contribution of FDI to the expansion of exports was little during 1962-71. The first free trade zone explicitly designed to attract foreign participation in exports was not established until 1970. Among formal transfer of technology, turnkey plants and machinery imports had played the greater role. Such modes were typically accompanied by disembodied technology in the forms of manuals and training. Rapid industrialization without extensive reliance on proprietary transfers of technology was in part explained by the nature of technology and product differentiation in the export industries that led industrialization until the mid-1970s. These industries had used relatively mature technologies. In such cases, mastery of well-established and conventional methods, embodied in equipment readily available from foreign suppliers, was sufficient to permit efficient production. The products of these industries were either quite highly standardized or differentiated in technologically minor respects and not greatly dependent on brand recognition for purchaser acceptance. Hence, few advantages were gained from licensing or direct foreign investment as far as technology acquisition and overseas marketing were concerned.

The sources of the basic production technologies most frequently cited were buyers of output and suppliers of equipment or materials. The next most important were employees with previous experience working in firms overseas—many as a result of training under

turnkey and similar arrangements—and in domestic establishments. Formal mechanisms of licensing and technical assistance were cited only a third of the time that foreign sources were indicated. In turn, foreign buyers contributed informal transfers of technology, frequently as a result of periodic visits to inspect production facilities, or ongoing programs to control and improve quality. The transfer of knowhow from export buyers had contributed to minor process innovations of the sort that sequentially led to gradual improvements, the cumulative effects of which had been great.

For product-design technologies that either conform to the structure of demand or anticipate changes in demand, exporters had relied heavily on foreign buyers far more so than for process technology. Foreign buyers had contributed to product innovation through the influence they exercised on the characteristics of exported products. Most exported products were produced in direct accord with buyers' specifications—product design, styling, packaging, basic and minor technical specifications—and the characteristics of products were modified to accommodate buyers' requests.

The underpinning of export performance during the 1960s can be understood in the conventional paradigm of static comparative advantage. Exports were concentrated in industries where Korea either already had or could easily acquire the needed technological capability. Moreover, these industries had factor intensities in line with relative factor endowment. It was in the late 1960s that export activity became important in establishing new industries in which Korea did not already have technological capability. In the late 1960s, new industries were established to serve both the domestic and export market.

For some of these new industries characterized by pronounced economies of scale, constructing plants at scales sufficient only to meet expected domestic demand would have resulted in production costs well above internationally competitive levels. Thus, exports were used to gain the economies of scale needed to realize the potential comparative advantage that Korea had in such industries. Some other new industries recorded low domestic sales in the beginning. A few, the electronic components industry being an early example, were created by FDI or relied on other forms of international subcontracting for technology transfer and market access. The remainder of these new industries, such as large-scale shipbuilding, obtained their technology through licensing and turnkey plant contracts and did not have guaranteed markets when they first appeared.

Export activity undoubtedly enforced and fostered the acquisition of technological capability.[3] Exporting required the ability to meet product specifications at a competitive

3. Transfers of technology often accompany FDI, and may also be an integral part of transactions involving other means of international subcontracting. But there were few such instances in Korea, since FDI and international subcontracting had not been very important to most exports.

price. And the drive to penetrate overseas markets stimulated efforts leading to the gradual upgrading of product quality. These might even be the most important ways in which export activity adds to technological capability.

2. Promotion of Heavy-Chemical Industry

Despite interventions, there had been little sectoral bias in development strategy prior to the early 1970s.[4] The shift from general export promotion to the heavy-chemical industry drive was announced in 1973. The heavy-chemical industry drive involved government initiatives in sector-specific import substitution. The heavy-chemical industry promotion had already been an important priority in the Third Five-Year Plan. The objective of deepening the industrial structure had been seen as a logical response to a rapid increase in the domestic wage rate and increased global competition in traditional export industries. The Heavy and Chemical Industry Development Plan, launched in 1973, called for an accelerated schedule because of the new political and economic environment.

In the early 1970s, the external environment facing Korea went through a series of drastic changes. In 1971, the Nixon Administration reduced the U.S. troop level in Korea by one third, and the Bretton Woods system began to fall apart. The reduction in U.S. troops was seen as the first of several moves toward the eventual withdrawal of all U.S. troops from Korea, and this prompted the government to seek an industrial base for an independent defense effort. As for the Bretton Woods system, it was widely believed that the breakdown of the system would lead to a balance of payments adjustment by exchange rate modifications, and that a period of freer trade would begin after the system broke down. It was also expected that the steady decline in the value of the U.S. dollar would stimulate exports, since the Korean currency was rigidly pegged to the dollar. In actuality, the opposite occurred. With the rise in protectionism, the Korean economy was forced to diversify trade partners and to restructure the commodity composition of its exports in favor of more sophisticated, high value-added industrial goods. The latter requirements along with the desire to develop defense industries led to efforts to accelerate the development of heavy and chemical industries to a degree unjustified by factor endowments. The quadrupling of oil prices between 1973 and 1974 and the subsequent deterioration in external accounts further intensified the government's efforts to accelerate the development of heavy and chemical industries. The government believed that the new directions required large-scale risky investments, which would not be undertaken by private firms without decisive government leadership.

4. Although special laws promoting machinery and shipbuilding were adopted in 1967, and basic materials and intermediate goods were frequently mentioned as an objective, the First and Second Five-Year Plans identified labor-intensive exports as a high priority, and the export imperative generally dominated government policies.

The basic goal of the plan was to promote skilled labor-intensive export industries such as machinery, shipbuilding and electronics. The government assisted the introduction and local adaptation of foreign advanced technologies as well as private R&D investments.[5] Support measures were taken to facilitate diffusion of technology and management skills, as well as increasing the supply of skilled manpower. The government also took steps to correct imbalances among industries created in the course of rapid industrialization, and to foster inter-industry linkages by promoting subcontractor SMEs. A number of steps were taken to promote SMEs. Business areas suitable for SMEs were protected. Specialization of subcontracting SMEs was encouraged to strengthen the linkages with large assemblers. Capital-intensive industries such as iron and steel, non-ferrous metals, and petrochemicals were established on scales large enough to ensure competitiveness in the world market. A petrochemical industrial estate was developed in Yeocheon district, where a naphtha cracking center and nine related plants were built. The light industry was encouraged to strengthen its competitiveness through quality improvements and product diversification. In textile industries, policies focused on improving product quality and competitiveness, replacing old and obsolete equipment, and developing design capabilities and dyeing techniques.

Highest priority was given to investment in the machinery industry. To improve the competitiveness of locally produced machines, the government liberalized the import of basic materials, parts and components, and machineries that could not be produced locally at competitive costs. The import of foreign advanced technology and private R&D activities were encouraged. To expand the export capacity of the machinery industry, new product development was subsidized. To improve product quality, the government enforced standardized production for machine parts and materials together with strict inspection and quality control. Local financing was provided to encourage domestic production of equipment. Purchase of plants on a turn-key basis was discouraged. Export promotion was intensified through a sales engineers training program. The promotion was concentrated on the development of strategic items in basic materials, machine parts, machine tools, and industrial machinery. To promote product specialization and inter-industry linkages, small and medium scale machinery plants were designated and supported intensively. A machinery industrial estate was constructed in Changwon district, which contained over 100 plants.

The electronics industry was promoted as a major export industry. The government encouraged the local production of basic components and parts that were typically imported,

5. For example, to induce local development of new shipbuilding technology and design capability, advanced foreign technology was imported. Measures to raise the level of technical sophistication in the non-ferrous metal industry included importation of the latest smelting techniques and development of special alloy production techniques.

to develop new technology products, and to expand overseas sales activities. Strategic products were selected, which included 57 items such as semi-conductors, computers, and related items. An industrial estate was constructed for the production of semi-conductors and computers, where a research institute was established to assist in the adaptation of advanced technology and accelerate technical progress.

By enforcing legislation, small and medium-scale industries (SMIs) were induced to specialize in the production of parts and components, and semi-processed goods. In an effort to improve the structure of SMI, financial support for the modernization of production facilities, especially for the replacement of old and obsolete equipment, was expanded. To induce technical innovation and productivity improvements in SMI, programs for technical and management guidance were carried out through industrial and university research institutes. Industrial estates for SMI and collective estates for each industry were developed. Common service and testing facilities to enhance standardized production, quality improvement, and product specialization were established in the industrial estates.

The promotion of heavy and chemical industries was supported by a broad range of policy measures. A new Tax Exemption and Reduction Control Law (1975) introduced five-year tax holidays, investment tax credits, and accelerated depreciation to designated industries. Other industries faced higher taxes. The commodity tax exemption previously available to all exporters was withdrawn. Important export preferences were reduced, including wastage allowances, public utility subsidies, and the scope of export credits. The macroeconomic consequences of the heavy-chemical industry drive further injured export industries. Since the high rate of capital formation was supported partly by rapid monetary expansion, inflation accelerated. But the nominal exchange rate was held constant to minimize the pressure on prices. The result was a sharp appreciation of the real value of the won currency and significant erosion in the competitiveness of a wide range of export industries.

The overall level of effective protection fell due to the appreciation of the exchange rate, but effective protection rates became dispersed with higher rates offered to the targeted industries, and lower rates facing traditional export industries. Protection was viewed as a selective surgical tool for advancing sectoral priorities and investment programs. The automatic exemption of direct and indirect exports from tariffs and import controls was revised to increase the domestic sales of producers in the heavy-chemical industry. The tariff concessions, previously granted to exporters on a wide range of products, were reduced or eliminated. Newly established "Prior Import Recommendations" permitted certain imports for export production only if the price advantage of the imported item exceeded a minimum level. Certain imports in some industries were prohibited even if used for export production. Minimum domestic content requirements were established for large plant facilities and

for plants built with foreign loans. These measures undermined one of the most effective components of the previous incentive regime. The margin of incentives favoring exports deteriorated substantially.

However, the intervention that mattered most and had the greatest impact on industrial incentives and structure was the allocation of credit. To finance the accelerated development of the heavy industries, the government relied heavily on its control of the entire credit system and provided strategic industries with preferential access to credit at substantially subsidized rates. The high interest rate policy of the late 1960s was discontinued in 1972, and a lower interest ceiling was introduced. Real bank interest rates were negative throughout the 1970s and created severe excess demand for bank credit. The differential between bank rates and those charged in the curb market represented a substantial discount for industries eligible for credit from the government-controlled banks.

Policy loans accounted for between 47.5 percent and 60.2 percent of total domestic credit during the 1970s. Beginning in the early 1960s, the government made extensive use of a wide range of incentives designed to assure private industry's compliance with its ambitious development plan. Differential access to credit was the most widely used incentive. Access to a stable and low-cost source of credit was the most effective instrument since Korean industries were heavily indebted, and the larger proportion of their liability was in the form of short-term debt. The government allocated cheap bank credit and foreign loans, and controlled the interest rates to change the expected rate of return on investment. In the 1970s, foreign and bank loans accounted for about half of the available funds for the corporate sector, and the cost of these two sources of credit was the cheapest due to strict interest ceilings on bank credit and continuously fixed exchange rates.[6]

The substantial gap in access to capital contributed to rapid growth and high profitability in selected industries despite their relatively low rate of return. The strong government intervention created substantial distortion in the allocation of financial resources by creating large disparities in the cost of capital among different sectors. Heavy-chemical industries, export industries and large firms had greater access to capital and lower capital costs than

6. The use of policy loans was pervasive; and at the end of 1981, there were 221 types of policy loans extant among the total 298 types of bank loans. By source, policy loans could be classified into those financed by the government, either directly or through Bank of Korea rediscounting on the National Investment Fund (NIF) and those funded by banks. While it is impossible to assess the full role of policy loans in the credit system, lending by the NIF and deposit-money banks provided good insight into how directed credits were used to underpin industrial objectives. The NIF, established in 1974, lent as much as two thirds of its portfolio to HCI projects. Whereas the NIF was the most visible and most clearly directed financial support for specific industries, it only constituted between 3.0-4.5 percent of total domestic credit during this period. Therefore, its real impact on credit allocation stemmed from its "announcement effect" on bank lending practices. It was estimated that one third of bank lending went into policy loans. Strategic industries received favored access to other bank lending as well, as compared to traditional industries producing either for the domestic market or for export.

did light industries, domestic industries, or small and medium-sized firms.[7] The former grew at higher rates, although their rates of return on investments were significantly lower. The government could also change the perceived risk of an investment by assuring a stable flow of bank loans to selected industries regardless of their economic or financial performance.

Strategic industries, such as chemicals, basic metals, and fabricated metal products and equipment, received favored access to bank loans. The share of credit allocated to the three strategic industries almost doubled from one third of total deposit-money bank loans in 1973-74 to about 60 percent in 1975-77. Supported by policy loans, fixed capital formation expanded sharply, but its contribution was primarily in the form of increased capacity in the heavy-chemical industry. Nearly all of the investments projected by the Fourth Five-Year Plan (1977-81) in the heavy-chemical industry were completed by 1979, while the investments planned in other industries were less than half completed. Nevertheless, neglected industries like textiles managed to survive, and indeed carried the greater share of export performance in the latter half of the 1970s, while most of the heavy-chemical industry lumbered along with excess capacity. The heavy and chemical industry not only had better access to capital, but also enjoyed much lower borrowing costs.

The growth rate of exports slowed to 8.4 percent in between 1973 and 1979. The fixed nominal exchange rate and inflationary demand policies led to an appreciation of 23.6 percent of the real effective exchange rate between 1973 and 1979. A rapid increase in wages and lack of access to bank credit also injured the profitability of labor-intensive exports. As a result of an overheated labor market, real wages in manufacturing industries more than doubled from 1974 to 1979. Because of an appreciation of the real exchange rate and expansionary demand policies, the current account deficit as a share of GNP increased from 1.1 percent between 1975 and 1976 to 6.7 percent in 1979, and then 8.7 percent in 1980. In response to deteriorating external accounts, the government encouraged the exports of construction services to the Middle East, which expanded sharply due mainly to heavy government subsidies.

Despite the slowdown in export growth, the Korean economy achieved an annual growth rate of 8.2 percent between 1973 and 1980, due mainly to expansionary aggregate demand policies and heavy foreign borrowing. Nevertheless, external debt grew at an annual rate of 28.8 percent, and the expansionary monetary policy resulted in a high inflation rate of 21.3 percent. The rapid increase in investment supported by an expansionary policy initially

7. Beginning in 1974, the year of inception of the NIF and the year when heavy industry began to claim a decidedly larger share of preferential loans, the gap in effective borrowing costs began to widen in favor of HCIs. Indeed, between 1975 and 1978, at the height of the HCI push, the cost of borrowing averaged approximately 25 percent lower for the heavy compared to light industry. A similar bias was evident in the ratio of the average borrowing costs of large companies versus SMEs. This disparity began to recede over the 1979-80 period of reform, and the bias in favor of exports was reestablished.

neutralized the recessionary effect of the sharp drop in the terms of trade. Between 1972 and 1975, the terms of trade deteriorated by 30.0 percent. An expansionary monetary policy, however, resulted in a large foreign debt-financed current account deficit, which reached 10.9 percent of GNP in 1974. In addition, the large deficits in the government-run Grain Management Fund and the Fertilizer Account were responsible for a rapid growth in money supply during 1976-78. A sharp rise in the import prices of grains after the first oil shock led to an extension of the price support program for self-sufficiency in the major food grains in 1975-78. The sharp rise in the domestic wage rate together with remittances from the Middle East resulted in excess demand for many wage goods. The government imposed price controls on wage goods, which merely resulted in a flourishing black market. The labor market was very tight: the unemployment rate fell almost continuously during the period, reaching 3.2 percent in 1978, and then increasing slightly to 3.8 percent in 1979 and 5.2 percent in 1980.

It is now widely accepted in Korea that the heavy-chemical industry drive was overambitious and resulted in a serious misallocation of resources. Investment was not sufficiently conditioned to the test of export performance. In some industries, investment exceeded levels consistent with market size, technological capability, and financing capacity while, in others, the investment program was continued beyond the point when market signals turned negative. The heavy-chemical industry program substituted bureaucratic judgments for market tests, and absorbed too much of the economy's resources. Investment funds were preferentially allocated to heavy and chemical industries at the expense of light industries, which consequently faced severe difficulties in raising the financial resources necessary for improving their cost-competitiveness and upgrading their quality, skill and technology levels. The feedback mechanism between government and business was neglected. Interactive decision-making between business and the bureaucracy—the close balance between private initiative and bureaucratic monitoring—diminished in proportion to the overwhelming support provided for key industries. It was more important to participate in the HCI program than to produce efficiently or to build export markets. The rapid expansion of debt financing for heavy industry investments led to the overheating of the economy and the acceleration of inflation, which in turn further eroded export competitiveness, especially between 1978 and 1979 when the nominal exchange rate was held constant despite considerable erosion of the real exchange rate.

There is little doubt that the large scale investment in the heavy and chemical industry distorted capital markets and was economically costly in the medium run. Nevertheless, in evaluating this policy, it is only fair to add that many of the objectives of the policy were in fact achieved. Exports of heavy and chemical industry products did not reach the levels set for 1980, but exceeded them only a few years later. The industrial structure also shifted rapidly toward the heavy-chemical industry.

The Korean economy had made strong progress in shifting its export structure from labor-intensive to capital- and skill-intensive products by the early 1980s, even though textiles and garments still occupied the largest share of exports. Light manufacturing exports, such as wigs and plywood, were replaced by capital-intensive products like ships and steel. Comparative advantage emerged during the 1970s in industries with higher physical and human capital intensity. This was attributable not only to rapid capital formation supported by industrialization policies, but also to incentives given to capital-intensive exports. Although costly to establish, capital-intensive industries had eventually obtained competitiveness in the world markets. The export ratio of the heavy-chemical industry rose substantially from 7.4 percent to 19.3 percent in 1970-80. The rations were relatively low in chemicals and primary metal manufacturing, but higher in metal products and machinery. In electronics and transportation especially, the ratios were even higher than those for textiles in the early 1980s. This indicates that export expansion provided the impetus to output growth not only for light industries, but also for heavy industries. During the 1970s, export incentives still played an important role in the rapid expansion of output.

The heavy-chemical industry promotion policies were also effective in reducing import dependency. The share of intermediate inputs in production increased continuously from 50.4 percent in 1970 to 60.4 percent in 1980, indicating a deepening of inter-industry linkages. Inter-industry linkage in Korea has been higher than in other developing countries with similar levels of per capita income, and much closer to the pattern observed in advanced countries such as Japan. Domestic linkage in Korea, however, has been significantly lower than in Japan, which indicates that the Korean economy achieved a high level of inter-industry linkage through importation of intermediate goods. Reliance on imported intermediate inputs in production of heavy-chemical products increased in 1970-75, but has declined since that period. Within those trends, however, changes in import dependency have not been uniform among subsectors. In primary metal manufacturing, import dependency declined substantially during the 1970s, while in metal products and machinery it rose slightly up to 1975 and then declined steadily. In contrast, import dependency in chemicals increased continuously throughout the 1970s, probably due to rising oil prices. Although import dependency in heavy industries declined rapidly in the 1970s, it remained significantly higher than that of advanced countries into the early 1980s. The heavy-chemical industry's share of total output almost doubled during 1970-75, and continued to rise significantly up to 1980. The heavy industry thus surpassed the light industry in its share of total output by 1980. The increase in composition share has been particularly substantial in general machinery, electrical machinery, and transportation equipment.

From a comprehensive, dynamic perspective, an evaluation of the heavy-chemical industry promotion policy calls for in-depth analysis. However, it is hard to demonstrate

that an alternative strategy would have had better results. The policy was distinct from the inward-looking import substitution policy, in that it aimed at promoting export industries with higher capital and skill intensity. The import dependency of heavy chemical industries remained quite high into the early 1980s, and yet heavy industries managed to expand exports. This indicates that the heavy and chemical industry was promoted in such a way so as to be highly integrated with the global economy. The strategy was effective in some industries, but ineffective in others. It may be true that some of the successes could have been attained at a lower cost, but it may also be argued that disappointments in some industries were due to external causes, and that the variance in outcomes was inevitable in light of the inherent risk assumed by the heavy-chemical industry program.[8] It may be also argued that private firms would not have been willing to bear the risks without the virtually unlimited government support. On the whole, the structural transformation effected by the Heavy-Chemical Industry Promotion Policy was consistent with emerging changes in comparative advantage, but occurred too rapidly, and at a high cost.

Until the mid1970s, the government's technology strategy largely operated on the accumulation of production capability. The government policy discriminated against domestic investment capability, most notably by favoring imported capital goods. This bias was reversed when the Heavy Chemical Industry Promotion Plan was announced. The plan called for the buildup of capacity to manufacture capital goods, in particular the fabricated structural elements and equipment used in industrial plants producing basic intermediate goods, power generation and transmission, and other social overhead facilities. Export activity likewise became an integral part of efforts to promote the acquisition of technological capability. Legislative acts to promote technological development included the provision of incentives for exports of the elements of technology. These measures were supplemented by

8. The integrated iron and steel mill, POSCO, had continued to operate near capacity despite a major slump in world steel markets. While the industry had become technologically efficient, it was developed with highly subsidized capital and thus might not have been an economically efficient investment in and of itself, although it provided benefits to the economy in a dynamic sense. Consumer electronics had achieved a strong competitive position in the world market, although some of the most successful branches of the industry involved assembly of imported components. Other industries became competitive but faced unusually adverse changes in the world markets. Shipbuilding sharply increased in world market share and operated profitably during the boom of the late 1970s. Even though world capacity utilization began to decline at around that time, Korea's competitive position seemed so strong that capacity was rapidly expanded. The utilization of this new capacity proved disappointing; and utilization rates in the 1980s fell as orders declined. Automobiles presented a reverse case of mixed results. Early experiences with expansion were disappointing. Yet the industry had some startling market successes since the mid-1980s. The weakest results of HCI investment were seen in segments of the petrochemical and heavy machinery industries. Fertilizers were a prime example of over-ambitious investment. Investment in capacity far exceeded domestic demand. Heavy machinery investment, particularly at the Changwon machinery complex, overestimated domestic and world demand for electrical generators and equipment for heavy industry, failing on the whole to produce competitively priced products. The industry underwent a series of reorganization in the early 1980s.

others that were designed to foster education and training in various technical fields, as well as to establish an infrastructure of scientific and technological institutes to support industry.

FDI had been an important vehicle for technological development in establishing the chemical industry and the electrical and nonelectrical machinery industries. FDI had also contributed to technological development in the basic metals sector.[9] Licensing had been an important source of technology transfer in many of the same industries as FDI – chemicals, basic metals, and machinery. In the chemical industry, extensive reliance on FDI was inevitable to establish and expand production, primarily due to the reluctance of the technology suppliers to transfer technology via other modes. But in other industries where technology was also proprietary, Korean had managed to initiate, and in most cases to operate successfully, a variety of high technology industrial activities by means of licensing and turnkey arrangements. Formal transfer of disembodied technologies had played a minor part in technological development. In technologically sophisticated sectors, however, technological development involved greater reliance on R&D as well as licensing as a way of acquiring technology.

Reliance on imported capital goods had, in contrast, been relatively large. Imports of capital goods were more than 20 percent of the investment throughout the 1970s. Dependence on imported capital goods should be seen as a result of specialization within the capital goods sector and of the demands of a rapidly growing and diversifying industrial sector rather than as the result of failure to develop a capital goods sector. Over time, all the important metalworking processes, such as casting and machining, were assimilated by domestic firms and used in copying many types of imported equipment, with the designs subsequently modified on the basis of experience to make them more appropriate to local circumstances. The capability to design and produce capital goods was oriented toward more labor-intensive segments of the machinery industry. Most export industries used imported equipment extensively, as did most new industries established under government incentives.

9. By the end of 1981, in the manufacturing industry, 693 instances of FDI had been approved. The cumulative gross inflow amounted to roughly US$1.25 billion, which was small when compared with the cumulative total investment in manufacturing over the same period, US$22.7 billion. The cumulative value of technical assistance in manufacturing by the end of 1981 was less than US$100 million, as was the cumulative value of technical consultancy by private parties. The number of manufacturing technology imports during 1962-81 totaled 1,840; and royalty payments amounted to US$565 million. The volume of licensed imports was modest until the mid1970s. The increased reliance on licensing can be explained by the accelerated development of technologically more advanced industries in later years. Much of the inflow of FDI in 1972-76 was approved on the condition of exports. The principal sectors for the FDI included textiles and apparel, chemicals—synthetic fibers and resins plus petroleum refining and other chemicals—and machinery. Much of the FDI in textiles and apparel and electronics were related to production for export and played a small role in technological development. In the former sector, the inflow mostly consisted of the relocation of small plants from Japan to take advantage of low wages. In the latter sector, a large share was earmarked for offshore assembly with very little spin-off to local producers. However, FDI for offshore production became relatively less important after 1976.

The effective assimilation of technology came partly from human capital formation. Important features of the educational pattern in Korea were the high secondary enrollment rate, the high percentage of engineering students among post secondary students, and the high proportion of post secondary students abroad. Even more remarkable was the rapid growth of scientists and engineers. Compared with other newly industrialized economies (NIEs), Korea likewise had proportionately more scientists and engineers engaged in R&D and spent proportionately more on R&D.

Korean exporters had relied extensively on foreign sources for product innovation. Such reliance was inevitable when technology was transferred to start new lines of production intended to serve export markets from their inception. But reliance could also develop if production had first been established to serve the local market, with exports following later. Here, mastery of technology was in the first instance often confined to achieving rudimentary standards of product design. These standards might suffice to gain entry into export markets, but continued growth of exports sooner or later required that product standards be upgraded. Successful penetration of export markets frequently required that product specifications be tailored to the different demands of individual markets. It was more cost effective to rely on export buyers for product design technology until some experience had been gained in producing to meet differentiated demands. Production for export provided a potent means of acquiring product design technology through learning by doing, which spilled over to product development in local markets as well.

3. Liberalization, Restructuring and Technological Development

In 1979, the Korean economy faced structural problems and macroeconomic imbalances. While the macroeconomic shock was mainly external in origin, the industrial policies of the 1970s had reduced the resiliency of the economy; inflation was already high, reflecting an overheated economy; capacity utilization in the heavy and chemical industries was low; and exports were faltering. In the early 1980s, the new government sought to (1) stabilize macroeconomic conditions, (2) resolve mounting financial problems in heavy and chemical industries, and (3) establish new directions for industrial policy. Top priority was given to fighting inflation. Paying close attention to curbing inflation, the government also put greater emphasis on institutional and structural reforms aimed at improving the efficiency of resource allocation. It was generally agreed that efforts should be concentrated on technology- and skill-intensive rather than capital-intensive industries, and that the incentive regime should be reformed for industrial restructuring. These efforts led to important steps toward major reforms in three areas, including financial liberalization, realignment of the industrial incentive system, and promotion of competition among domestic and foreign firms.

In response to unduly slow recovery, the stance of fiscal and monetary policies was relaxed somewhat during 1980-81.[10] Monetary expansion slowed substantially after 1982. During 1981-82, exchange rate management remained relatively rigid so as to minimize the inflationary pressure from rising import costs. After a 35 percent nominal depreciation in 1980, the exchange rate appreciated 4-5 percent in real terms over the next two years. Stabilization efforts also relied on income policies, including informal wage guide lines, stabilizing government purchase prices for major grains, and controlling interest rates and dividend payoffs.

The combination of these policy responses and falling unit import prices resulted in a sharp decline in the inflation rate, from 25.6 percent in 1980 to only 7.1 percent in 1982. Real GNP, which decreased 5.2 percent in 1980, recorded only a modest recovery of 6.2 percent in 1981, despite relatively good export performance aided by large exchange rate depreciation. Growth performance for 1982 was also disappointing with the slowdown in export growth. On the other hand, the annual current account deficit fell from US$5 billion, during 1979-81 to US$2.7 billion by 1982, mainly due to improving terms of trade and active overseas construction in the Middle East. Nevertheless, Korea emerged as the fourth largest borrower among developing countries, with more frequent loan rescheduling as the international financial market became increasingly unstable. The government therefore decided to give higher priority to reducing the external debt and improving the balance of payments.

In line with the economic recovery from 1982 onward, the focus of macroeconomic policies shifted toward consolidating price stability and eliminating the current account deficit. Both fiscal and monetary policies remained very restrictive.[11] Expansion of the M2 was slowed to 19.5 percent in 1983 and 11-12 percent during 1984-85. Bank interest rates were adjusted slightly upward to make them more attractive to deposits relative to non-bank rates. In line with renewed concerns about the external balance, exchange rate management was made more flexible to allow the real effective rate to depreciate 9 percent in 1983-84.

The economy regained strong growth momentum in 1983. Real GNP grew by 9.5 percent. Private consumption and construction initially led the recovery, but from the latter half of

10. Recovery took much longer than expected because of external conditions such as the second oil shock, the rise in international interest rate, and the slowdown in OECD economic activity. Financial support for small and medium-sized firms, public construction, residential construction for low-income families, and exports of heavy industrial products on a deferred payment basis were increased. The tax system was also utilized actively. Temporary investment tax credits, reduction in personal and corporate income taxes and selective use of capital gains and special excise taxes were introduced. The government also prepared a supplementary budget and borrowed for speedy spending.

11. The general account budget was designed on zero-base budgeting to generate a sizable surplus in order to finance the deficits in some government-run funds. Consequently, the consolidated public sector deficit was reduced from 4.3 percent to 1.4 percent of GNP between 1982 and 1984.

1983, an increase in exports had been the major source of growth. Late in 1984, however, export growth began to falter, in line with a slowdown in the U.S. economy and rising protectionism against Korean exports. Housing and other private construction activity were also sluggish, and GNP growth slowed from 7.5 percent in 1984 to 5.4 percent in 1985. The government pursued stimulatory measures, including further depreciation, a relaxation of monetary policy, a new investment tax credit, and a stimulatory supplementary budget. In 1986, the growth rate of real GNP accelerated to 12.5 percent, primarily due to sharp export expansion of more than 26 percent. As export growth recovered in 1983-84, the current account deficit fell steadily to US$1.5 billion. In the face of declining revenues from overseas construction and growing protectionism abroad, the current account deficit fell further to US$0.9 billion, mainly because of a drop in imports of almost US$1.0 billion. The government made efforts to improve the maturity structure of external debt. As short-term borrowing was discouraged, its share of total foreign debt declined steadily from 33.5 percent in 1982 to 23 percent by the end of 1985. However, only in 1986 was there a big turnaround in Korea's external balance.

The policy shift toward greater industrial neutrality was clearly articulated in the Fifth Five-Year Plan. The proximate cause for the shift in strategy was mounting evidence of structural distortions and financial losses caused by the heavy and chemical industry drive. A greater role for the market emphasized in the Fifth Plan was eventually reflected in financial and import liberalization programs. The government began to reduce its role in credit allocation and terminate policies that awarded the heavy and chemical industry large-scale preferences. The tax reform of 1981 largely reduced the scope of special tax treatment for key industries. Special depreciation became the only available option for most beneficiaries as the tax holiday option was replaced, and the scope and degree of the investment tax credit option were narrowed. Financial liberalization started by lifting restrictions on bank management and by divesting government equity shares in five nationwide commercial banks by transferring ownership to private shareholders, although the government continued to exercise significant influence over banking decisions. New financial institutions were established, and some growth in the international activities of domestic banks and the domestic activities of foreign banks was permitted. Real interest rate rose to reduce the gap between the organized market and the curb market. Interest rate subsidies were eliminated; and the size of special funds was decreased. With regard to protection, the government committed itself to increasing the liberalization ratio, from 69 percent in 1980 to 95 percent by 1988, according to a schedule announced in advance. The customs law was revised in order to reduce variations in protection. The average legal tariff rate was lowered by one third and continued to decrease according to a schedule during 1984-88. The system of controls over foreign direct investment was partially liberalized.

Significant progress was made in credit management and the interest rate. By 1982, most policy loans were no longer extended at preferential interest rates, making it easier to scale down policy loans. The relative share of policy loans actually declined. Flexibility in interest management was introduced in 1984 to allow financial intermediaries to determine their own lending rates within a given range. However, further financial liberalization has been hindered by the legacy of heavy intervention in private resource allocation in the 1970s. The government would not let troubled firms go bankrupt for fear of enormous financial losses to the banking sector and the ensuing social and economic repercussions. The government helped the banking institutions by permitting attractive new services while tightening controls on non-bank interest rates, providing subsidized central bank credit, as well as waiving the capital gains tax on collateral supplied by the troubled firms. In other words, the cost of imprudent government intervention that was paid by consumers and tax payers resulted in continued financial problems.

The more extensive interest rate deregulation took place in 1988, by which time price stability introduced in 1983 and high national savings in excess of domestic investment had narrowed the disparity between regulated and free market rates. Policy-makers believed that flexible interest rates were essential for domestic monetary stability with freer external capital flows, and that continued interest rate controls could lead to under-pricing of capital-intensive investment due to rapid wage increases with stronger labor unions. Deregulated interest rates included bank and non-bank lending rates and most capital and money market rates. The actual results of interest deregulation fell short of expectations. Bank lending rates and most rates in the primary securities market were very rigid and unresponsive to market conditions, indicating that Korean financial market was far from full integration and operation on a purely competitive basis. The phenomenon seemed to be due in part to limited interest rate deregulation, and also to an inertia and mentality of the past when most financial institutions were run like public enterprises.

Despite the general thrust toward neutrality, the government continued to take an active role in restructuring distressed industries, supporting the development of technology, and promoting competition. An active role in these functional areas could be regarded as consistent with the liberalization efforts, at least to the extent that it could be rigorously justified on the basis of market imperfections. After the second oil shock, several industries, including shipbuilding, shipping, and overseas construction, suffered severely from declining orders, overcapacity, and financial distress. The government had to intervene to bail out many troubled firms because the situation was partly due to its promotion policies in the past, and since major bankruptcies could bring about grave repercussions in labor and financial markets. The firms involved were large and highly leveraged, with their loans representing a significant share of commercial bank assets. A rationalization

program involved mergers and capacity reduction, as well as general support to commercial banks. But the rationalization programs were criticized for excluding the involved financial intermediaries in designing the programs, for being largely firm-specific rather than industry-specific, for their inconsistencies across cases, and for their failure to clearly define the extent of government commitment.

In these restructuring operations, the government bypassed competitive solutions. Reluctance to permit market forces to guide the adjustments appeared inconsistent with the policy emphasis on liberalization. However, it can be argued that there were justifications for some intervention in the Korean context. Financial distress was so widespread that it had threatened the viability of commercial banks as a group. Allowing the failure of major commercial banks would have undermined confidence in Korean finance with serious repercussions for access to foreign capital. Korean banks had little experience in dealing with financially distressed firms. Non-financial firms could not be counted on to finance mergers or buyouts of other troubled firms since they were highly leveraged. The government also believed that letting firms fend for themselves would have increased private perceptions of investment risk and undermined its ability to implement policies in the future, since the investment programs that generated the financial distress had been encouraged by past government policy.

Despite the possible validity of these justifications, the restructuring operations still had serious side-effects of a moral hazard nature. Repeated government intervention reduced incentives for positive private restructuring programs and encouraged firms to wait to be rescued by the government. Distressed companies could postpone restructuring until a rescue, hoping that their share in the final merger or cartel would be an improvement over scaling down or private merger proposals. These considerations were especially relevant to rescue attempts structured after the Japanese model, which tended to distribute cartel gains roughly in proportion with pre-cartel market shares.

An import liberalization program was adopted in 1983, by which time the Korean economy had almost corrected the severe external imbalances caused by the second oil shock. With the completion of the five-year liberalization program in 1984-88, the import liberalization ratio rose from 80 percent in 1983 to more than 95 percent in 1988. About three quarters of the items remaining under restrictions were primary products, foods and beverages. Together with the reduced quantitative import restrictions, the average nominal tariff rate was gradually lowered from 24 to 13 percent between 1983 and 1989. Import licensing, however, was also restricted by means other than the usual mechanisms. There were about 39 special laws that allowed relevant ministries to designate commodities requiring their import approval. A surveillance system had also been in operation to prevent import surges. Moreover, an import-source diversification program had been in effect

in order to ease excessive bilateral trade imbalances by providing protection to newly-developing industries.

Import liberalization did not bring about any significant industrial dislocations. This might be explained by the policy of providing advance notice and liberalizing first the items with a competitive edge. Firms producing the least competitive items had yet to be seriously affected as the liberalization coincided with appreciation of the won currency and rapid wage increases. On the other hand, there was evidence that firms responded to import liberalization with stronger efforts at quality improvement, technological development, and deepening of vertical intra-industry specialization.

Restrictions on FDI were also relaxed substantially in recognition of its most important role of promoting competition and transferring advanced technology. The Foreign Capital Inducement Act was revised in 1984 to switch to a negative system, to establish an automatic approval system, and to abolish restrictions on the repatriation of capital and the foreign ownership ratio. Tax benefits given to FDI had gradually been reduced to make most foreign firms subject to the same tax system as domestic firms. Since 1984, FDI increased rapidly.

The government showed a strong interest in institutions that would enhance competition behavior. It adopted the Fair Trade Law (1981), designed to guard against anticompetitive mergers as well as unfair advertising and restrictive trade practices. Most of the Office of Fair Trade's activities involved domestic unfair trade practices, which were resolved through the voluntary cooperation of the involved firms. The policy on mergers and cartels in the context of restructuring was set by the high-level Industrial Policy Council and did not generally involve the Office of Fair Trade. Measures to reduce business concentration had been in effect since the early 1970s, and this issue had received special attention in the Special Presidential Directives of 1974. Under these directives, firms were to issue public shares and take steps to divest unrelated businesses and real estate. In general, these measures had not been successful; and the share of the conglomerates in GNP rose markedly in the late 1970s, partly because the heavy-chemical industry drive emphasized scale-economy activities managed by large firms. In 1985, the government restricted additional bank lending to the five largest groups to their share of outstanding loans in 1983, but then quickly lifted the restrictions due to increasing pressures on export performance.

Intervention in technological development put emphasis on the establishment of institutions to train scientists and engineers, and to conduct basic and applied research. The government budget supported general research and scientific training, as well as special research centers for energy and resources, telecommunications, electronics, machinery and chemicals. Under the Fifth Five-Year Plan, national S&T investment was to be increased from 0.9 to 2 percent of GNP between 1980 and 1986.

To cope with the developments in the world economy—the increased catch-up attempts of latecomers, intensified competition among the NIEs, and technological protectionism in advanced countries[12]—it was imperative to deepen the industrial structure through technological advances. Efforts for scientific and technological development had been insufficient in the 1970s. Private investment in technology and manpower development had been negligible. Government and industry became aware of the importance of technological development to economic growth, and both began to increase their R&D investments in the early 1980s. To encourage private R&D investment, financial and tax incentives for technological development were evaluated and improved. The number of industries required to set aside reserves for R&D investment was increased, and the scope of available uses for such funds was also increased. Tax deductions for investments in technology and manpower development were widely provided. Financial incentives were adopted including extended application of the guarantee system for technological development funds to encourage commercial banks and other financial institutions to extend loans for R&D. A long- and medium-term purchase system was introduced to encourage industries to formulate longer range R&D programs.

A prerequisite to meeting the growing demand for R&D is securing high-caliber research manpower. The advanced degree courses of the Korea Advanced Institute of Science and Technology (KAIST) were expanded to increase the supply of high-level scientists and engineers; and the special training programs at government funded research institutes (GRIs) were intensified.[13] The KAIS (renamed as KAIST) was established in 1971 as a research-oriented science and engineering university. BY 1998, KAIST had produced 18,684 graduates, of which 11,092 obtained a Master of Science Degree, and 3,392 received a Ph.D. Overseas training in high-technology areas such as semiconductors and fine chemicals was intensified, and increased attempts were made to encourage overseas Korean scientists and engineers in these areas to return and work in their home country. Exchange

12. The appearance of low-priced Korean products in world markets had made foreign owners of proprietary technology wary of licensing to Korean companies to protect their own home markets.

13. The Korea Institute of Science and Technology (KIST), the first GRI, was established in 1966. KIST was a legally independent foundation but received financial support from the government according to the Promotion Act of the Korea Institute of Science and Technology. The government wanted to prevent the inefficiencies that existed at national or public institutes. By adopting a contract-based research system and attracting Korean scientists from abroad, KIST decided to concentrate its resources on studies of industrial technologies that would contribute to national economic growth. In 1967, the Science and Technology Promotion Act was enacted, and the Ministry of Science and Technology (MOST) was established. In 1971, the first GDI in the field of social science, the Korea Development Institute (KDI), was established. The establishment of KIST was followed by the creation of other institutes and organizations for the development of science and technology. There was a boom of GRIs in science and technology in the 1970s. Nineteen GRIs were in operation by the late 1980s. The GRIs had played a pivotal role in independent science and technology research at a time when universities or industry did not show a strong interest or did not possess sufficient competence in R&D (Moon 2011).

programs for scientists and engineers were introduced in collaboration with the industrial sector, the university, and GRIs – effectively advancing the quality of their manpower and promoting their industry-related R&D activities.

A National Project for Research and Development was established in 1982 to fund public as well as joint public-private R&D projects in the high-technology fields of electronics, chemistry, and engineering. With the help of these programs and new tax incentives under the Technology Development Promotion Act, which was reinforced in 1981, private R&D expenditures expanded rapidly, with an increase in the number of private research centers. Mutual cooperation and coordination among GRIs, industrial laboratories, and universities were promoted; and their major roles were clearly defined: GRIs chiefly engaged in the development of public technology; industrial laboratories in the development of industrial technology; and universities in the basic research and education of scientists and engineers.

The Korea Science Foundation's funds were increased, and a fixed portion of research funds for GRIs was set aside for basic research. Each university was also encouraged to set up its own, relevant basic research institute. It became one of the main responsibilities of GRIs to develop and disseminate common key technologies such as precision technology and durability technology. For this purpose, the support function of GRIs for the private sector was strengthened, and cooperative research among firms was encouraged. Support was provided for the development of high technologies with long gestation periods and extensive spill-over effects, such as biotechnology and new materials technology.

To expand the sources of investment for venture capital, technological development reserve funds could be used for venture capital investments. The conditions for listing stocks on the security exchange were eased for venture businesses, and a fixed portion of various pension funds was utilized for investment in venture capital. Investment trusts of unlisted shares of venture businesses were authorized, and large businesses were encouraged to set up firms specializing in venture capital. Special banks such as the Korea Development Bank (KDB) and the Industrial Bank of Korea (IBK) were encouraged to set aside venture capital funds. Industrial Parks were built in the vicinity of the Daeduk Science Park. Support in funding, taxation, sales, information, and R&D was provided to new technology-based enterprises. Engineers were sent abroad to acquire advanced technologies directly from the source, and Korean scientists and engineers working abroad in high technology areas were encouraged to return to contribute to the advancement of science and technology in their home country.

The reorientation of industrial policy began in 1979 and took root by the mid-1980s. Major financial distortions with respect to access to preferred sources of credit were reduced. Specifically, disparities in average borrowing cost between large and small firms,

and between heavy and light industries, were narrowed. In addition, perhaps to compensate for some lingering protection, export industries again began to obtain funds at a lower cost than domestic industries. Even in this area, however, there was a trend towards greater neutrality.

In order to further streamline the industrial incentive system and deal with industrial rationalization more efficiently, the Industrial Development Law came into effect in July 1986. The law replaced seven individual industry promotion laws and defined the role of government mainly as that of a trouble-shooter. The government was supposed to intervene for industrial rationalization in areas where market failure occurred. In industrial sectors where competitiveness was vital to the economy but could not be encouraged by the market alone, the government encouraged specialization through indirect incentives designed to promote technological advancement. In declining industries, the government intervened in the phasing-out process. Under the law, eight industries were designated for rationalization over two to three years. Included in rationalization programs for the four declining industries and four emerging industries were subsidized credit for upgrading capital equipment, mergers, barriers to entry, and long-term supply contracts.

The Sixth Plan (1987-91) also responded to numerous challenges at home and abroad. Externally, the most serious challenge was growing protectionism in advanced countries. Domestically, major issues to be addressed included continued industrial restructuring, enhancing technological innovation, promoting cooperative labor relations, and reducing economic concentration.

There remained institutions and practices restricting the autonomy and creativity of the private sector. The government made efforts to establish a market economy order. The government simplified various licensing systems that unnecessarily regulated the business activities of the private sector. At the same time, the autonomy of financial institutions was expanded to improve the efficiency of funds allocation through the use of market forces. To curb the economic concentration of a number of large conglomerates, excessive borrowings by such conglomerates were prohibited. These companies, instead, were urged to list their shares on the Korean Stock Exchange and increase their capital by allotting new shares to the public. Fair subcontracting practices between large firms and small subcontractors were promoted to enhance their complementary arrangements. Steps were taken to increase the availability of credit loans to SMEs and to strengthen institutional support for new entry firms, especially for manufacturing SMEs. The central government reduced its regulatory functions to an essential minimum, transferring such functions to the private sector or local governments where appropriate.

In response to changing external and internal conditions,[14] the Korea must foster machinery, electronics and automobile industries, which were relatively less intensive in resource consumption and more intensive in technical manpower. The government continued to encourage plant and equipment investment in potentially high-growth industries such as machinery, electronics, automobiles and fine chemicals. To bolster the weak industrial base, measures were implemented to accelerate the development of SMI. In this effort, particular emphasis was placed on the manufacturing of materials, parts and components, and machinery in order to reduce reliance on imports for such products, which accounted for much of Korea's trade deficit with Japan. These manufacturers were fostered so that they might eventually become exporters. Meanwhile, appropriate steps were taken to spur rationalization or realignment of declining industries. The light industries such as textiles and footwear needed to be restructured to produce export products with higher value added—diversifying products and improving product quality—and structurally vulnerable industries that were losing competitiveness had to be rationalized. To this end, the government promoted the development of technology and skilled manpower under the newly enacted Industrial Development Act. The government took steps to enhance productivity and induce businesses to revamp their business structures to increase the value added in production. As a basic strategy, it was preferable for each private firm to adjust its business structure on the basis of its own judgment of market conditions. While encouraging private initiatives in shifting toward industries with stronger competitiveness, the government took steps to bring about smooth restructuring of those industries that were structurally vulnerable, and would likely become both economic and social burdens, if left unadjusted.

For the development of the machinery industry, steady demand for domestically produced machinery and technological development of subcontracting SMEs were necessary. The government helped SMEs resolve common technological problems, especially those involving dies and molds, gilding, and heat treatment, while strengthening on-site technical guidance to eliminate technological bottlenecks. The quality certification system

14. As high-technology industries rose rapidly in importance, and industrial information became an important factor of production, advanced countries were expected to turn increasingly toward high-tech fields, including new materials, biotechnology, and the space industry, as well as software industries involving engineering and marketing. Newly emerging developing countries, on the other hand, were expected to participate actively in light industries, including textiles, wood products and to some extent in heavy industries. Given this expected shift in comparative advantage, the light industrial sectors such as textiles and footwear that had led Korea's economic growth were not likely to continue to grow as rapidly as in the past. Instead, the manufacturing and processing industries, such as machinery, electronics, and automobiles were expected to gain competitiveness. Moreover, the appreciation of the Japanese Yen against the U.S. dollar provided an opportunity for Korea to upgrade its industrial structure. The government facilitated the industrial restructuring, focusing on industries that produce high value added products and spurring the advancement in industrial technology.

was strengthened to enhance user confidence in locally manufactured machinery, while government funding to encourage domestic production of machinery was increased.

To develop the automobile industry as a leading export industry during this Five Year Plan, the government helped automobile firms attain economies of scale, while spurring production automation and computerization to improve productivity. The government also encouraged subcontracting SMEs to advance technology through products standardization and specialization. The government also encouraged cooperation with advanced foreign automakers and promoted technological advances that enhance the safety and fuel efficiency of Korean automobiles.

In the electronics industry, which had heavily relied on imported parts and components, the government emphasized the development of parts and components through technological improvement in order to increase the value added, as well as to increase employment opportunities for technical manpower. The government also encouraged the development of sophisticated electronics like semiconductors, automation equipment and software. To this end, a joint research system among high-tech electronics manufacturers was established. In order to increase the demand for sophisticated electronics products, the government expanded the information communications network, promoted office and factory automation, and encouraged small-quantity, multi-product production.

As a result of the growth of the capital goods industry such as automobiles, machinery and electronics, the demand for steel and nonferrous metals increased rapidly. To meet the increasing demand, steel production capacity was increased by completing the construction of the Kwangyang steel mills during the Five-Year Plan period. The government also encouraged an expansion of production capacity for special steel, including stainless hot coils and galvanized steel sheets. Demand was expected to increase substantially for certain kinds of nonferrous metals, such as electrolytic copper and aluminum. Since production of these nonferrous metals was highly energy-consuming, any expansion of production capacity required prudence. The smelting facilities for zinc and lead were expanded in line with trends in demand.

The shipbuilding industry had been in a world-wide recession in the first half of the 1980s and was expected to recover gradually in the remaining years of the decade. The government encouraged shipbuilders to bolster their competitiveness by improving production methods, developing multi-skilled manpower and introducing computer-aided design/computer aided manufacturing (CAD/CAM) techniques for ship design and ship building processes. The government also stepped up the development of domestically manufactured equipment and parts to lower shipbuilding cost, while encouraging the diversification of the business to include manufacturing of plants, rigs and other offshore structures.

The government facilitated technical innovation to enhance the product quality of textiles in response to increasing competition from late developing countries and tougher import restrictions imposed by developed countries. The textile industry was urged to replace obsolete equipment and to set up technological improvement in the development of new materials and high fashion designs that entailed greater value added. On-site technical guidance and introduction of advanced foreign technologies were also encouraged.

The demand for petrochemical products was projected to rise steadily during the Plan period. With the planned introduction of the material patent system, the demand for domestically developed fine chemicals increased rapidly. The government took steps to expand the production capacity for petrochemical products to an optimal level, while urging the petrochemical industries to convert their energy sources to liquefied natural gas (LNG) and other less expensive forms of energy and to upgrade their product quality. The government supported the development of domestic technology for the production of fine chemicals and intermediate materials used by other industries, as well as for the development of new materials.

The government took measures to accelerate technological development in both the public and private sectors, while creating institutional devices to ensure the efficiency of R&D investments. The government increased its own budgetary outlays for R&D activities in science and technology while at the same time provided strong incentives for private enterprises to boost their science and technology investment to 2-3 percent of their gross sales, a level comparable to those of advanced countries. Tax benefits and financial incentives for private R&D investments were augmented, and institutional protection for intellectual property rights with regard to newly-developed technologies was strengthened. The government increased its investments in basic research, which private firms tended to find difficult to undertake, and continued to pursue even more aggressively special R&D projects in strategic high technologies. Accelerated development of science and technology called for training capable scientists and engineers. Advanced science and engineering programs at the master's and doctorate levels were expanded. To train high-level technical manpower needed to lead high technology and industrial technology development, the government reinforced education and research in basic sciences at the science and engineering departments of graduate schools by expanding and upgrading their research facilities. The government also supported specialized research institutes affiliated with universities. To enhance the quality of high-level technical manpower, those who had acquired doctorates at domestic universities was sent abroad for advanced studies. In addition, a survey of technological manpower resources was conducted periodically, and the government established an agency to process such information and ensure sufficient supply of needed technical manpower to industries.

To spur commercialization of new technologies and to develop the market for new-technology products, the government supported the development of venture capital companies. At the same time, the government procurement system became more supportive of new products. To increase the efficiency of R&D investments, steps were taken to encourage research projects conducted jointly by industries, academia and research institutes. In addition, the government fostered the market for technological information by developing a technological information-gathering and marketing system.

In order to overcome the large gap with advanced countries in science and technology investments, Korea focused on the development of key strategic technologies on a selective basis while raising the level of existing technology. Expanding technological cooperation with advanced countries could help strengthen technological capabilities. In the same spirit, exports of technology to other developing countries were promoted. The government encouraged increased research activities in basic science at universities, and revitalized the activities of science-and-technology-related academic associations. Construction of the Daeduk research complex was accelerated, which would be linked closely with specialized high-technology research complexes in other regions. The nationwide network of research complexes was developed as an integral part of a comprehensive regional development policy. The government expanded the operations of local industrial testing stations and government-sponsored research institutes to provide increased technological support for SMEs.

Remnants of the distorted industrial finance system lingered, including a highly-leveraged industrial sector, low industrial profit ratios and a pervasive dichotomy between performance and borrowing cost. For these reasons, industrial policies could not proceed independently of financial liberalization. While the government abolished the preferential rate of policy loans in 1982 as part of the financial liberalization program, there remained differences between lending rates in the formal and informal sectors, and this represented an opportunity for continued rationing of bank credit. But rapid growth in the amount of credit available through the non-bank sector and the direct credit market reduced market segmentation, and generally equalized borrowing costs to a greater extent across industries. Greater equality of credit access undoubtedly contributed to a converging trend in industry profitability. Nevertheless, despite their high debt, large borrowers continued to have wider borrowing options as banks had yet extricate themselves from the risk-sharing partners that they became during the 1970s. The more competitive allocation of credit had been forcing reductions in the debt ratios which had peaked in 1980-81 for the previously-promoted manufacturing industries. Debt-equity ratios were still quite high, but the policies designed to encourage equity financing began to bear fruit.

Korea embarked on establishing an infrastructure for greater market control over economic activity. The new policy regime was cautiously building, reinforcing, and decentralizing

institutions in several areas of policy. The decision-making power of government was gradually transferred to firms as sectoral investment priorities were abandoned, to capital markets as financial institutions were liberalized, and to product markets as import controls were relaxed. The efficiency of firms and markets was strengthened by establishing rules of competition, and by supporting activities with externalities. The view that substantial liberalization had been underway was not universally shared, however. Some argued that Korean policy and decision-making were still too heavily influenced by the government. For example, the financial system was still basically credit-based and subject to the government's influence. Some even claimed that intervention actually brought about good results. Others argued that it was premature to expect a major-change in the conduct of industrial policy, given that the actual reforms witnessed had mainly involved changes in the objectives pursued and in the openness of policy tools. In any event, the government had been sending out revised, though not uniformly consistent, signals concerning its own preferred level of intervention.

The liberalization efforts should be evaluated in the context of the legacies embodied not only in economic conditions, but also in the capabilities of allocated decision-making institutions and the expectations of economic agents. The aggressive industrial policy in the 1960s and 1970s retarded the development of private institutions, particularly with regard to industrial decision-making and risk-bearing. The equity market was not fully developed, and the experience of commercial banks and corporations in financial decision-making was thin. Institutions for business-government cooperation, in contrast, had been strong, which demanded continuation of government support and criticized the liberalization efforts. Firms working closely with the bureaucracy had been reluctant to accept change. For all of these reasons, efforts to reduce government intervention in resource allocation would take time.

The rapid growth and increasing diversification of exports of all kinds had been the most compelling evidence of acquisition of technological capabilities over time. FDI or other forms of international subcontracting had not been critical to Korea's exports. Korea's industrialization up to the late 1970s was based largely on proficiency in production engineering, more specifically on mastery of production processes as opposed to design adaptation. In turn, the extent and nature of acquisition of investment capability did not become readily apparent until the late 1970s when Korea began to experience rapid growth in technology exports.

The acquisition of technological capability in basic production processes had progressed further than in product design. Evidence of the importance of diffusion from domestic sources was found in many exporting firms. The increasing importance of domestic sources of process technology attested to considerable mastery of basic production technology. It had far more to do with the importance of the assimilation and adaptation of technology by local producers, and of the diffusion of technology through formal and informal contracts,

as well as labor transfers among domestic firms. In industries for which process technology was not product specific, mastery had frequently led to copying foreign products as a means of enlarging technological capability. In mechanical engineering industries, processes such as machining and casting once learned after producing an item, can easily be applied in the production of other items. Korean manufacturers had not only been able to produce capital goods that met world standards, but also managed to adapt the product design to make it more appropriate to Korean circumstances.

In industries with more product specific technology like chemicals, mastery of underlying principles had enabled greater local participation in the technological efforts associated with the subsequent establishment of closely allied lines of production. In relation to subsequent undertakings in the same lines of production, process technologies mostly came from local sources within five to ten years after the initial introduction of the technologies in Korea.

Two distinct patterns of technology assimilation were apparent – the apprentice pattern and imitation pattern. Under the apprentice pattern, which prevailed in cement and synthetic fibers, the first plant was typically built on a turnkey basis with indigenous involvement limited to assimilating as much of the production and investment capability as was practical. The development of investment capabilities began with the participation of Korean engineers in the initial project execution and continued through experience gained in production and plant expansion projects. Construction of the second and subsequent plants followed quickly, with Korean engineers and technicians assuming a rapidly expanding role in project design and execution. Indigenous involvement in project implementation expanded through concerted efforts to assimilate the knowhow involved in project design and execution. The process was effectively one of highly selective and experience centered import substitution, in which successively more complicated aspects of investment capability were acquired and put into practice. The result was a growing capability in all elements of investment activity.

In the imitation pattern, local firms started with small and rather primitive technologies developed by themselves and gradually upgraded both processes and products through operating experience and by using technical information and ideas that came from observing foreign technology. Among the capital goods producers known to have followed this pattern were suppliers of machinery for paper manufacturing and textile weaving. The fast pace of industrial growth had been an important factor in both this and the apprentice pattern. The short intervals between the construction of successive plants had greatly facilitated experience-based learning. Informal transfers had dominated in the imitation pattern and were significant in broadening the technological capabilities of exporters. They had been important in innovations by small scale capital goods producers as well, many of whom initiated new product lines by imitating foreign equipment—by copying imported models and using information from sales catalogues or from visits to foreign manufacturers.

The technology factor that underlay most of the technology exports was for the most part the same factor that underlay most of the manufactured exports. The rapid growth of both kinds of exports reflected the rapid accumulation of proficiency in production. But the emphasis on proficiency in production did not imply that Korea lacked a design capability. Exports of idiosyncratic manufacturing technology indicated that there was some capability in the design of machinery. But these are only a small fraction of the total. Korea did not appear to have much capability in basic project engineering.

Export activity had made it possible to establish investment capabilities that could not otherwise have been realized without a tremendous cost to economies of scale. Due to their highly specialized nature, many activities of project execution were characterized by extreme economies of scale. Korean firms could not be internationally competitive in these activities if they served only the domestic market. Moreover, the accumulation of experience was a critical input in acquiring most of these capabilities. Export activity not only compressed the time for experience to be accumulated; but it also offered a wider variety of experience in more diverse circumstances. It could therefore be expected to accelerate cost reductions from learning and to deepen existing capabilities. These benefits seemed to be reflected in changes over time in the composition of Korea's exports of technology elements toward increasingly more complex and sophisticated activities. Participation in project execution with foreign firms had provided opportunities for acquiring additional capabilities and new technologies. The broadening and deepening of technological competence, particularly its investment capability, appeared to be an important motive in the promotion of exports of technology elements.

4. Scientific and Technological Development

The major feature of the Korean economy in the 1990s was that its industrial structure had become further sophisticated, with a rising share of heavy and chemical industries within the manufacturing sector. This structural realignment had been prompted to enhance competitiveness.[15] In the face of eroding competitiveness caused by rapidly rising wages, increasing difficulty in acquiring foreign technology and the consequent imperative to shift

15. Since 1989, the contribution of exports to overall growth dropped significantly as the Korean won currency appreciated and the world economy slipped into a recession. The pace of growth was not weakened, however, as domestic demand such as private consumption and housing construction began to rise. Dwindling exports accompanied by rapidly expanding domestic demand resulted in an acceleration of inflation and trade deficits. Increasing aggregate demand due to rapid economic growth and wage hikes in the wake of the democratization process provided the impetus for inflation. The current account balance shifted from chronic deficits to a surplus in 1986, recording a surplus of US$9.9 billion and US$14.2 billion in 1987 and 1988, respectively. As the surplus volume continued to grow, Korea faced mounting foreign pressures to open its domestic market and to appreciate the won currency. The balance of payments, however, reverted to deficits in 1990 as sharp domestic wage increases eroded competitiveness, and domestic demand expanded rapidly.

to higher-value, technology-intensive products, Korean companies intensified indigenous R&D to strengthen their competitive advantage through creative imitation of sophisticated foreign technologies. However, the future growth of the Korean economy could be obstructed by ever widening trade deficits and a low level of technological capability.[16] In the 1990s, imports increased at a faster rate than exports, mainly due to the import of technology-intensive intermediate goods and capital goods. Despite significant advancements in technology, Korea's technological capability was still far behind that of advanced countries throughout the 1980s, especially in product design and basic project engineering.[17]

Korea was still far from achieving a fully advanced economy. Korea's exports were highly concentrated on consumption goods, implying a lack of vertical depth. Competitiveness was almost exclusively in end products, with virtually no specialty input industries and few machinery industries. Nearly all major industries depended heavily on foreign sources for core components and key production machinery. Korea had few positions in components, tools, and production machinery. The absence of sophisticated local components and machinery manufacturers made it difficult to compete in differentiated industry segments or keep up with process innovations. Product and process technology in Korean industries were often a generation behind the world leaders. Almost all Korean industries still competed on cost, and Korea had yet to build the competencies necessary to compete on innovation and differentiation. Most companies were production-oriented and followed strategies based heavily on achieving low production costs. Mass production of standardized products was the predominant approach. Low-cost, highly productive workers were combined with large-scale modern facilities employing the best available technology to yield a significant cost advantage. The focus was on the more price sensitive industry segments, and Korean products were usually a generation behind the performance leaders in quality.

16. The Korean capital goods industry had developed rapidly, but its level of development still lagged far behind Japan, Germany and the U.S., indicating a low share of locally-made machinery in major industries. For the automobile and petrochemical industries, machinery had been localized at around 50 percent and 60 percent, respectively. Consequently, the Korean economy resorted to imports to support the economic expansion.

17. In many activities related to the production of intermediate and capital goods with significant economies of scale, technological acquisition had been restricted by the relatively small size of the domestic market. Investments would strengthen existing competitive advantages, as well as develop dynamic competitive advantages. But investments were delayed until the size of the domestic market, together with export production, grew large enough to allow a minimally efficient scale of operation.

Table 1-1 | International Comparison of Labor Productivity

	US	Japan	Germany	Italy	Korea
Manufacturing	100.0	104.9	91.1	66.9	49.7
Textiles & Apparels	52.5	31.4	56.0	46.8	19.8
Chemicals	151.6	148.7	134.9	91.0	60.8
General Machinery	106.7	94.2	76.2	71.2	44.3
Electronic Equipment	149.2	133.1	92.0	77.8	51.2
Transportation Equipment	94.3	120.7	94.5	62.6	57.1
Scientific Instruments	86.9	100.7	63.6	79.8	31.1

Source: The OECD STAN Database for Industry Analysis, 1997

Note: Value added / Number of employees / Exchange rate

In the early 1990s, the R&D system still presented features typical of developing countries in terms of structure and levels of effort. Despite the increased intensity of R&D, the dependence on foreign technology seemed to be very difficult to lower. While R&D investment increased from 0.8 percent of GNP in 1980 to 2.3 percent in 1994, the ratio of payments for licenses to R&D expenditures declined only slightly from 21 percent between 1977 and 1981 to 18 percent between 1987 and 1993. In fact, the ratio of technology imports to manufacturing value added in current dollars increased from 0.5 percent in 1980 to 1.5 percent in 1994. The government's role had declined in terms of direct financial influence.[18] The government should identify indirect incentives and means to further stimulate science and technology. Korea was fortunate to have well-educated human resources, but these were wasted or underutilized to a significant degree as a result of a lack of mobility and social rigidities.[19] Better links between science and industry were required to enlarge the indigenous technological base. The objectives of S&T policy and the problems to be solved were different from those of the 1980s. Promoting and supporting indigenous innovation capability required more than building infrastructure and supporting R&D for adapting imported technology in certain sectors. The set of programs developed over the years appeared to lack certain coherence and gave the impression of a patchwork of poorly related policy measures. This was the result of a lack of coordination and related ministerial rivalries.

18. In the early 1980s, government was responsible for 60 percent of R&D expenditures, but in the late 1980s, industry financed a little more than 70 percent. Industry's investment, however, was not yet at a level comparable to that of industrialized countries. The industrial sector devoted 2.4 percent of total turnover to R&D in 1993, whereas that of Japan was 3.5 percent.

19. Nearly 75 percent of doctorate degrees were conferred at local universities, but industry received mostly those with lower-level diplomas. Government laboratories recruited approximately an equal share of the various categories. University researchers were lacking in resources for research and devoted most of their time to teaching students. A large share of Ph.D.s trained and remained abroad.

Table 1-2 | Korea's Major Export Commodities

1980		1990		1998	
Apparel	15.9	Apparel	11.7	Semiconductors	12.9
Steel Plates	4.1	Semiconductors	7.0	Motor vehicles	7.5
Ship	3.5	Leather Footwear	4.6	Ship	6.1
Woven Fabrics	3.2	Ship	4.3	Metal products	5.6
Audio Apparatus	2.8	Video Apparatus	4.1	Chemicals	5.0
Tire/Tubes	2.7	Steel Plates	3.8	Computers	3.8
Wood Products	2.7	Woven Fabrics	3.6	Steel Plate	3.7
Misc. Goods	2.6	Computers	3.3	Apparel	3.3
Semiconductors	2.5	Audio Apparatus	3.0	Woven Fabrics	3.0
Video Apparatus	2.4	Motor Vehicles	3.0	Wireless Telecom	2.0
Subtotal (%)	42.4	Subtotal (%)	48.3	Subtotal (%)	52.9
Total US$ 175.0b	100.0	Total US$ 650.2b	100.0	Total US$ 1,323.1b	100.0

Table 1-3 | Composition of Exports by Industry (1995)

	U.S.	Japan	Germany	Italy	Korea
Chemicals	10.3	6.0	10.9	5.4	6.5
Rubber & Plastics	1.6	1.8	2.3	2.6	2.0
Medicines	1.3	0.4	2.1	1.7	0.2
Iron, Steel & Non-Ferrous Metals	3.2	5.7	7.1	8.0	7.6
General Machinery	15.3	18.8	19.1	19.6	6.0
Electric & Electronic Equipment	10.9	17.3	8.8	6.5	23.8
Computer & Office Equipment	7.5	8.7	2.7	2.4	4.1
Telecommunication Equipment	3.9	6.6	2.5	1.2	7.4
Automobile & Auto Parts	9.8	18.1	17.2	8.8	8.4
Aircraft & Ship-Building	5.5	2.7	2.7	1.4	4.9
Scientific & Precision Instrument	4.8	5.5	3.7	2.2	1.4
Textiles, Apparels & Leather Goods	3.2	1.9	5.1	18.3	17.5
Miscellaneous	22.5	6.6	15.7	22.0	10.0

Source: OECD, Foreign Trade by Commodities, 1995

During 1991-95, government and industry cooperated in developing production technologies identified as essential to the competitiveness of machinery, electronic parts and semiconductors, and petrochemicals. The government and the relevant industry equally shared the financial costs of this endeavor. Financial support was provided either through government subsidies or through long-term loans from KDB. The government also implemented the Second Five-Year Plan for Localizing Production of Machinery, Parts and Materials (1992-96) to improve high import dependency. A total of 4,000 items were selected as candidates for local development, which were composed of core components of high performance machinery; parts and materials for high-tech products that were either witnessing a surge in import demand or were expected to be essential to future industrial development; and machinery, parts and components, and materials considered important for export promotion. Emphasis was placed on securing and providing funds for developing prototypes, purchasing domestically-produced machinery, and installing automation facilities that were expected to facilitate the local development of candidate items, as well as increase demand for domestically-produced machinery. The Industrial Development Fund and the Fund for Restructuring of SMEs were made available for prototype development, while customer financing was provided by KDB, IBK, or lease companies.

An effective support system was established to encourage the innovation needed to spur domestic production of machinery. GRIs such as the Center for Machinery, Electronics and New Materials in the Korea Institute of Industrial Technology (KITECH) helped firms to localize production and facilitated the diffusion of developed technologies. The Korea Institute of Science and Technology (KIST) also played a leading role in loosening the technological bottlenecks related to localization. They provided technical guidance to firms concerning system, design, and quality control. Regulations were adjusted to promote purchases of domestically-produced machinery. Mutual purchasing of parts and components among related firms was encouraged where product standardization was possible. Firms that successfully established cooperative relationships between large assembly-type companies and parts and components manufacturing SMEs received priority in the provision of local machinery purchasing funds. A database of newly developed items was developed to increase public awareness of locally produced machinery. The Industrial Testing Board evaluated and compared the performance of domestically-manufactured goods with that of their foreign-made counterparts and helped publicize the results.

The Highly-Advanced National (HAN) project was launched in 1992. It was a large-scale R&D project carried out with funding from government and industry under the long-term project management system. Designed as an inter-ministerial program under the existing national R&D program framework, the objective of the HAN Project was development of strategic industrial technologies to make Korea more self-reliant in

science and technology. The HAN Project was broadly composed of two categories – product technology development and fundamental technology development. Product technology development focused on technologies for developing specific products, particularly high-tech products in which Korea had the potential to compete with advanced countries by the early 21st century—including new agrochemicals, ISDN, HDTV, ASIC, flat panel displays, bio-medicals, micro-machine, next-generation vehicles, and express railways. Fundamental technology development emphasized core technologies indispensable for long-term economic growth and improving the quality of human life—including advanced materials, next-generation semiconductors, advanced manufacturing systems, new functional biomaterials, environment technology, new forms of energy, and next-generation nuclear reactors. A total of 2,085.9 billon won had been invested over the period from 1992 to 1997, when the second-phase of the program was completed. The HAN project was very significant with respect to its relative importance in the national R&D effort. It had created a number of innovation networks by forcing enterprises, laboratories and universities to work together. It had exposed many people to challenging research and thus provided some form of research training in basic technology areas.

The Ministry of Science and Technology (MOST) introduced a broad range of innovative measures in 1997, which included the enactment of the Special Law for S&T Innovation, the formation of Five-Year Plan for S&T Innovation, the Highly-Advanced National (HAN) Project, and the Creative Research Initiative (CRI).

The Five-Year Plan for S&T Innovation (1997-2002) was formulated, pursuant to the Special Law for S&T Innovation enacted. The plan was designed to promote the national R&D capacity to the level of G-7 countries. It was hoped that this goal could be achieved by the early part of the 21st century through innovation in strategic technologies and the promotion of S&T activities. Public R&D needed to be expanded in order to induce private firms to invest in R&D and to encourage collaborative R&D among industries, universities, and GRIs. In response to various new socio-economic demands, the program was enlarged to various research projects. Major sub-programs include the Highly Advanced National (HAN) Project, the Creative Research Initiative, the Strategic National R&D Project, and the National Research Laboratory.

The industries played a major role in the third-phase of the HAN Project (1998-2001) which consistently largely of utilization and application of the project outcomes. To follow up on the HAN Project, the so-called "Post HAN Projects (21st Century Frontier R&D Program)" would be completed by the end of 1999 and implemented to develop core technologies to secure world-class technological levels in certain technological fields.

The Creative Research Initiative (CRI) was launched in 1997 in line with the vision of transitioning toward a knowledge-based economy. The program symbolized the policy shift in S&T development "from imitation to innovation." It was launched to strengthen the nation's potential for long-term growth through creative basic research. It focused on developing new fields of scientific research and developing technological breakthroughs that would revolutionize conventional technology. The grant supported creativity and originality in research. There were two types of grants based on the themes of "Bud-type project" and "Branch-type project". Bud-type grants supported very creative but as of yet uncertain research projects that were in the hypothetical or theoretical stages of development. Branch-type grants supported projects that were already at the forefront of new research. Above all, the CRI emphasized autonomy in research to enhance creativity. The project leader, selected using strict criteria based on creativity, leadership, research experience, etc., had complete authority and responsibility for the project's implementation. The government planned to execute a general evaluation of the CRI in 2003, six years after implementation. At that time, the future direction of the CRI would be decided.

The objectives of the Strategic National R&D Projects were to address national problems and advance Korea's science and technology capabilities. In 1998, 43 projects were supported in such fields as life science, aeronautics and space, information and electronics, key engineering technologies, and semiconductors. The National Research Laboratory Program, launched in 1999, fosters the growth of small-scale laboratories of industrial, academic and public research institutes into major, national R&D projects.

Universities had not been active in R&D because of their heavy teaching responsibilities and insufficient funding and research facilities. In order to promote basic research at universities, Science Research Centers (SRCs) and Engineering Research Centers (ERCs) were selected based on research performance and capability, and Regional Research Centers (RRCs) were selected based on regional development.[20] To ensure the continuation of their research activities, the centers received government funding for nine years, provided that an evaluation took place every three years and showed good progress. As of 1999, there were 14 SRCs, 28 ERCs, and 37 RRCs. Another way to improve basic research was to provide modern R&D equipment and facilities. The Korea Basic Science

20. In the 1980s, national R&D projects were formed around GRIs, and universities did not have the means to participate in such projects. In the 1990s, university applicants for basic research increased. The Basic Sciences Promotion Act was enacted in 1989, and 13 universities were selected as the SRC and ERC. This project was a long-term basic research project that received research funds of one billion per year to conduct research for a maximum of 9 years. GRIs had been effective tools for supporting the country's S&T development; however, times have changed, and the roles and missions of the GRIs needed to be comprehensively evaluated. Most institutes were in the process of strategic reorientation in order to be able to respond to the needs of the economy.

Institute assumed this task by maintaining equipment that was shared by universities and related organizations.

While MOST had been the major catalyst for national R&D programs, the Ministry of Trade, Industry and Energy (MOTIE) played an increasingly important role, reflecting the growing emphasis on the promotion of technology in overall industrial policy. The industrial technology policy of MOTIE had three components: (1) support given to R&D projects in response to the needs and requests of firms for developing and commercializing products; (2) support for large-scale, focused projects such as the HAN sub-projects, as well as other areas like aeronautics, energy, and electronics; and (3) support for technology diffusion, particularly to SMEs. The first component represented 55 percent of the industrial technology budget and was declining in importance. The second component represented 40 percent of the budget and was growing in importance. The third represented 5 percent of the budget. Industry was making serious efforts to match government investment in R&D through these industrial technology programs. In fact, industry funding appeared to represent twice the amount allocated by the government.[21]

Apart from the HAN Project, the government launched a series of sectoral R&D programs. A significant program concerned the aeronautics and space sector. The operating agency was the Korean Aerospace Research Institute (KARI), which possessed good facilities, financial means, and considerable operating flexibility. Focal projects included the development of observatory satellites, sounding rockets, and a regional transport aircraft. Information technology was still at an early stage, and considerable efforts would be needed. The most crucial issue seemed to be the coordination of actors whose interests did not necessarily coincide. In particular, new information infrastructure from specific application sectors such as education, health, and libraries was needed.

Major Korean corporations began to make the transition from an imitative to a defensive position in the late 1980s.[22] Defensive innovators may lack the capacity for original innovation, especially the links with fundamental research, but they must design models as good as the early innovators and still incorporate some technical advances to differentiate their products at a lower costs. In the 1990s, an increasing number of Korean

21. Statistics indicate that 21 percent of the projects supported by MOTIE since 1987 had been successfully commercialized, and about 3 percent were in the process of being commercialized.

22. The strategy that a firm can pursue is strongly influenced by its national environment. The accumulation of human and institutional capital in a specific technological capability has not been without opportunity costs. The necessary costs and benefits that are foregone by dedicating scarce resources to developing specific capabilities should be evaluated. Naturally, Korean companies had been mostly imitative in their R&D strategies until the late 1980s. While resources were devoted to R&D activities, such activities had been far less important for Korean firms than for defensive innovators who try to stay close to the leaders.

companies began to move toward defensive positions, making it imperative for these firms to assimilate R&D-intensive and system-oriented technologies. In the face of accelerating global technological advancement, efficiency in local technological development implied continued imports of technology elements. However, the pattern of technology imports shifted as local capabilities were developed and the growing size of the domestic market allowed for the acquisition of new technologies related to activities with significant economies of scale. Given the technological conditions, technological development should be based on continuous and cumulative processes rather than on abrupt breakthroughs, especially since the commercialization of technology was also an evolutionary process, subject to natural selection in markets and organizations. However, globalization of R&D rapidly expanded the boundaries of R&D endeavors in major Korean corporations, and would accelerate their learning through R&D.

Korean industry had rapidly increased overseas direct investments since the early 1990s. Overseas direct investments contributed to Korean firms' acquiring advanced technology in major industries as well as expanding their shares in the world market. In the face of accelerating global technological advancement, major Korean corporations established extensive networks of in-house laboratories in order to learn by research. At the same time, they established a number of R&D facilities in the U.S., Europe and Japan to monitor technological change and to access a larger pool of high caliber scientists.[23] They also used M&As to gain access to frontier technologies.[24] In some technology areas, major Korean corporations had grown sophisticated enough to enter into strategic alliances with leading foreign companies. In 1997, 15 Korean companies owned 32 R&D

23. LG Electronics had developed a network of R&D laboratories in Tokyo, Sunnyvale, Chicago and Aachen (Germany). These facilities monitored technological change at the frontier; sought opportunities to develop strategic alliances with local firms; and developed state-of-the-art products through advanced R&D. LG Technology in Sunnyvale played a pivotal role in designing the latest PCs, display terminals, and high-resolution monitors, while the LG North American Laboratory in Chicago concentrated on high-definition TVs, digital VCRs, and telecommunications equipment. Samsung and Hyundai Electronics had developed similarly extensive R&D branches.

24 .Korean firms also globalized R&D through M&As. Hyundai had been the most aggressive at acquiring equity stakes in foreign firms as a way to gain access to cutting-edge technologies. In California, it acquired full ownership of Axil Computer for computer development; significant stakes in Laserbyte Corp. to gain access to magneto-optical disk drive technology; in Metaflow to develop SPARC compatible microprocessors; in Image Quest to develop TFT-LCD technology; and in Maxtor to develop hard disk drives. In 1995, Samsung Electronics acquired a controlling share of AST Research, one of the largest makers of personal computers. The acquisition gave Samsung access to more than 190 patents and a strategic alliance with IBM, Apple, and Compaq. Samsung also obtained a majority interest in Union Optical (Japan) and Rollei (Germany) to enhance its competitiveness in camera and optical equipment making.

facilities in the U.S.[25] The government also played an important role in the supply side of technology by strengthening public R&D capabilities and promoting joint research among industry, public R&D institutes and the academia. Korean companies registered 1,567 U.S. patents in 1996, which is the seventh largest number of U.S. patents registered by foreign countries.

Overseas investment by Korean MNCs began to decline in 1997. The contracted domestic market and shortage of investment capital accounted for the reduction in FDI. The successive bankruptcies of Korean conglomerates had negative impacts on credit ratings for Korea and Korean companies. Under such circumstances, foreign affiliates of Korean MNCs could not use local financing and had to abandon overseas operations. Moreover, the foreign currency crisis forced the companies to modify, suspend or abort their overseas operations. Southeast Asian countries in particular were subject to these pullout decisions. However, as the Korean economy began to edge out of economic hardship, Korean MNCs redirected their attention to FDI. To transform themselves from domestic players to global players, they set out to take on the challenge once again.

The currency crisis occurred as a result of the business cycle as well as the vulnerable structure of Korean firms.[26] Fluctuation in export performance had been the main cause of the business cycle. The composition of Korea's major export commodities was very similar to that of Japan. The major export commodities were mainly competing with Japanese products in the world market, and thus Korean export performance was largely affected by the exchange rate of the yen to the dollar. Aside from the yen's depreciation, Korean companies were at a disadvantage because of their fragile structure, characterized by high-cost and overproduction, which resulted from the overheated economy since the mid-1980s. Although the economic fundamentals were not bad, the pace of recovery remained slow due to these structural problems. The underlying cause of the crisis was rooted in certain aspects of the Korean economy, which were less suited to face the more competitive open economy and more integrated product and capital markets of the 1990s. Market institutions and principles were not sufficiently developed. Investment decisions by business groups seemed to respond more to the objective of growing in size than assuring adequate profitability. The

25. There were 695 U.S. R&D facilities owned by 363 foreign parent companies from twenty-four different countries. The 249 Japanese R&D facilities in the U.S. account for over 30 percent of the total foreign-owned U.S. R&D facilities. The UK was second with 103 facilities, followed by Germany (96 facilities), France (44 facilities), Switzerland (42 facilities), and Korea (32 facilities).

26. The East Asian financial crisis emerged in Thailand in July 1997 and spread to the neighboring countries, which forced Korea to request assistance from the IMF. The Korean government had officially made the request on November 21 after nearly all of its foreign reserves were depleted to defend the Korean currency. The crisis in Korea was touched off in November when a loss of confidence by foreign investors resulted in huge withdrawals of funds and a swift, massive depreciation of the Korean currency.

corporate governance system failed to keep business groups from taking excessive credit and exchange rate risks. Regulations also failed to prevent moral hazard among the financial and corporate sectors.[27]

FDI projects by Korean MNCs in the early 1990s were aimed at overcoming the short-comings of high cost/low efficiency structures. Thus, the dominant trend was to locate and invest in sites that would reduce production costs. This pattern of FDI reflected scale-driven globalization plans. The Korean MNCs' strategies in 1999 differed from their expansionary overseas investment goals of the pre-crisis days. In particular, the strategies focused on traditional key industries, i.e., electronics, automobile and telecommunications, and investing in their core competencies. Investments used for the acquisition of market knowledge and ties with local agents would enhance marketing capability. Building R&D centers in local markets would broaden technology bases. Pursuing strategic alliances were an effective way to acquire complementary resources and build core competencies.

Since the financial crisis of 1997, the Korean government started to actively promote attracting FDI. In November 1998, the government enacted the Foreign Investment Promotion Act. This new legislation focused on creating an investor-oriented policy environment by streamlining foreign investment procedures and establishing an institutional framework for investor relations, including a one-stop service. The government also undertook full-fledged liberalization in the area of hostile cross-border M&As and foreign land ownership. In April 1999, Korea abolished the restrictive Foreign Exchange Management Act and replaced it with the Foreign Exchange Transaction Act. Most of the restrictions on foreign exchange transactions and domestic transactions in foreign currencies have been eliminated. FDI inflow increased sharply since 1998. In particular, the pace of FDI through cross-border M&As picked up markedly.

In the 1990s, Korean carmakers had been in the process of building up their R&D and engineering capabilities to design their own power trains or major subsystems. They invested

27. The problems of Korean firms and banks in mid-1997 were not unprecedented. The Korean economy had experienced growth slowdowns, leading to periodic increases in non-performing loans. What made the 1997 experience exceptional was the high level of private foreign debt that had been accumulated following the government's decision to widen the scope for short-term foreign currency borrowing in 1993. The ability of enterprises to borrow from abroad to finance imports of capital goods led to a massive increase of foreign debt among Korean firms and financial institutions during the investment boom between 1993 and 1996. In contrast to the liberalization of loans of less than one year, restrictions on long-term overseas borrowings were maintained. Short-term foreign debt of the financial and corporate sectors reached $100 billion in December 1996, accounting for two-thirds of the total external debt of $150 billion. The liberalization of the capital account in Korea was not accompanied by a commensurate strengthening of prudential supervision. This turned out to be extremely costly given the lack of sound risk management practices at banks that were inexperienced when it came to overseas borrowing.

in R&D to attain technical independence, to raise their level of competence in supply and manufacturing, and to become a credible partner in future alliances with major carmakers. Although Korean carmakers were yet to develop capabilities in generic research and advanced engineering,[28] they accumulated significant skills and the expertise necessary to develop new models, including the ability to initiate concepts, define of car attributes, and understand car engineering and design, production readiness, and styling. Korean carmakers had a cost advantage when implementing new car programs, especially small-size cars.

The machinery industry had yet to match its Japanese counterpart in terms of technology. The technological gap was especially wide in the area of software design, network, and system establishment technology. In addition, the Korean machinery industry resourced key components through imports. But the Korean machinery industry had also accumulated significant skills and expertise in developing and manufacturing its own models of sophisticated machines.[29]

28. Generic research focuses on anticipating developments and innovatively applying new technologies. Anticipating the future requires knowledge of technological trajectories such as combustion, composites, alternative power sources, electronics, software, and communications. Research also needs to respond to advanced engineering for future generations of engines or major subsystems. Advanced engineering develops engineering solutions for eventual integration into new car programs. Activities are concerned with outlining and proving innovative technical designs; managing applied research programs with technology suppliers; and creating and testing experimental prototypes. Concept initiation and definition of car attributes translate into conceptual issues, cost target, product positioning, functions for customers and competitive bench-marking. Decisions are made on styling; configurations of key subsystems such as motor, power-train, and transmission; supply and parts development with Tier 1 suppliers; and external packaging. Estimates are made for potential sales, required investments for product development, manufacturing processes and profitability. Car engineering and design is the most structured phase: more than 50 percent of resources necessary to design a car up to the actual manufacturing stage are expended at this phase. Engineering specifications and plans describe the car in terms of its specific components and its functional/logical interfaces. Moreover, engineering the manufacturing process, assembly of subsystems and systems, and tooling are completed in detail to finalize business plans and commit resources to plants, marketing, services, and other execution elements. Production readiness involves working on experimental production lines. Actual products are manufactured using planned production tools to test quality requirements. The plant is also prepared for accelerated production. Sales and service programs are finalized. Linkages between production readiness and production planning activities require continuous interaction and physical proximity. Engineering support of regional centers is mainly concerned with informing program managers about the specifications appropriate to national/regional markets. If justified by sales volume, adaptations to the car's upper-body development are also performed to meet regional needs. Regional engineering centers then work closely with design and engineering activities while also supporting assembly plants and supplier network development.

29. The machine tool industry, for example, began to develop its own technology at the end of the 1970s, and around the early 1990s it began to produce high-speed multi-processing machines. Efforts had focused on enhancing the main shaft and conveyor functions to curtail cutting time, improving processed surface quality, and saving on chip processing costs. The main shaft machines operated in excess of 20,000 rpm for high-speed processing at the micron unit level, and multi-function machines were beginning to appear on the market. The industry introduced FMS (Flexible Manufacturing System) that could operate for more than 72 hours continuously without human inputs. Under development were machines that featured open-style CNC equipment, as well as machines that were Internet, intranet and CAD/CAM-capable, enabling users to acquire new technological information and obtain long-distance follow-up service through the Internet by accessing the websites of machine tool builder-vendors.

In the late 1990s, major corporations started to make the transition to industry leader status. Transition to full leadership status requires international brand recognition,[30] strong marketing capabilities, and control over foreign distribution channels. Leadership necessitates a strategic mindset quite different from that of a firm in catch-up mode. Bold strategies towards new product creation and the development of entirely new product categories are the hallmark of successful leaders. Major Korean corporations pursued a portfolio strategy with differentiated approaches depending on the stage of development of their product offerings, in-house technological capability and the firm's particular strategy toward further technology development.[31] In other words, technology strategy was executed in relation to the needs of specific products (or closely related product families). Several leading business groups were certainly reaching the innovation frontier in some product areas and were facing the challenge of a full leadership position, involving new product design, R&D, distribution and brand development. However, many other firms had not yet reached this stage and, even within the leading business groups, some product lines continued in subcontracting relations with foreign partner companies. In other cases, firms had decided, implicitly or explicitly, that the most appropriate strategy for some products was to continue their behind-the-scene, low cost, product improvement approach, relying on the senior foreign partner to make the heavy investments in new product development, branding and distribution. Their goal for the future seemed to be to continually increase the share of leadership products in order to capture more value added and to control the direction of their business. This process of catch up has been an incremental one, and the risks of moving too quickly towards leadership could outweigh the benefits (Hobday, Rush and Bessant, 2004).

As major corporations moved into more sophisticated designs for global markets, they had to collaborate with and rely upon the highest technology capital goods producers. Access to advanced capital goods technology was needed in order to be able to design and manufacture new products. In some cases, this access itself required detailed technological knowledge of the capital goods and systems in question. Moves to radical new product development required more intense and direct collaborations with foreign suppliers of capital goods as well as the designers of key components. They had to work continually with high-technology specialist capital goods producers in advance of new product development in order to ensure a design-for-manufacturing outcome. Such collaboration would in turn

30. The business groups had created corporations that challenged the largest multinationals in the West. The eight Korean firms listed by Fortune (1995) among the first 500 firms world-wide were subsidiaries of these business groups.

31. Typically, R&D was organized at three levels: at the production line, where incremental improvements were made to existing processes; at the division level, where work focused on improving the performance of their business sector by developing new designs, products and processes; and at the corporate level, where basic research was conducted not directly related to application.

require a greater physical presence in Korea of capital goods makers and greater capabilities on the part of Korean manufacturers to shape the development of new capital goods. As major corporations formed partnerships with foreign capital goods producers abroad, local producers of capital goods were relegated to low technology fields, and small niches and their shares in the market fell considerably. Major corporations pointed to weaknesses in the local supply of capital goods and related technologies within Korea.[32] From the viewpoint of the motor industry wishing to move towards a full service supply chain approach, for example, very few local suppliers were capable of meeting quality, technology and service requirements. Several small local capital goods producers felt they suffered a 'credibility' problem even when they were able to master the technology because they lacked the strong reputation of foreign suppliers, essential for gaining acceptance by major corporations.

These trends presented difficulties for the lower technology capital goods and component suppliers serving the domestic market (e.g. for autos and electronics). Not surprisingly, some of these firms found it increasingly difficult to compete with the capability and R&D spending of international competitors such as Bosch and Lucas. As a result, they had resigned themselves to lower technology options (e.g. mechanical as opposed to electronic components for automobiles) where they had proven advantages in terms of price and quality. At the same time, these local producers felt threatened by the emergence of low price capital goods and component suppliers from China. Whilst in the short-term, China and other lower cost regional suppliers might not yet be capable of producing complex mechanical products, strategically, domestic low cost capital goods makers saw themselves as being 'sandwiched' between even lower cost regional producers and the high technology foreign leaders.

32. There was also ambiguity in terms of firm strategy towards capital goods. Some firms had considered entry into capital goods by applying technology in reverse order, culminating in design and production. However, they realized this strategy could incur very high costs and risks, not least due to the likelihood of conflict with their existing foreign suppliers. Electronics producers, for example, were concerned that the production of capital goods was not their business and would extend their competencies into yet more domains at a time when they needed to curtail diversification.

2012 Modularization of Korea's Development Experience
Small and Medium Enterprise Promotion Policy

Chapter 2

SME Promotion and Structural Changes in SMI

1. SME Promotion Policy
2. Structural Change in SMI and Evolution of Diffusion Policies
3. Implications for Latecomers

SME Promotion and Structural Changes in SMI

From the early 1960s, SME policies were carried out with a legal system, but not fully initiated until the mid-1970s. During the first three five-year plan periods, most of the SMEs manufactured daily necessities and established their development foundation in light industries, which was in line with policies to promote exports of light industry products. SMEs contributed significantly to production of export commodities, and hence to earning foreign exchanges. Between 1962 and 1976, however, the share of SMEs in manufacturing employment and value added had decreased along with an increasing share of industry segments with economies of scale.

Between 1978 and 1997, SME policies were designed to promote the modernization of production facilities and to strengthen the technological capabilities of SMEs, especially the specialized SMEs that supply parts and components for large assemblers. Between 1978 and 1991, the share of SMEs in manufacturing employment and value added increased. However, the productivity differential between large firms and SMEs was widened. The productivity gap had increased in branches such as general machinery, electronics and transportation equipment. This reflected the increasing proportion of subcontracting SMEs in the total manufacturing SMEs, from 20.4 percent in 1976 to 73.6 percent in 1991. The employment share of these branches in the SMI had expanded, primarily because large firms looking for opportunities to cut costs were increasingly contracting out manufacturing functions previously performed internally.

In advanced countries where industry had grown organically from traditional technology bases, a large sector of SMEs had been sources of innovation as well as providers of parts and components. In Korea, rapid industrialization and the centralized nature of investment made it difficult to nurture the growth of SMEs that manufactured parts and components with design and development capability. The SMI appeared to be facing significant challenges, particularly from the viewpoint of technology-based growth. In 1993, only 7.7

percent of the manufacturing companies carried out their own R&D. For the majority of these companies, R&D activities were much less planned and formalized. Korea had to innovate and develop more sophisticated knowledge of technical design in SMEs. SMEs with the capability to innovate, design, and manufacture must be nurtured. SMEs needed a long-term program formulated to upgrade their design and innovative potential.

In the mid-1990s, SME policy shifted from providing protection and assistance towards laying the groundwork for autonomy and competition. Protective measures such as reserved markets—which had been damaging to the entrepreneurial spirit—and the policies that had administered subsidies on account of political pressures were gradually phased out. The industrial base for technological development had been strengthened by stimulating the markets through mobilization of measures such as technological development policy, policies for technology transfer, and regional development policies. In the 1990s, the number of innovative small and medium-sized businesses increased rapidly, and their technical competence also improved considerably. The relationship between large firms and their suppliers was also undergoing a fundamental transformation. Subcontracting firms had been viewed in a somewhat condescending way as low-cost suppliers, and this attitude changed in the early 1990s as companies began to realize that the competitiveness of final products could not be maintained without the engineering and innovation capability of parts and components suppliers. Large firms were aware of the opportunities presented by small and medium-sized businesses with technical competence.

1. SME Promotion Policy

In the early 1960s, the government started to carry out SME policies deliberately with a legal system. In 1961, the Small and Medium Business (SMB) Cooperative Act and the SMB Transaction Coordination Act were enacted. The SMB Cooperative Act provided SMBs with the necessary organization to carry out cooperative activities in the spirit of mutual assistance, thereby fostering self-reliant economic activities and improving their economic status. The SMB Transaction Coordination Act prohibited large enterprises from entering into certain areas of industrial activity specifically designated by the law and prevented excessive competition among SMEs. The government also established the Industrial Bank of Korea (IBK), which had played a pivotal role in supporting the modernization of SME facilities and thus contributing significantly to export growth in the 1960s.[33] In 1962, the Federation

33. In the 1960s, manufacturing establishments were mostly SMB in scale. The IBK had provided loans for facility renovation of SMEs since 1962. The second amendment of IBK Act in 1964 allowed IBK to secure foreign sources of funding. However, due to the shortage in foreign exchange reserves, SMEs could not modernize their production facilities. In 1966, the government earmarked US$30 million from reparations—received from Japan for its colonial rule—as long-term facility funds to foster SMEs. Most of the SMEs that applied for the loans sought to replace their obsolete facilities by adopting new machinery imported from Japan. A task force team selected the eligible SMEs for loans (Lee, 2011).

of SMB was founded on the basis of the SMB Cooperative Act. The Korea Trade Investment Promotion Agency (KOTRA) was also established in 1962, which dedicated itself to exploring overseas markets and supporting the export activities of SMEs. In 1965, the government adopted a mandatory ratio of bank loans extended to SMEs. The SME Fundamental Act was enacted in 1966. This Act defined the scope of SMEs and provides the government with the mandate to research and formulate policies in order to improve the competitiveness of SMBs, the relationship between large companies and their suppliers, financial assistance, managerial and technical guidance, and other issues.[34] Regulations, orders and policies relating to SMBs emanated indirectly or directly from this law. In 1967, the SME Credit Insurance Act was enacted, and the SME Technology Instructing Center was established. The SME Department was established inside the Ministry of Commerce and Industry (MCI) in 1968 to implement SME policies more efficiently and systematically. The Commercial Paper Discount System was introduced in 1969, which discounted commercial papers received by SMEs from large companies as proceeds. The Bank of Korea took measures to increase available funding to SMEs by adjusting the mandatory SME loan ratio of regional banks upward (from 30 percent to 40 percent). In 1972, the government drew up guidelines for three business types for the modernization of SMEs – the original SME, specialized supplier SME, and large-scale business SME. The Industry Promotion Agency was inaugurated under the MCI in 1973, which carried out industry standardization and quality management. A general trading company system was introduced in 1975 to promote the exports of SMEs, develop new products, explore export markets, and subcontract export production to SMEs. The Subcontracting System Promotion Act was enacted in 1975.[35] The Korea Credit Guarantee Fund was established in 1976, which guaranteed the debts of SMEs suffering from a lack of collateral.[36]

During the Fourth Five Year Plan period (1977-81), the government induced SMEs to specialize in the production of parts and components and semi-processed goods. These

34. The scope of SME stipulated in the Act was 200 and fewer employees or KRW50 million or less in total assets in the case of manufacturing, mining and transportation industries, and 20 or fewer employees or KRW10 million or less in total assets in the case of commercial and other service industries. The scope of SME was expanded in 1976 to catch up with the growing size SMEs and to facilitate investment in modernizing SME facilities. For manufacturing mining, and transportation, the scope was expanded to 300 or fewer employees or KRW50 million or less in total assets. In the case of commercial and other service industries, the limit was raised to 50 or fewer employees or KRW50 million or less in total assets.

35. Such efforts were first initiated in 1969. In an attempt to enhance efficiency in industries and nurture SMEs at the same time by promoting the division of labor between large companies and SMEs, the government announced a facilitating plan as part of a scheme to develop the machinery industry in 1969, and selected businesses that were to be subject to systemization in 1970, suggesting a standard by which designated companies produced items in select business areas. In the mid-1970s, the rapid expansion of heavy and chemical industries required the supply of parts, components, and materials. As the heavy and chemical industries were developed, division of labor was expanded along assembly and processing functions.

36. The SME Credit Guarantee Act was enacted in 1965, and the IBK was responsible for the operation and management of SME credit guarantees before the Korea Credit Guarantee Fund was established.

products were supplied to large companies, which in turn transferred their technologies to smaller firms. In an effort to improve the SMI structure, financial support for the modernization of production facilities, especially for the replacement of old and obsolete equipment, was expanded. Policy measures also encouraged business integration and a gradual shift in business activity toward growing industries. To induce technical innovation and productivity improvements in SMI, programs for technical and management guidance were carried out through industrial and university research institutes. To achieve regional dispersion and mitigate pollution in urban areas, industrial estates for SMI and collective estates for each industry were developed. Common service and testing facilities to enhance standardized production were established in the industrial estates.

For systematic execution of SME modernization policies, the government enacted the SMB Promotion Act in 1978. Pursuant to the Act, the SME Promotion Fund was established and the Small and Medium Business Corporations (SBC) was founded in 1979. The SBC has been responsible for the operation and management of the SME Promotion Fund, the modernization of SMBs, cooperative businesses, training and education, technology guidance, information provision, and management diagnosis.[37] The Bank of Korea raised the mandatory ratio of loans extended to SMEs in 1980 – for commercial banks from 30 percent to 35 percent; and regional banks from 40 percent to 55 percent – as more funds were needed to enhance the production of SMEs and increase exports. SMEs were also allowed to tap into funds from the Korea Credit Guarantee Fund when they borrowed money from secondary financial institutions such as insurance companies. In an effort to protect SMEs and promote equal development of the nation's economy, the government blocked the advancement of large companies into specific business areas traditionally occupied by SMEs in 1978. In 1981, the stage was set for the government and public organizations to procure items produced by SMEs based on the SME Product Procurement Promotion Act enacted in 1981. It was stipulated that the government and public organizations signed collective private agreements with SME cooperatives to procure items, without competitive bidding.

In the early 1980s, the government recognized that SMI had been relatively neglected in the course of the heavy-chemical industry drive, and it became imperative that SMI be developed in order to improve overall industrial efficiency. It was widely accepted that financial support,

37. The SBC's function responded to the SME promotion policies and the demands of SMEs. The SBC provided long-term policy loans at low interest rates to support facility improvements, start-ups, commercialization of technologies, and other efforts. The SBC has continually developed new training programs to meet the needs of SMEs, including executive, technology, quality management, administrative and management training, as well as working level programs. In management diagnosis and technical support programs, experts visit SME sites, analyze businesses for strengths and weaknesses, diagnose problems, present solutions, and provide support in line with the relevant policies. While providing the technical consulting services, the SBC developed a program to attract experts from overseas to Korea, assisting them with wages, living expenses and travel costs (Lee, 2012).

tax breaks, and complementary relationships with large businesses were not well established. As a result, SMI remained one of the less developed sectors in the economy. Even in the machinery industry, promotion policies had concentrated on the assemblers and thus impeded the development of parts and components producers, which led to high dependency on imports. Recognizing these problems, the government began to develop policies to promote SMI such as facility modernization and the establishment of linkages with large firms. SME policy emphasized improving the accessibility of SMEs to bank credit and technological information, as well as on rectifying unfair trade conditions in their relationships with large firms.

The government took measures to alleviate the financial difficulties of SMBs that stemmed from insufficient collateral. Financial support by the Credit Guarantee Fund under a flexible credit rating system was strengthened (Lee 2011). Financial support for local SMBs by local banks and non-bank financial institutions was expanded. Regulations on the eligibility of firms for investments from the IBK and debenture guarantees from the Credit Guarantee Fund were eased to increase opportunities for direct financial support to SMBs. A fixed portion of postal savings and new increments in the Civil Servants Pension Fund were utilized to finance long-term loans to SMBs through the IBK. The mandatory ratio of loans extended to SMEs from regional banks was raised from 55 percent to 80 percent in 1986.

Policy measures were undertaken to prevent large firms from entering into business areas that were suitable for SMEs, and to promote a division of labor between large enterprises and SMBs.[38] To that end, the lines of business suitable for SMEs and the product items designated for subcontracts were expanded. In order to address the disadvantages of subcontracting SMBs, contractors were encouraged to conclude a long-term contract with subcontractors, pursue sanctions on unfair pricing, and strengthen penalties against undue delinquent payments. As unfair trading practices increased, resulting from the expansion of subcontracted businesses, the Act on Fair Trade based on Subcontracting was enacted in 1984 to set out a process and priorities when trading through subcontracts. Existing rules and regulations on subcontracting were streamlined with a view to strengthening supervision of subcontracting practices.

SMBs were designated to be developed as a specialized supplier of parts and components, as well as given priority for support measures and benefits, such as government quality assurances and designation as promising SMEs.[39] The number of products designated for subcontracting items was increased annually to achieve a spill-over effect on close subcontracting linkages. On the basis of a survey on the performance and quality of imported

38. The government designated 23 industry segments as "Priority Industries for SMEs" in 1979 to protect the business areas occupied by SMEs. These were changed to "Business only for SMEs" in 1982. Large companies were prevented from moving into these areas.

39. The diverse and confusing categorization of SMBs for each supportive measure such as "Small and Medium Type Special Machinery Factories" and "Companies Authorized for Modernization" was consolidated under the name of "Promising SMBs."

parts and components, those parts and components that could be produced domestically were designated as import substitution items, which were made public annually in advance. The difference in import duty between components and finished products was reduced from 7.7 percent in 1983 to 3-4 percent in 1986. In order to expand the export market for parts and components, participation in the quality guarantee system of advanced countries was promoted. For increasing exports of parts and components, international subcontracting was encouraged through joint ventures and technical tie-up with foreign businesses.

The SBC opened an SME Training Institute in 1982 to train SMEs effectively through various technologies and management skills. The SBC set up provincial and city branch offices so that they could provide local companies with better services on technology and market information. The system for promising SMEs that showed self-sufficiency had been implemented from 1983 in order to strengthen their competitiveness. Between 1983 and 1987, 4,760 promising SMEs were designated and given various forms of support by the government. The government decided to focus on medium-sized companies that had exported less than US$8 million annually, but would be able to increase the amount to around US$10 million within three to four years with support from the government. Between 1985 and 1987, 742 medium-sized export companies were identified and supported intensively.

In the Sixth Plan (1987-91), the government continued to place greater emphasis on the development of SMEs so that they might play a leading role in industrial growth and employment creation. SMEs were encouraged to improve their competitiveness to cope with growing foreign competition resulting from Korea's market opening policy and technological innovation abroad. In addition, the government continued to promote division of labor and cooperation between large and small enterprises. In 1987, the Industry-based Technology Development Project was adopted to support technology development of SMEs and assist them in resolving technological difficulties in different regions by strengthening technology support through regional industry testing centers. In order to improve the industry structure that relied heavily on imports and address chronic trade deficits with Japan, the government drew up the Five-Year Plan for Localization of Production of Machinery, Parts and Materials (1987-91).

The government worked to create a business environment that encouraged the start-up of competitive SMEs and accelerated the growth of existing firms in that category, thereby strengthening the basic structure of the manufacturing sector. To this end, the government provided increased budgetary and financial support for the start-up of such firms under the SME Start-up Promotion Act (1986). The government took measures to invigorate the R&D activities of SMEs, enabling them to strengthen their competitiveness through improvements in technology and product quality. Plant-floor-level technical guidance was provided to help resolve technological bottlenecks. The government ensured the smooth supply of funds needed to finance the R&D activities of SMEs and provided greater access

to technological information and technical manpower for SMEs. The government promoted efficient division of labor between large and small firms and helped develop a sound subcontracting system that linked large firms and ancillary parts and components suppliers. Export-import procedures for SMEs were also simplified.

Table 2-1 | SMB Promotion Policies

1961	The Industrial Bank of Korea (IBK) was established. SMB Transaction Coordination Act was enacted.
1962	The Korea Trade Promotion Agency (KOTRA) was established.
1965	Mandatory loan to extended SMEs from commercial banks was introduced.
1967	SME Technology Instructing Center was established.
1968	The SME Department was established inside the Ministry of Commerce.
1969	Commercial Paper Discount System was introduced.
1973	The Industry Promotion Agency was inaugurated.
1975	The Subcontracting System Promotion Act was enacted. General Trading Companies were introduced.
1976	Korea Credit Guarantee Fund was established.
1979	The SME Promotion Fund was established. The SMB Corporation (SBC) was founded.
1981	SMB Products Procurement Act was enacted.
1982	Priority Industries for SME promotion was designated. SBC opens SME Training Institute.
1983	System for Promising SMEs was introduced.
1986	Industry Development Act was enacted. SMB Start-up Promotion Act was enacted.
1987	Five-Year Plan for Localization of Production of Machinery, Parts and Materials Industry-based Technology Development Projects was initiated.
1989	The Act to Promote Restructuring and Stability of SMEs were enacted. The Korea Institute of Industrial Technology (KITECH) was established.
1992	Second Five-Year Plan for Localization of Production of Machinery, Parts and Materials (1992-96).
1994	Phasing-out of protective measures that restrict competition announced.
1996	Small and Medium Business Administration (SMBA) was inaugurated.
1998	The KOSDAQ market was established. Venture Businesses were identified and promoted.

1999	The Institute of Industrial Technology Evaluation and Planning was established. Act on Building Industrial Technology Infrastructure was enacted.
2001	The Act on SME Technology Innovation Promotion was enacted. SMBA initiated SME Technology Innovation Promotion Projects.

1) The SMB Transaction Coordination Act (1961) prevented excessive competition among SMBs and prohibited large enterprises from entering in areas of industrial activity specifically designated by law for SMBs. The SMB Products Procurement Act (1981) aimed to promote the procurement of SMB products by government, local autonomous bodies, public organizations and government-run agencies through policies such as the conclusion of collective agreements. The Subcontracting System Promotion Act (1975) prevented the parent companies from producing materials, parts and components specifically designated by law for SMBs. In 1994, the government announced plans to phase out such protective measure that restricted competition in domestic markets. These measures were eventually abolished in 2007

2) Pursuant to the Act on SME Technology Innovation Promotion, the SMBA initiated SME Technology Innovation Promotion Projects. From 2002, Inno-Biz (innovative businesses) were identified and promoted

The government opened an Off-board Stock Market in 1987 to open up more opportunities for SMEs to mobilize funds through direct financing. This was a so-called unlisted stock market, which was considered a stepping stone to listing on the exchange. For active investment in new technology businesses, a Technology Credit Guarantee Fund was established in 1989, which guaranteed debt repayments of companies that developed new technologies or commercialized new technologies. The government introduced measures to organize and operate a Cooperative to Invest in Start-ups in 1987. From 1990, SMEs that developed advanced technologies were selected so that they obtained technologies that would lead to upgraded technology levels.

In the second half of the 1980s, the business environment of SMEs deteriorated due to the rapid appreciation of the Korean currency, increased labor disputes and wage increases by SMEs. Hence, the government enacted the Act to Promote the Restructuring and Stability of SMEs in 1989. This act supported the sound business activities of SMEs in the short term, devising measures to strengthen management and establishing systematic policies to improve the structures of SMEs in the mid- and long-term. Pursuant to the Act, the Korea Institute of Industrial Technology (KITECH) was established in 1989. KITECH provided a variety of services, including technical research, open laboratories for testing and design, advice through visits to enterprises, response to requests for technological information, and technical training. To support the search for new combinations of technological resources for SMBs operating in the different branches of the manufacturing industry, the government introduced the Group for Exchanges in Different Businesses in 1989 and drew up the "Plan to Advance Technology of the Group for Exchange" in 1990.

With regard to the SME support system, the "Promising SMEs" program that had been in place since 1983, a graduation system was introduced in 1988. Promising SMEs that were judged to be self-sufficient after a certain period of support would then be graduated from the

system, and many new promising SMEs would be identified and supported for continuous growth and development. From 1990, the "Business Transfer Project from Large Companies to SMEs" was promoted so that those businesses deemed more appropriate for SMEs than large companies could be transferred to SMEs. For the protection of SME business areas, the government implemented a system of businesses strictly for SMEs. In order to prevent inefficiency emanating from long-term protection, the "System to Cancel the Designation of SMEs" was adopted. Sound management and technology development were encouraged further through the "Public Organizations' Prior Procurement of SME Products" initiative.

In the 1990s, economic growth was expected to be led by high-technology industries such as general machinery, electrical equipment, electronic products and automobiles. For these industries to be competitive, the development of parts and components manufacturing industries and industrial material industries, which were composed mainly of SMEs, was crucial. The support policies for SME restructuring focused on R&D, factory automation, management skills, and business start-ups. A special support program was introduced to encourage R&D activities at SMEs. The Second Five-Year Plan for Localization of Production of Machinery, Parts and Materials (1992-97) put emphasis on removing the technological bottlenecks faced by SMEs. The government selected 2,000 SMEs whose R&D spending exceeded 5 percent of sales and supported them for 10 years. Factory automation technology was developed and disseminated to 1,700 SMEs by the end of 1996. Investments for factory automation and employee training were increased. Measures to promote business start-ups were implemented, with the aim of creating 5,000 new firms in the technology-intensive industries. The SMEs engaged in declining industries were exhorted to switch to other promising business fields.

In the early stage of industrialization, economic development is generally led by large assembling manufacturers with low technology. As industrialization progresses, their competitiveness becomes dependent on equally well-developed suppliers of parts and components. Industrialized countries had established an efficient parts supplying system. In Korea, however, large firms did not have the chance to establish such an efficient system because of their relatively small size when compared to competing foreign manufacturers. They were limited in their capacity to develop R&D, quality control and marketing activities, which were essential to establishing the system. In addition, major corporations had expanded their diverse business activities to include unrelated industries, which had weakened their competitive advantage. The unbalanced development between large firms and small parts manufacturers had deepened the dependence of large firms on foreign parts suppliers, resulting in Korea's chronic structural trade deficits. The government promoted technology transfers from large firms to the SMEs to upgrade the technological level of the SMEs. The Second Five-Year Plan for Localization of Production of Machinery, Parts and Materials (1992-97)

emphasized establishing closer links between large firms and parts suppliers. Large firms were allowed to invest up to 10 percent of a parts manufacturing SME so that they could develop cooperative relationships in the areas of technology, human resources and finance. The government made efforts to monitor and curb unfair trade practices in the subcontracting system such as delays in payments by large firms to its subcontracted parts suppliers. The Fair Trade Commission strengthened its surveillance activities against unfair trade.

Efforts were made to remove obstacles in finance, human resources, and land supply that the SMEs were experiencing. The mandatory ratio of loans extended to the SMEs from commercial banks was raised in 1992 (from 35 percent to 45 percent), and the capital of the IBK was increased. Under the total limit system, the Bank of Korea supported financial institutions that extended loans to SMEs with low interest rates on the basis of the institution's loan performance. Two Credit Guarantee Funds expanded their support for SMEs that lacked collateral for loans. Small-scale industrial complexes were constructed for exclusive use by SMEs that did not have a factory. Likewise, the supply of apartment-type factories was increased. The government introduced a Competition System among SMEs in 1995 to support the sales channels of SMEs and bring about proper competition among designated SMEs when the government or public organizations procured the same items. In order to relieve the shortage of labor in the 3D (dirty, difficult and dangerous) fields, the Industrial Technology Training System for Foreigners was adopted in 1993. The Elderly Volunteer Group was launched to offer working opportunities to retirees with special skills as part of the effort to support SMEs. The government enacted the Act for Balanced Regional Development and Support of Regional SMEs in 1994, and efforts were made to support SMEs by mobilizing funds to support SMEs in specific regions, designating and supporting SMEs in special support zones, establishing comprehensive support centers for SMEs in districts and cities, promoting special industries in regions, and establishing credit guarantees. For practical implementation of SME policy, the Small and Medium Business Administration (SMBA) was established in 1996, which supported SMEs closely through its regional SME administrations.

The government promoted a "Business Incubator" model from 1992. The Act on Special Measures for the Promotion of Venture Businesses was enacted in 1997, which defined venture companies as (1) companies invested by venture capital, (2) a company that invested 5 percent or more of sales into R&D, and (3) a company with patents or new technologies. The government opened the KOSDAQ, a stock market dedicated to SMEs

and venture companies in 1996.[40] In order to assist in the technology development of SMEs, the government supported the Regional Consortium Project for Technology Development among the Industry, Academia and Research Centers from 1993, and implemented a Certification System for New Technology Markets. The SME Technology Innovation Promotion Project was carried out from 1997. A Special Support System for Technology Credit Guarantees was introduced and operated to expand credit guarantee support for SMEs that lacked collateral but possessed promising technologies.

To address the financial crisis in 1997, financial aid and venture company development were the key points of SME policies during the period 1998-2002. After the agreement for emergency funds support signed between the Korean government and IMF, the financial strain worsened with the restructuring of companies and financial institutions, which led to a higher risk of default by SMEs. As a result, the government drew up emergency measures to ease the financial difficulties of SMEs in 1998, which primarily consisted of extending the loan repayment period for SMEs, expanding the BOK's credit system, implementing a direct loan system for policy funds for SMEs through the SBC, establishing and operating a center to handle financial difficulties, and supporting the efforts of SMEs in export and import financing. The government also promoted the second SME structural improvement project from 1998 to support the restructuring of SMEs. In 1998, the "SME M&A Center" was established, which operated in the SBC. As it became more difficult for SMEs to manage their companies because of the dramatic decrease in sales after the 1997 financial crisis, the government urged public organizations to buy SME products to expand sales channels and stabilize management. The SME Products Distribution Center (SME department store) was constructed in 1999 so that around 10,000 products made by SMEs could be promoted directly at the center. In 1999, the government established a fund for management stabilization that was used solely for operating capital. The government also maximized its fund support to prevent bankruptcies, including a bill insurance system.

The government continued to expand its support of SME start-ups. Venture companies were identified and developed from 1998. In order to promote investments into venture companies, the government opened an investment mart in 1998 and provided benefits to cooperatives that invested in venture companies, allowing 20 percent of the amount invested to be deducted from general income. For effective support of venture companies, the government attracted foreign investment funds and established a Korea Venture Fund worth KRW100 billion. To facilitate financing of venture companies, a Department for Venture Companies was established in the

40. SMEs needed a creative financial services market to supply the venture capital required to develop new products. The Korean Technology Development Corporation (renamed the Korean Technology Banking Corporation in 1992), established in the early 1980s provided venture capital funding to a significant number of projects (around 100 a year), notably from small businesses. Nevertheless, just as OECD countries lacked a dynamic over-the-counter secondary market to resell the shares of promising high-tech enterprises, this type of venture capital had a limited impact.

KOSDAQ market. To enhance the success of start-ups after the financial crisis, the government expanded its Project for Supporting the Establishment of a Start-up Instruction Center. For rapid commercialization of new technologies, the government established a Korean Techno-mart in 1998, where SME technology-related information was loaded onto an SME Technology Exchange in the SBC. The government constructed a Technology Innovation Support Connecting System where information such as research tools and professionals employed at research centers and universities could be searched. In 1999, a "Professor/Researcher Start-up Support System" and laboratory system for start-ups at universities and research centers were promoted. Professors and researchers were allowed to conduct multiple duties after obtaining approval and participate in the management of start-ups. The number of people who received stock options was expanded to include professors and researchers.

The government recognized the importance of supporting technologically innovative SMEs. The Act on SME Technological Innovation Promotion took effect in 2001. "Inno-Biz" (innovative business) companies were identified and developed from 2001. The government set a goal of identifying and supporting 5,000 technologically innovative SMEs between 2001 and 2005.[41] A Center for the Information Development of SMEs was established in 2002

41. The propensity of a firm to innovate depends on the technological opportunities available to it, as well as its ability to recognize and exploit technological opportunities. A firm should figure out what these opportunities are, set up a relevant strategy, and have the capabilities to transform these inputs into actual innovation. The technological capability of a firm is partly embedded in its labor force. Skilled employees are a key asset for an innovative firm. Without skilled workers, a firm cannot master new technologies, let alone innovate. Apart from researchers, a firm needs engineers who can manage manufacturing operations, sales people who are able to understand the technology they are selling, and general managers who are aware of technological issues. Innovation capability also depends on the characteristics of the firm: the structure of its labor force and facilities (skills, departments), its financial structure, its market strategies, competitors, alliances with other firms or universities, and above all its internal organizations. Many of these aspects are complementary. The most significant factor determining the SMEs' propensity for and ability to access external technology is internal to the firm: most notably the employment of qualified scientists and engineers and outward-looking managers. The lack of internal technological know-how can inhibit external know-how accumulation and the firm's receptiveness to externally-developed technology. R&D expenditures can be seen as an investment in the absorptive capacity of the firm. A firm's ability to evaluate and utilize external knowledge is related to its prior knowledge and expertise which, is in turn, driven by prior R&D investment (OECD, 1997).

to ensure efficient implementation of SME information projects.[42] In 2002, the Technology Development Project on Conditions of Procurement was introduced, which allowed SMEs to concentrate on technology development based on established sales channels.

The Ministry of Commerce, Industry and Energy (MOCIE) was responsible for developing and implementing industrial policies. The main thrust of MOCIE's policy efforts was to stimulate technology development and technology transfer. MOCIE stimulated private R&D investment by rendering various supports. MOCIE identified strategic sectors in accordance with the key principle of "selection and concentration." MOCIE also reviewed the externalities and feasibility of the technology, and explicitly defined the division of work with supporting agencies. In particular, priority in the selection of components and parts was given to future-oriented promising industries. The Ministry believed that it was also necessary to provide support on a short- or long-term basis, depending on the characteristics of the technology involved. Short-term support would be used to remove bottlenecks in production lines and support R&D projects conducive to technology innovation in SMEs. Long-term support was directed toward strategic R&D projects in order to secure a competitive edge for key traditional industries, and to create future-oriented new industries. In 1999, the Act on the Development of Industrial Technology Infrastructure took effect. Pursuant to the Act, MOCIE invested in developing the infrastructure required to back up strategic R&D projects. Implementation of R&D projects and the needs-based evaluation of their relevance were undertaken by separate entities. The evaluation results were made public so as to enhance objectiveness and transparency in the entire process.

42. Information technology had not only found applications in every branch of the manufacturing industry, often significantly changing both products and processes, but also affected every function in each firm: design (CAD); manufacturing (instrumentation, robotics, FMS, control systems, CIM, etc.); marketing (computer based inventory and distribution system), and accounts and administration (management information systems, etc.). Through its convergence with the telecommunications system, information technology affected the network of communications within the firm and among the firm and its supplier networks, technology networks and customer networks. Information technology provided entirely new possibilities for rapid exchanges of information, data, drawings and specifications between geographically dispersed sites via fax, VANs, electronic mail, teleconferencing, distance learning, and other media. Most of the new developments in networking had been associated in one way or another with the diffusion of information technology, and its diffusion throughout the economy to new sectors of application depended on the development of new networks in every sector—banks, machine tool makers, travel agents, consultants, airlines, law firms, accountants, hospitals, chemical engineers, etc.

Institute of Industrial Technology Evaluation and Planning (ITEP)

ITEP was established in 1999 as a government-funded research institute by the Industrial Technology Infrastructure Promotion Law. ITEP carried out 1) industrial technology policy research and development of mid- and long-term strategies for national industrial technology development; 2) planning, management and assessment the industrial technology development and infrastructure building programs; 3) industrial technology needs surveys, technological capacity measurement, technology forecasting and trends analysis; 4) technology development feasibility studies and support for commercialization of developed technologies; and 5) promotion of international industrial technology cooperation and technology diffusion.

Industrial technology policy research included: technology development support policy and industrial technology infrastructure promotion policy research; 3) mid- and long-term national industrial technology development action plans; 3) short-term problem-solving study for national policy; 4) and technological innovation policy research for SMEs. Trend analyses included: monitoring and analysis of industrial technology policy trends; monitoring of the industrial technology policy development of major industrial countries; and study on the effectiveness of technology policy as part of the policy infrastructure.

ITEP provided guidelines for developing industrial technology policy and developed effective institutional support systems that included, among other things, research on the technology policy and support system for SMEs, study on how to strengthen the legal and institutional foundation for promoting techno-park type R&D complexes, and study on how to integrate the technical support system for SMEs.

MOCIE created an overall program for technology transfer and practical commercialization. In support of this program, MOCIE encouraged the establishment of technology transfer promotion teams at universities—University Industrial Technology

Forces (UNITEF)—and research institutes.[43] With joint investments by the government and private sector, the Korea Technology Exchange was established in 2000, which facilitated transactions in technologies and practical commercialization of technologies, and fostered technology trading firms.

MOCIE expanded the Regional Innovation System to establish a solid foundation for the National Innovation System.[44] MOCIE assigned specific roles to regional R&D support agencies including regional Technology Innovation Centers (TIC) and Techno-parks, establishing a mutual network for closer cooperation. MOCIE fostered techno-parks as overall technology centers with the concentrated support of related industries, academia and the government. Moreover, applications for patents and the commercialization of technologies developed by universities were actively supported, and spin-off programs

43. Professors established the University Industrial Technology Force (UNITEF) in 1996 to advance technologies and the competitiveness of SMEs. UNITEF expanded and upgraded industry-academia cooperation to the national level. Universities established Technology Licensing Offices (TLOs) dedicated to creating various activities for the transfer of technologies they developed. UNITEF's core project included developing a database for industry-academia networks, managing technological forums, and providing R&D consultancy services tailor-made for SMEs. University research should concentrate on discovery and technology transfer—securing intellectual property rights, assessing valuations of technology, and implementing licensing strategies. There are complex links and feedback relationships between industry and the S&T system. At the base of competitive advantages in innovation are such organizational capabilities as firm-specific knowledge, communities of practices, and technology platforms. Communities of practices are ensembles of skilled technical people with expertise in working across organizations. These communities span organizational divisions and provide both a repository for the firm's expertise and a medium for communication and application of new knowledge. Technology platforms are an output of the design process, which provides a common framework on which families of specific products and services can be created over time. The process of technology development consists of prototyping, proof of concept, on-going intellectual property protection, site testing, establishing business plans and raising seed capital.

44. The concept of the regional innovation system (RIS) is based on the assumption that the regional level can play a balancing role in the age of growing globalization. The national innovation system (NIS) cannot function well without RIS with respect to the enterprise and innovation support infrastructure, specialized human capital, leading edge basic and applied research, and the varieties of network relationships that function most effectively in the relatively close proximity of regional clusters. Specific regional or local characteristics and structural patterns exist, which have a deep impact on the competitiveness of regions. Some sectors or clusters interact with the regional governance and innovation support infrastructures as well as national and global levels. The RIS approach tries to explain how and to what extent the institutional and cultural environment of a region supports or obstructs innovation. In regional clusters of industries, higher efficiencies can be gained by jointly designing products, purchasing raw materials and energy, jointly using equipment, office space, and transport vehicles, joint production, financing, marketing, advertising, distribution, organization of exports, R&D, training, and other means. In addition, efficiency is gained through spatial agglomeration of SMBs, which reduces transportation costs and facilitates various sorts of inter-firm exchanges of information and other resources. Concentration in a locality may not only be significant for the pooling and exchange of resources, but also for the process of diffusion of innovation and new technology. Density of demand and supply is also an important functional requirement of occupational labor markets that rest on the easy substitution and mobility of workers with the same skills across firms. There must be enough employers and workers in the local market to enforce the law of large numbers, which forms the basis for quantitative and qualitative adjustments in this labor market structure. Further, the work sites must be close enough geographically to avoid undue mobility costs.

for commercialization of excellent technologies developed by universities and research institutes were expanded.

MOCIE supported proper remuneration for outstanding R&D workers. A portion of profits and royalties gained from the commercialization of developed technologies was distributed to their respective researchers. MOCIE also worked to develop a concrete remuneration formula for private R&D. MOCIE commissioned a survey of the supply and demand status of industrial technological manpower during September 1999 – January 2000. Based on the results, MOCIE established an effective supply and demand program and reflected the results in revised training programs at universities and other institutes.

The SMBA targeted its policies at improving the structure and competitiveness of SMEs. Efforts were made to strengthen the management of existing SMEs and to promote the start-up of new, technologically viable SMEs. Production and management restructuring was being pursued through automation and computerization. Marginal companies were encouraged to liquidate completely or transition to more competitive business lines. Credit guarantee programs were expanded to achieve more effective lending services. Consignment training programs and the systematic training of skilled workers were expanded to relieve manpower shortages at SMEs. Positive support was available for those who wanted to start new venture businesses and for SMEs desiring to convert to venture businesses in technology- and knowledge-intensive fields. Being promoted for this purpose was a system under which efficient financial resources were available for young people, especially those at colleges, to start businesses that would eventually go public as listed companies. To help SMEs improve their technological capabilities, various technology development programs and the transfer of outstanding technology from the academia and research organizations to SMEs were encouraged and promoted. To this end, tripartite cooperation among SMEs, institutions of higher education and research organizations was promoted along with technology guidance programs. SMEs were given the support to explore export markets and to link up with partners abroad for joint investment in their respective or third countries.

In most advanced and developing economies, governments have been anxious to help SMEs lower their failure rate and grow to become job-creating employers. Under a national strategic framework, a wide range of SME support policies were developed and implemented. However, the effectiveness or appropriateness of the policies is unclear. The policy choices are complex, and the outcomes of the policy decisions are difficult to evaluate. Even when appropriate policy decisions are made, their implementation is neither obvious nor easy. It is a challenge to design organizations that can deliver selected policies effectively. The major issues raised by experts on SME support policies and programs include policy gaps, targeting of policies, and delivery organizations.

Many owner-managers express dissatisfaction with the inconsistency and instabilities of SME policies. The influence of political decision-making led to policies that were not necessarily in the best interests of SMEs. Instead, SME policy often served as a compromise and a part of wider government objectives such as overcoming unemployment. Thus, switches in support policy were not always based on careful assessments. Instead, they were the result of budgetary constraints or other extraneous factors. The majority of experts emphasized the need for more comprehensive evaluations of existing policies for improved policy formulation.[45]

Owner-managers consider policies aimed at improving SME financing to be among the more successful government initiatives. Many of these support programs have relatively clear objectives, and their targeting has also been successful. The Loan Guarantee Scheme was viewed as a relatively successful support measure. Efforts to improve SMEs' access to financing were also considered successful. These programs embodied a number of principles for good policy development as they served several functions: 1) fulfilled a particular market gap; 2) were relatively stable over time; and 3) were continuously refined after evaluation and research. Support for management stability had been commonly cited as somewhat of a failure, primarily because many of the investments and tax breaks were used for purposes not originally intended. Finance support for management stability was highlighted as one of the less successful initiatives, suffering from poor targeting and design. As a result, much of the support was also not used in its intended manner. Evidence suggests that successful policies had been in place for some time and continued to be shaped by incremental improvements. Support programs take time to make an impact, but the risk of terminating policies before they have been given a chance to achieve their full potential is great. Policies and programs need to become well known among those who deliver them as well as to the recipients. The government needs to recognize that the financial requirements of SMEs are diverse and vary according to circumstances, ranging from development at the start-up stage to the established SME, and possibly listing on the stock markets. Availability of financing is not

45. Most OECD counties spend significant amounts of public money on SME support and it has been recognized that the impacts of such initiatives need to be evaluated. However, evaluations are a rather reactive way to develop best practice. Instead, best practice development should be more proactive. This can be achieved when policy development is based on a cycle where market research and understanding of SMEs' needs provides a basis for policy design, targeting and delivery, followed by rigorous evaluations and feedback. As evaluations are made an obligatory element of the policy process, there is a danger that they become a ritual rather than a rigorous examination of the positive and negative outcomes of support programs. This research suggests best practice for evaluation that should involve the examination of 1) the take-up of schemes, 2) opinions from delivery agencies and recipients, and 3) recipients' view of the difference made by the assistance. In addition rigorous evaluation and best practice development requires 1) comparison of performance of assisted with non-assisted 'matched' firms, 2) longitudinal comparisons of indicators over a significant period of time, and 3) a knowledge base of accumulated evaluation information. See OECD (1997), Small Businesses, Job Creation and Growth: Facts, Obstacles and Best practices, Paris.

the only problem for SMEs. A lack of financial skills may cause problems as well. Thus policy design needs to take into consideration the training and advisory requirements.

The portion of SMEs that implement training is considered to be lower than it should be. Many owner-managers are reluctant to allocate limited financial resources to training, spend time away from their workplace and give allowances for staff training. Various training options has been developed, some of which were perceived as quite innovative and effective. However, cost effectiveness seems to be a weakness of the system. Researchers remain deeply divided on whether or not training has positive effects on enterprise level performance. The fact that a clear correlation between training and improved business performance has not been identified may stem from problems endemic to the research, as well as the quality of the training itself. The supply of training programs increased rapidly in the 1990s, mainly because training is assumed to have positive effects for the individual, the business and the economy. However, research has not been able to prove a link between training and business performance. Despite their ample supply, not many training programs are well suited to meeting the needs of SMEs. Consequently, the training among SMEs has been low. The rapid growth in training courses also raises questions regarding the quality of new programs. There is clearly a need to pay more attention to policy objectives and the quality of the consultants and trainers. Decision-makers should also pay attention to the displacement of existing institutions. At the same time, when funds are re-allocated to various types of new training, longer standing institutions suffer from scarce resources. This raises serious concerns about the net effects of the new types of training programs. It could be more effective to deliver training through well-established organizations and networks rather than set up new organizations.

It was widely acknowledged that policies can benefit from better targeting. However, the views on the appropriate criteria defining who or what should be targeted were often contradictory. This requires the use of more sophisticated market segmentation and consultation models, which can shape the support provided so as to be more sensitive to recipients' needs. Program design and delivery should be based on an identified operational problem, and support had to be tailored to tackle this specific issue. Clear understanding of SME needs is essential, and statistical aggregate data is hardly sufficient in evaluating and designing SME support programs. It was suggested that new enterprise promotion policies were largely motivated by high unemployment rates rather than more specific objectives aimed at strengthening the SME sector. There is a continuous debate concerning if government support should focus on business start-ups or fast-growing enterprises. Fast growing enterprises represent a large share of new jobs and economic growth created by the SME sector. However, it is extremely difficult to identify which SMEs would qualify as a fast-growing business, and they represent a very small fraction of the SME population. Thus it is more appropriate to target support for the sectors that have growth potential and are thus

important to the competitiveness of the economy. It is also essential that support programs are delivered by organizations that are effective in reaching the targeted growing businesses. A clearly positive outcome of SME support is better awareness of the SME sector overall.

The fact that programs aimed at SMEs tend to have poor market penetration is partly related to delivery channels that operate inflexibly, are budget-driven and are short-lived. The less active the targeted groups are in terms of seeking support, as time-constrained owner-managers tend to be, the more important active, customer-oriented policy delivery organizations become. Private organizations—for example, banks—can be an effective policy delivery channel, provided they are offered sufficient commercial incentives. Effective delivery organizations develop over time as they gain experience and knowledge of support programs, their clients and the sector or geographic area where they operate. Policy delivery agencies, like any service organizations, are very much dependent on their staff, so they should offer stable and rewarding environments for employees.

The need for a balance between central coordination of SME support policy (providing economies of scale in design, delivery and evaluation) and local delivery (tailoring for diversity) was recognized. Evidence suggests that local delivery of SME support is more appropriate than a centralized approach. The main task of the central government is to provide a strategic framework for support and to coordinate policy design, content, and delivery. The tensions between the central government and local level organizations can be managed better if effective information channels between national and local agencies exist. Support and delivery organizations should themselves act as effective information channels. The government also needs to set carefully designed and clearly defined performance criteria for support delivery organizations. Such criteria give them an incentive to deliver support to the targeted SMEs. Finally, program objectives, targeting and performance criteria for delivery organizations need to be in sync.

Local and regional agencies have the best knowledge of their area and needs for SME support, thus they have an important role in policy delivery and design. Spatial policy is also an area that involves numerous objectives, interest groups, support agencies and funding sources. Thus, national strategy is required to create balance and coordination between contradictory regional and local priorities. Key elements of successful program design and delivery include locally based skilled staff, knowledge of the targeted SMEs and the involvement of local communities.

The Regional Development Commission (RDC) is often recognized as a successful support delivery organization. This institution has clear objectives and a good understanding of its target audiences. However, RDCs and their programs have tended to concentrate on attracting investments of large businesses and multinationals rather than promoting indigenous enterprises. Although this approach achieved some success, at the same time,

several high-tech firms recently closed their factories as a consequence of the global economic downturn. The RDCs stand out as an exception to the above profile. According to the experts, they have been exceptionally active and successful in supporting regional SMEs. Their knowledge of the local communities, well established organization and highly skilled local staff have formed the basis of their success.

2. Structural Change in SMI and Evolution of Diffusion Policies

Data on the size distribution of SMBs is available only for the manufacturing industry. An annual report on manufacturing provides the number of establishments, the number of employees, employees' remuneration, gross output, and value added by establishment size. This data shows that in 1992, 98.6 percent of all establishments in the manufacturing sector were SMBs, and these SMBs employed 65.8 percent of total employment and accounted for 47.6 percent of total value added in the manufacturing industry.[46] The branches of the manufacturing sector dominated by SMBs were textile, clothing and leather, printing, metal fabricating, general machinery and miscellaneous manufacturing.

The relative share of employment in SMBs had increased since 1980. Table 1 shows the development of the size distribution of manufacturing establishments, which clearly indicates a shift in the share of employment towards smaller establishments. The share of SMBs in manufacturing employment had increased from 49.6 percent in 1980 to 61.8 percent by 1992. SMBs had also increased their share in the total value added of the manufacturing industry since 1980. However, due to the widening productivity differential between large firms and SMBs, the increase in the relative share of SMBs in value added was less than that in employment. In 1980, the value-added per employee at SMBs was 55.0 percent of that in the large firms, and further decreased to 47.0 by 1992. The productivity differential between large firms and SMBs was slightly larger in Korea than in Japan, where value added per employee at SMBs was 49.5 percent of that of large firms in 1991.

The widening productivity differential between large firms and SMBs resulted from two factors: the value added per employee at SMBs in all size groups declined compared with that of large firms; and the smaller establishments with larger productivity gaps increased their employment share, while the medium-sized establishments with smaller productivity gaps lost

46. SMBs are officially defined as firms with fewer than 300 employees in manufacturing and firms with fewer than 20 employees in wholesale and retail trade and services. This definition is applied to all of the official statistics and regulations relating to SMBs. In view of this official definition of SMBs, the usual research practice is to define SMBs in terms of employment using 299 employees as the upper limit of classification. Unfortunately, the coverage is not always complete because many official statistics often exclude extremely small firms below 5 persons.

their employment share. The productivity gap increased as the size of firms decreased. During 1980-1992, the smaller establishments employing more than 4 but fewer than 100 increased their employment share from 28.6 percent to 48.3 percent. Medium-sized establishments with between 100 and 299 employees experienced a decrease in employment share from 21.0 percent to 17.5 percent. During the same period, the value added per employee, as the ratio to that of large firms, decreased from 37.2 percent to 32.4 percent at establishments with 5-19 employees, declined from 49.6 percent to 44.2 percent in establishments with 20-99 employees, and fell slightly from 67.3 percent to 66.2 percent in establishments with 100-299 employees.

Table 2-2 | Employment Share and Productivity Gaps by Establishment Size (Korea)

	Establishment size (number of employees)				
	5-19	20-99	100-299	5-299	300+
〈Employment share〉					
1980	8.2	20.4	21.0	49.6	50.4
1992	16.8	31.5	17.5	65.8	34.2
〈Productivity differentials〉					
1980	37.2	49.6	67.3	55.0	100.0
1992	32.4	44.2	66.2	47.0	100.0
〈Wage differentials〉					
1980	66.0	80.1	86.6	80.5	100.0
1992	55.6	65.6	79.1	66.7	100.0

Sources: National Bureau of Statistics, The Report on Manufacturing Survey for each year

Table 2-3 | Employment Share and Productivity Gaps by Establishment Size (Japan)

	Establishment Size (Number of Employees)				
	5-19	20-99	100-299	5-299	300+
〈Employment share〉					
1960	20.9	30.2	16.2	67.2	32.7
1970	27.2	24.4	15.9	67.5	32.5
1980	30.1	27.9	15.5	73.4	26.6
1991	23.2	31.0	17.9	72.1	27.9
〈Productivity differentials〉					
1960	30.9	43.5	60.8	51.0	100.0
1970	37.6	53.8	67.4	50.0	100.0
1980	34.8	49.5	67.6	47.3	100.0
1991	38.2	48.6	65.9	49.5	100.0

Source: Ministry of Industry and International Trade, Manufacturing Census for each year

The wage differential between SMBs and large firms also increased between 1980 and 1992. Size-related differentials, however, were far less for wages than for productivity. The wage differentials by firm size might not be entirely accurate because the quality of labor was not controlled for. Wages were usually strongly related to age, years of service, education, and gender, and workers' career patterns were very different in large companies versus SMBs. The share of skilled workers rose as the size of the firm increased. Many blue collar workers at SMBs might become independent owners of small businesses mostly by their late thirties or early forties. When workers of the same experience level and educational background were compared, wage differentials still existed between SMBs and large enterprises. Work hours were longer at SMBs than in large firms. There were also considerable size-related differentials in other benefits such as lump sum retirement allowances, pensions and medical care, company welfare facilities, and housing loans. SMB workers were also more prone to work accidents. The vast majority of SMBs had no trade union, primarily because of the specific social structure of these firms: paternalism among the employers and close social contact between employees and employers.

Productivity gaps between SMBs and large firms had not widened in all branches of manufacturing. In branches such as food processing, textiles and clothing, footwear, and miscellaneous manufacturing, the productivity gaps between SMBs and large firms had actually narrowed. These branches were also those that witnessed declining levels of employment share in the SMB sector. It seemed that closing low-value added businesses contributed to narrowing the productivity gap. On the other hand, the productivity gap had increased in branches such as general machinery, electronics and transportation equipment. The employment share of these branches in the SMB sector expanded, primarily because large firms looking for opportunities to cut costs were increasingly contracting out manufacturing functions previously performed internally. This strategy might be implemented both by placing orders with SMBs and by splitting off the relevant sections in the form of new companies.

Table 2-4 | Value-added Shares and Productivity Gaps in the SMB Sector

	Value added		Productivity (1)		Productivity (2)	
	1980	1992	1980	1992	1980	1992
Food Processing	13.2	10.7	28.9	36.6	128.1	135.5
Textiles, Apparel & Leather	22.3	18.0	64.0	72.9	69.9	70.2
Wood Products	2.9	3.6	100.8	69.2	83.4	88.4
Paper, Printing & Publishing	6.5	6.4	51.5	45.3	106.7	104.5

	Value added		Productivity (1)		Productivity (2)	
	1980	1992	1980	1992	1980	1992
Chemicals	19.3	15.2	74.1	39.1	181.5	153.1
Non-metallic Mineral Products	7.5	8.2	52.0	62.8	128.2	140.8
Metal Products	4.3	4.6	39.5	41.6	126.5	145.0
Machinery & Equipment	20.5	31.0	62.4	46.8	88.0	90.2
Miscellaneous Manufacturing	3.5	2.3	80.3	82.7	70.7	76.8
Manufacturing SMB	100.0	100.0	55.0	47.0	100.0	100.0

Source: National Statistics Bureau, The Report on Manufacturing Survey for each year

Note: Productivity gap (1) is between SMBs and large firms, and productivity gap (2) is between different branches of small and medium-scale industries

The role of SMBs in any economy may change over time. The increasing relative share of SMBs in the 1980s could be attributed largely to the outsourcing strategy of large firms. Although it was evident that prosperous and innovative independent SMBs had flourished in the 1980s, it was also undeniable that employment was forced to increase more rapidly among small firms due to the limited job generation ability of large firms. In manufacturing, the proportion of subcontract firms (the proportion of subcontracted sales in total shipments exceeds 80 percent) increased from 23.2 percent in 1981 to 63.2 percent by 1992. The proportion of subcontract firms was higher than average in the machinery and equipment industry. The technological gap between the subcontractor and large parent firm could be expected to narrow as technology was transferred from large companies to SMBs.

Table 2-5 | GDP Share by Branches of Small and Medium Scale Manufacturing

	1963	1970	1980	1990	2000
Food Processing	24.6	21.6	13.2	9.3	11.7
Textiles, Apparel & Leather	16.6	20.8	22.3	18.2	13.3
Wood Products	3.4	3.2	2.9	2.8	1.0
Paper, Printing &Publishing	8.9	7.4	6.5	6.1	6.2
Chemicals	16.6	12.4	19.3	17.0	17.5
Non-metallic Mineral Products	6.2	10.6	7.5	7.0	5.1
Metal Products	4.9	3.0	4.3	4.3	4.4
Machinery & Equipment	14.2	16.9	20.5	32.4	37.8
Miscellaneous Manufacturing	4.3	4.2	3.5	2.9	3.1
Manufacturing	100.0	100.0	100.0	100.0	100.0

Source: National Statistics Bureau, The Report on Manufacturing Survey for each year

There was a close correlation between the way in which the SMB sector develops in an economy and the working conditions that SMBs offer their employees relative to large firms. The greater the difference between wages and working conditions in firms in different size categories, the more difficult it was for SMBs to hire better, more highly qualified personnel, and the more difficult it was for them to compete with large firms in markets that make high demands on product quality, innovative capacity and company flexibility. Given the diversity of the SMB sector, one would expect a multiplicity of different working situations. The spectrum ranges from SMBs with extremely unfavorable working conditions, such as repetitive and physically demanding work, unstable employment and excessively long working hours, to SMBs where there are mostly skilled jobs, offering much potential for planning and creativity, stable employment, and enhanced safety at work.

The resilience of the SMB sector should be based largely on the ability of many SMBs to introduce high quality, individualized products, and to adapt quickly to changes in product markets. The precondition for this route was the availability of skilled labor. If unfavorable working conditions relative to large firms were not improved, SMBs would find it more difficult in the future to recruit and retain qualified, innovative and adaptable personnel. This would probably lead to further deterioration of their competitiveness through the loss of innovativeness and adaptability, eventually resulting in a decrease in the employment share of SMBs. The diversity of SMBs made it difficult to analyze the SMB sector by company type. At one end were innovative SMBs with a strong market position, which employed highly qualified personnel to produce high quality goods, which were themselves innovative, and in which working conditions matched or even exceeded those in large firms. At the other end were SMBs that produced a relatively simple, substitutable product, which operated in a market with sharp fluctuations in demand, and in which the jobs required few qualifications and were low paid and physically demanding. Compared with industrialized countries, innovative SMBs were relatively small in number, and their innovative capacities were significantly weaker. In particular, the proportion of SMBs that often produced technologically advanced specialist products for a particular market niche was negligible.

In 1993, only 7.7 percent of the manufacturing SMBs carried out their own R&D.[47] For the majority of these SMBs, R&D activities were much less planned and formalized, and technological innovation was of lesser importance in their competitive and market strategies than qualities such as meeting deadlines, short delivery times and flexibility in

47. In Germany, there are approximately 33,000 manufacturing SMBs with fewer than 1,000 and more than 20 employees which provide about two thirds of all industrial employment. About 40 percent of these firms perform R&D, mainly development. See Frieder Meyer-Krahmer, Science and Technology in the Federal Republic of Germany, Longman, 1990.

adapting to special requests from customers. Their innovative activities had been more akin to development rather than research, and highly dependent on technology imports. There were few employees engaged solely in R&D, and staff was made available for R&D work on a case-by-case basis. Innovative activities at SMBs were directed more towards product innovation than towards innovations in the manufacturing process, and usually followed closely the current product program and consisted for the most part of further development of existing products. In the 1990s, however, the number of innovative SMBs increased rapidly, and their technical competence was also improved considerably. The growth and performance of SMBs depended largely on whether they were traditional businesses or new technology-based firms with higher R&D capabilities. The major business groups externalized their low value added activities and strengthened their technological competence.

With the exception of internal relations within the business group and relations between the parent companies and their suppliers, Korean companies were unaccustomed to the idea of cooperation. Mainly due to high dependence on imported technology, the Korean industry had been organized into separate firms dealing with each other at an arm's length. Moreover, SMBs' history with large firms made them reluctant to enter into cooperative arrangements with them. Large corporations, which had been and would be the technological leader in network collaboration, had a reputation for behaving in a predatory manner towards smaller firms. This legacy still lingered and constituted a major impediment to successful collaboration. Korean institutional frameworks were also less supportive than in advanced countries. There was clearly a significant difference between Korea and industrialized countries in the amount of support for both innovation in general and collaboration in particular. Only in the early 1990s did Korean firms become aware that in order to acquire and develop the next generation of generic technologies, the development of strategic alliances and partnerships among themselves as well as with foreign firms was key. Large firms were also aware of the opportunities presented by SMBs with technical competence, and technology-based SMBs also recognized the advantages of interacting with the research division of large corporations in order to gain on-site user expertise. The relationship between large firms and their suppliers was also undergoing a fundamental transformation. Subcontracting firms had been viewed in a somewhat condescending way as low-cost suppliers, and this attitude changed in the early 1990s as the industry came to

recognize that the competitiveness of final products could not be maintained without the engineering and innovation capability of parts and components suppliers.[48]

The production network of the Korean automobile industry was very similar to those of the Japanese automobile industry, which was in fact a managerial hierarchy to integrate, coordinate, and plan the development and production of parts and components. The strategy of the parent company was to organize production units in multi-tiered structures, in which the parent company directly controlled only the first-tier suppliers, relying on first-tier suppliers to control the second-tier subcontractors and so on down the hierarchy of subcontractors. In this way, the span of control at any level never became too large while the division of labor could be optimally developed.[49] This multi-tiered network of suppliers enabled the parent company to buy more high quality assembly-parts, and thereby to concentrate on R&D, design, and assembly rather than manufacturing. However, the degree of integration and coordination and, thus, the performance (efficiency) level of the system were much lower in Korea than in Japan. In fact, the Korean parent companies had emulated the Japanese system and practice. It should be noted that in Japan, repeated renewals of the linkages between the parent company and its suppliers, along with the rationalization of the production and management systems within the parent company, led to the evolution of an efficient supplier network, in which the decentralization of production, inventory control, and even design/R&D allows specific transactions to occur without any appreciable degree of overall control exercised by the parent company. To attain such a level of network efficiency, the parent companies had to make systematic efforts for more than a decade. First of all, the first-tier suppliers should be promoted to be systems-component manufacturers. In the early 1990s, few component suppliers fully understood the assembler's conception of end products and paid little attention to the whole production process. Several suppliers of major components organized other parts suppliers and specialized processors. The first-tier suppliers must be promoted to acquire the technical competence to conduct design/R&D and the management capability to reorganize and effectively control lower-tier subcontractors. The Korean parent companies began to promote their first-tier suppliers in this direction, in parallel with building up their own technological competence.

In the automobile industry, the suppliers were determined when a new model for a passenger car was developed, and were rarely replaced by other suppliers during the life

48. It has been generally recognized that the intensive use of subcontracting had helped parent companies to save on fixed capital, to mitigate the adverse effects of business cycles, and to exploit cheap labor. The majority of economists who were interested in SMBs tended to stress the subordination of subcontractors to parent companies and the exploitation of the former by the latter, which took advantage of low-wage and the inferior bargaining position of subcontractors.

49. As for the supplier network in the Japanese automobile industry, see W.M. Fruin, The Japanese Enterprise System: Competitive Strategies and Cooperative Structure, Clarendon Press, Oxford, 1992, ch.7.

cycle of that model (non-switching). The practice at that time was to make a full model change every four years and a minor model change in between. Each core firm sought to secure more than one supplier for each part (dual-sourcing), but only one supplier for each model. Dual-sourcing ensured against a sudden stoppage of delivery from the source due to accidents, putting competitive pressure on the suppliers and eliciting a more cooperative attitude with respect to prices and quality than might otherwise be possible. The reason for non-switching was to avoid duplicative investments in such equipment as specific dies and jigs for a model, which was paid for by the core firm. This practice stabilized the status of suppliers during the life cycle of a newly developed model. However, there was no guarantee that the incumbent supplier would be selected again at the next full model change. Competition resumed among potential suppliers who possessed the general capability of supplying the same part. Based on the ratings of the suppliers, the core firm selected a suitable supplier for each part of the new model.[50] This competition was for the most part limited to a small number of incumbents. Nonetheless, competition among potential suppliers seemed to work well, eliciting favorable terms of trade from suppliers because core firms manufactured a number of models simultaneously.

In the electronic industry, core firms were typically multi-product firms, producing a wide variety of final products that were extremely diverse with respect to the scale of production and the degree of technological maturity. Business units tended to specialize in a subset of the final products, which was substantially different among the business units, in view of the scale of production and degree of technological maturity. In contrast to the automobile industry, the details of purchasing activities were determined by each business unit rather than the purchasing division of the corporate headquarters, which only set the basic purchasing policies and supervised the purchasing activities of the business units. As in the automobile industry, few suppliers for a model were switched during the life cycle of that model, and the suppliers for the current model were not necessarily awarded the contract for the same parts for the next model. However, the life cycle of a model was much shorter than in the automobile industry and, therefore, competition among potential suppliers was keener. Each business unit had its own set of suppliers. Although some of the first-tier suppliers seemed to have long-standing relationships with their major clients, this did not apply to all of the first-tier suppliers. The share of marketed parts (such as memory ICs, connectors, resistors, motors, switches, cables, etc.) was much higher in the electronics

50. The parent company periodically exercises ratings on the first-tier suppliers in terms of performance as well as potential capabilities, classifying them into A, B, C, and D. With suppliers ranked as A or B based on cumulative ratings, the parent company seeks to keep business as continuous as possible, and with those ranked as D, the parent company seeks to terminate the relationship. Those ranked as C are considered marginal suppliers. The more intermittent and uneven the demand for the final product, the more necessary for the parent company to retain marginal suppliers on the first-tier as a capacity buffer.

industry than in the automobile industry, and a considerable proportion of marketed parts were imported from abroad, mainly due to the lack of technological competence.[51]

An efficient system of flexible specialization was yet to be developed. The precondition for such development was the availability of an adequate pool of efficient, flexible and innovative SMBs. The development of the technology-intensive industry (general machinery, electronics, transportation equipment, and precision instruments) required an extensive network of suppliers and subcontractors. The parent companies increasingly depended on the specialized equipment and technical competency of suppliers in specific engineering rather than on wage differentials. In the face of increasing technological and qualitative demands made on their products, accelerated rate of innovation, and increased price competition in product markets, the parent companies adopted the strategy of concentrating on their principal activities and using the knowhow and experience of specialist suppliers. As a result, there would emerge a trend towards supplying complete components rather than individual parts. In addition to taking advantage of the greater knowhow of specialist suppliers, the increased use of subcontracting was also intended to reduce costs (e.g., through a gradual decrease in suppliers' unit costs and the opportunity to exert pressure on suppliers to lower their prices and to take advantage of the greater flexibility of suppliers relative to in-house production). The parent companies would select efficient suppliers and fire the less efficient ones. The increasing sophistication of end products and advances in process technology would accelerate, resulting in an increasing number of SMBs with higher technical competence. Competition forced component suppliers to deepen and broaden their technical capabilities, as well as cooperate with others. Due to the increased pressure of competition in their own product markets, SMBs were also making increasing inroads into the subcontracting market.

51. Outsourced parts are classified into marketed parts and ordered parts. The latter is supplied according to specifications issued by the core firm; and the former is manufactured according to standardized specifications and purchased like market transactions. Ordered parts are classified into DS (drawing supplied) parts and DA (drawings approved) parts. The latter is manufactured according to drawings made by the suppliers themselves and approved by the core firm; and the former is manufactured according to the drawings supplied by the core firm. The DS parts supplier provides basically only manufacturing capabilities, while the DA parts supplier provides capabilities for product development as well. Subcontractors are used synonymously with DS parts suppliers, which also include the supplier of processing services. DA parts, such as custom IC, are important both with respect to their role in improving the final product and their share in the total amount of purchased intermediate goods. The mode of governance structure differs, depending on the nature of transactions. Long-standing relations between a core firm and the first-tier suppliers vary depending on the characteristics of the final products and parts, and relations are closer where customized parts are transacted. Long-standing relationships can be ascribed to high evaluations by the core firm of the relation-specific skills of individual suppliers. As for relation-specific skills, see B. Asanuma, Manufacturer-Supplier Relationships in Japan and the Concept of Relation-Specific Skills, Journal of the Japanese and International Economies 3, 1989.

Increasing reliance on the specialized technical resources of suppliers and subcontractors further altered the nature of the supplier networks, which eventually evolved into a highly developed division of labor system. As the technical competence of suppliers improved, specialized technical capabilities would be the primary motive for subcontracting by large corporations, and the core companies would transform their position into a nucleus within a more decentralized production network with a weak hierarchy. Technological competence and specialization would be the basis for more equal and trusting relationships between firms who needed each other's specialized capability in new product and systems development. The initiatives in the development of new components and new process technologies would be shifted to the SMBs. As a result, the progress of their specialized technologies would be accelerated. SMEs would increasingly advance themselves, thus strengthening inter-firm linkages. In the process of industrial restructuring, diverse transactions would emerge, transcending the traditional boundaries among industries, and both large firms and SMBs would seek new links with a view to expanding the scope of their main lines of business.

Under specific conditions, localized production networks based on SMBs linked by nonhierarchical relations can be competitive. The possibility of adjusting inter-firm relationships enhances the adaptability of a production system to external shocks and encourages its internal impulses to change, such as product and process innovation. The relationship among network members is one of cooperation-competition, which can be explained in terms of both economic and social behavior. Interacting firms become progressively specialized in their activity, and the cost of information and coordination are curbed by recognition among the companies in the area that they are part of a common group. This is akin to a collective learning effect, which contributes to dynamic economies of scale external to the individual firms but internal to the agglomeration of firms in the area. This collective learning effect is linked to specific technologies, and therefore the diffusion of innovation is based on incremental adjustments. This had been clearly demonstrated for the districts of the Third Italy, southern Germany and elsewhere,

which largely possess traditional production bases, such as textiles, clothing and general machinery.[52]

The transfer of information within a network appeared to function differently among different countries. In the Italian industrial districts, internal transfers of information were mainly made through business networks, including designers, merchandising directors, suppliers, and customers, as well as various component producers and subcontractors. Innovation was frequently the result of collective processes involving a flexible and decentralized system of production and local knowhow. The transfer of information coming from outside was slower but, once transferred through the inter-linked firms, the information spread rapidly to the entire district. Professional associations played a role in this transfer, but it was fostered and maintained above all by the mass of technical and productive ties between the members of the system. Localized production systems in southern Germany (especially in the BadenWürttemberg region) were based on more formal networks, including those among SMBs, principal contractors and their subcontractors. In the former case, information was transferred primarily via professional associations in which the SMBs systematically negotiated the definition not only of the coordinated specialization

52. The production knowledge regulating the division of labor and the generation of product and process innovations is the core of a good network. This production knowledge is not simply the technological learning related to a basic technology. It is also the social recognition of the reliability of the individual production units, as well as the capacity of the network members to produce a specialized part consistently, in terms of quality and scheduling. This production knowledge reduces the transaction costs within the network because the cost of information and the cost of coordination are reduced by the existence of this common, diffused learning, and by the reciprocal reliability in carrying out the actual production process. In incremental innovations of process and product, clan regulation guarantees the imitation process and person-to-person diffusion as part of the enrichment of common knowledge. This is made possible principally because the incremental innovation is not transferable without the support of the general knowledge diffused within the network. The network works as a clan, in which the transmission of orders is not essentially based on either price signals or hierarchical commands, but rather on traditions or a set of informal regulations that attribute positive reputations to active members and impose negative sanctions on free riders. However, the informal tradition must be reinforced by some explicit rules guaranteeing reliability; and a moderate selection can exclude those members that are not able to maintain the steady standards and regular timing of production and delivery. Moreover, traditions require a continuous process of self adjustment. Innovation requires an evolution of common traditions and language. Innovation also requires the capability of accelerating change and sometimes breaking up existing traditions. See G. Harrigel, Large Firms, Small Firms and the Governance of Flexible Specialization, in B. Kogut (ed.), *Country Competitive-ness: Technology and the Organizing of Work*, New York: Oxford University Press, 1993. The clan concept was developed to identify a social group based on solidarity among the participants, self-identification as a collective unit, common language, and sharing of basic knowledge and values. See W. Ouchi, A Framework for Understanding Organizational Failure, in J.R. Kimberley and R.H. Miles (eds.), *The Organizational Life Cycle*, Jossey Bass, San Fransico, 1980.

and market, but also of their technological options.[53] In the latter case, the principal contractors had a vital role to play as technological leaders, and technology transfers made subcontractors technologically dependent on the principal contractor. However, the principal contractors encouraged diversification among their subcontractors, which were thus partly able to sustain their technical development. In any case, information transfer was in large part fostered by inter-personal relations in more or less formal networks, which explained the "cooperation competition" based on ties of solidarity and confidence, as well as on the need for systematic technical change in order to ensure the development of the entire system.

In the late 1980s, mature industries such as apparel and footwear endured rapid structural adjustments due to domestic wage increases and shortages of labor, increasing competition from China and other Asian countries, decreasing exports to OECD countries, and increasing competition for high-quality products. The pace of structural change in these industries was expected to be even faster than before, mainly due to the expansion of division of labor among the Asian countries. The apparel industry suffered from poor market performance (operating in low value added segments) and a lack of constant and reliable flow of information with regard to fashion trends. Increasing competition from low-wage Asian countries was pushing Korean companies to put greater emphasis on the

53. Given their repeated experience with tough competition during industrialization, producers realized that if they were going to profit from their flexibility, they would have to control it in some way. Institutions in society were created that channeled flexibility into specialization and socialized risk. An important part of the administration of machinery production was thereby elevated above the individual firm to a more region-based set of institutions. The sequence of the core logic of the system is as follows: Firms agree to specialize in particular lines of product and coordinate their choice of specialties with other firms in the same branch. The aim is to make sure that nobody produces machines that overlap with another firm's product market. Furthermore, institutions help compensate for the added risk that each individual producer incurs from specialization. Though the logic is simple, the process is complex. Because there is much specialization and customization, drawing the boundary lines between one firm's area of expertise and that of another is not always easy. Firms must continuously negotiate with one another about what their markets are and what they are becoming. In the end, the process combines the individual interest of the firm with the long-term interest of the industry as a whole. Firms must remain innovative to stay in the process of negotiation, and the continuous exchange of technical information and strategy with other firms helps them to do so. Many institutions have come to be involved directly and indirectly in this form of coordinated specialization. Most directly, trade associations such as the VDMA and local Chambers of Commerce and Industry (IHKs) provide a forum in which negotiations can take place. They also provide many public goods to the producers. The VDMA and its numerous sub-associations, for example, help to coordinate joint research projects in the industry and ensure that local universities are outfitted with the appropriate facilities for industrial research. In a different way, the IHKs help firms by organizing contacts with local authorities and other firms in other branches. Public research institutes, Technisch Hochschulen (TH) and Fachhochschulen (FH) play an important role in enabling SMBs to sustain a strategy of specialization. They pool the separate resources of many independent firms to provide continuous access to technological information that would otherwise not be obtainable. Gradually, the responsibility for funding these institutes was taken over by the state, but their central role in conducting applied research for local firms and in training technicians and engineers remained unchanged. See G. Harrigel, Industrial Orders and the Politics of Industrial Change, in P.J. Katzenstein (ed.), *Industry and Politics in West Germany*, Ithaca, Cornell University Press, 1989.

fashion contents of their products in order to position themselves in higher value added segments of the market. Even in those regions where a large number of textile and apparel companies were clustered together and the regional economy depended significantly on this industry, there was no systematic effort to establish regional centers for production and market information such as those found in the Third Italy.

In Korea, SMBs failed to set up powerful self-help organizations, though they, either within a region or in the same branch of industry, established cooperatives under a central umbrella organization. The main characteristic of these cooperatives, however, is that they are influenced by interest groups. As a result, they neglected the operation of the entire training and examination system, further training, business consultancy, and specialist and expert departments. For these industrial regions to gain a competitive edge, regional centers for production and market information and consortiums involving the regional government and the associations of local companies should be established. The center would introduce a first level of selection between those firms that decide to remain in their existing positions and those that agree to change their position. For those companies that agree to be a part of the consortium, the center would offer fashion trend information and related technological information. This flow of qualified information would select within the region a group of innovators that accepts the challenge of moving up in their market position, by increasing their knowledge of product and processes. The center would become the catalyst for the emerging group of innovators because it would make explicit an existing innovation problem, and induce the individual firms to accelerate the pace of innovation. This would reinforce the sense of local community. The Center would provide services such as a work station for stylists based on every advanced CAM software, which would positively select innovative companies within the region.

Major agglomerated industrial regions in Korea had been simply specializing in production areas with limited local linkages and extensive long-distance connections, primarily due to the high import dependency of product design, core components and key production facilities. Although many local firms were clustered together in territorial space, local industries tended to be functionally or sectorally specialized due to the lack of regional developmental dynamics and the paternalism of major business groups, which had significant influence over the local environment but were also highly dependent on foreign technology. Government policy had also failed to promote localized networks. Government R&D programs allocated insufficient R&D resources among many projects of individual SMBs without considering either the effect on network formation or the concentration of R&D resources as the condition for successful innovation. Government support mostly aimed at simply promoting the adoption of foreign technologies and developing the

production technology of imported components and machineries without considering the cumulative effect on the design and R&D capability of SMBs.[54]

It was necessary to pursue investment in infrastructure and programs for addressing the issue of technology diffusion. Technology policy required some redistribution of the government budget as the share invested in such infrastructure was small—the total government R&D budget devoted to this task was negligible. These services were provided by GRI-type organizations and technical universities in many countries, and incentive mechanisms were systematically established to encourage their use by industry, notably by SMEs. The development of infrastructure and programs to support technology needed to involve local and regional authorities.[55] Well calibrated schemes—such as opening of technology information offices, open R&D laboratories in local technology colleges, establishment of incubators for entrepreneurs—needed to be designed and jointly promoted by means of matching funds from the central authorities. S&T-based actions in favor of local and regional development had been limited.[56]

Technology policies to promote diffusion can be broadly classified in accordance with an emphasis on five types of knowledge flows: 1) interactions among enterprises, primarily joint research and other technical collaborations; 2) interactions among enterprises, public research institutes and universities, including joint research, co-patenting, co-publications and more informal linkages; 3) other innovation-supporting institutional interactions, such as innovation funding, technical training, research and engineering facilities, and market services; 4) technology transfer, including industry adoption of new technologies and diffusion through capital equipment; and 5) personal mobility to and from universities and

54. SMEs contributed little to R&D, with ratios to sales rarely exceeding 0.3 percent. The top 20 corporations contributed over 50 percent of total industrial R&D funding. About 95 percent of the R&D carried out by the SME sector took place in 8,000 medium-sized companies rather than in the vast network of small firms, since a company with less than 50 employees would find it difficult to sustain a research program.

55. Technology diffusion infrastructure includes technology extension services, technology transfer centers, university technology transfer offices, bridging institutions, networking schemes, grants/subsidies, patent offices, etc.

56. Markets do not adequately reward the diffusion of technologies that are socially desirable. Asymmetric information concerning technological or market opportunities drives a wedge between the private rate of return from technology uptake and the cost of capital and skilled labor for investing in technology. Internal obstacles within firms, stemming from weak organizational, managerial or human capital abilities, can impede their capacity to evaluate, absorb and exploit technology. This is particularly the case for SMEs. Policy intervention cannot be limited to correcting for market failures, but needs to incorporate systemic failures, which may arise when public institutions lack the links and incentives to cooperate with firms in commercializing and diffusing technology. On the demand side, government subsidies or brokering consulting services can help firms identify and address management and organizational obstacles to the effective use of technology. On the supply side, the quantity or quality of available information can be improved by subsidizing technology acquisition and transfer services or supporting the distribution of technical information via public information networks and databases.

industry and between firms. Until the early 1980s, targeted diffusion policies had focused on the fourth category, providing subsidies for technology adoption, establishing technology data banks, licensing and transfer agencies, and manufacturing extension service centers to promote the adoption of specific technologies such as micro-electronics and computer-aided design and computer-aided manufacturing (CAD/CAM) systems. Less attention has been paid to knowledge flows such as managerial or marketing skills, technical expertise, skilled research personnel and network interactions between firms. While experience with supply-driven programs had been mixed, survey evidence had shown that many of the obstacles to diffusion were internal to the firm and stemmed from deficiencies in labor skills and in organizational and managerial capacities.

Since the mid-1980s, greater attention was paid to addressing these "internal" obstacles to technology diffusion by developing the absorptive capacity of firms. The diffusion of technology tended to require sunk costs on the part of adopters. Several OECD countries set up technology demonstration programs, technology brokerage services and business advisory services, as well as networking schemes. Another trend was the provision of training and human capital development in smaller firms to help enhance the absorptive capacity. Improving the ability of workers to keep pace with technical change not only facilitates diffusion, but could also have positive effects on the mismatch caused by skill-based technological change, speeding up the reallocation of labor.

<Table 2-6> illustrates the transition of diffusion policies from the one-way transfer of public research results (Level 1) to policies that recognize diffusion and innovation as interdependent processes. At the second level, these policies seek to improve the general technology receptor capacity of firms through instruments such as technical assistance and manufacturing extension services. On the third level are policies/initiatives for building the overall innovative capacity of firms, including the use of sector road maps, and diagnostic and benchmarking tools that can help firms develop and implement more strategic technology.

Table 2-6 | Typology of Technology Diffusion Programs

	Goal	Program types	Objectives
Level 1	Improve the adoption and adaptation of specific technologies	Technology-specific	Diffuse a specific technology to a wide number of firms and sectors
		Institution-specific	Technology transfer from specific institutions
		Sector-specific	Diffuse technology to particular industrial sector
		Demonstration	Demonstrate the practical implementation of technologies
Level 2	Improve the general technology receptor capacity	Technical assistance	Assist firms in diagnosing technology needs and in problem solving
		Information networks	Access to information on technology sources
		Assistance for small-scale R&D projects	Build capacity for autonomous technology development
Level 3	Build the innovation capacity of firms	Sector-wide Technology roadmap	Systematic planning for future strategic technology investments
		Diagnostic tools	Assist firms to develop innovation oriented management
		Benchmarking	Transmit best practice from elsewhere
		University/industry Collaboration	Upgrade the knowledge base of the firm

Source: OECD, Diffusing Technology to Industry: Government Programs and Policies, OCDE/GD (97) 60

In the late 1980s, the Korean government became aware that prosperity derived not so much from innovation as from the speedy and effective diffusion of innovation; and SMEs were indispensible in this diffusion process. Technology promotion in the transition phase was much more complex than in the catch-up phase. It was no longer simply a matter of giving money to build R&D centers. The government had not paid enough attention to the conditions under which technology was diffused in the economy. Korea had little experience in this matter and was on a learning curve in the 1990s. Diffusion policies to improve the receptor capacity of firms began to increase in the mid-1990s, and policies to build the overall innovative capacity of firms were introduced after the financial crisis in 1997. Cluster-based innovation policies were implemented first for the textile clusters in 1999, and then expanded for thirteen regional clusters.[57]

57. As for the policy scheme of developing regional SMEs, see (Sim, 2007).

The experiences of OECD countries provide examples of successful and less successful policy practices. Technology diffusion programs involve multiple stakeholders, therefore complicating implementation. Diffusion programs, if they are to be comprehensive, must often involve alliances and cross-sector networks as well as institutional investments and business incentives. Technology diffusion services generally have to be delivered locally. Regional innovation centers (RICs) are instituted to stimulate the transfer of technology to SMEs. RICs should be located regionally, not far from SMEs, and should concentrate on an intermediary role between SMEs and sources of technical expertise. The main task perceived for RICs is to focus on the target group of technology followers to generate awareness and receptiveness on their parts, and to establish links with suppliers of technology and other specialists and advisers.[58] SMEs are likely to vary in their needs and capabilities, even within the target group of technology followers. In this situation, it tends to be ineffective if one approaches all firms in the same way.

Table 2-7 | Cluster-based Innovation Policies

Systemic and market failures	Policy responses
Inefficient functioning of markets	Competition policy and regulatory reform
Information failures	• Technology foresight • Strategic market information and strategic cluster studies
Limited interaction between actors in innovation systems	• Broker and networking agencies and schemes • Providing platforms for constructive dialogue • Facilitating co-operation in networks
Institutional mismatches between knowledge infrastructure and market needs	• Joint industry-research centers of excellence • Facilitating joint industry-research co-operation • Human capital investment • Technology transfer programs
Missing demanding customers	• Public procurement policy • Attracting FDI
Government failures	• Privatization/reducing government interference • Bottom-up policy making and implementation

Source: OECD (1999), *Boosting Innovation, the Cluster Approach, Paris*

58. SMEs can be classified into three categories: non-technological, technology-following, and technology-driven SMEs. For the diffusion of technology, the last category presents no problem, because they are well aware of opportunities and capable of seeking out the required technical inputs. The first category may not be worth exploring since the scope for new technologies is limited. The target group for RICs is the second category, for which there are perspectives as well as obstacles for new technologies.

Effective technology diffusion takes time and money and is difficult to measure and evaluate.[59] It requires operational flexibility to meet the diverse and emerging needs of firms. These are elements that traditional decision-making and budgeting systems do not easily accommodate. Questions arise as to the appropriate target and scope of diffusion programs. Firms which already have advanced capabilities may be targeted but may have the lowest need for support. Policies should avoid prescribing uses of technology.[60] Promoting generic technologies in the early stages of development is likely to produce more social benefits than promoting specialized technologies. A main vehicle of technology diffusion is intermediary institutions that operate at the pre-competitive (non-proprietary) stage of technological development and/or at the interface between industry and the public research base. Intermediary institutions act as producers, users and carriers of knowledge.[61]

3. Implications for Latecomers

A unique feature of Korean industrial development in the early years was the efficiency with which the government utilized foreign markets, products, and resources to generate sustained economic growth. Outward orientation was not limited to increased exports; the development program included the opening of the economy toward imports and capital flows as well. Foreign borrowing boosted capital formation significantly above national savings. Contemporary development theory argues that an effective growth strategy requires a direct link between profitability in world markets and domestic incentives. Korean policy established such a link at a very early stage. Export activity had been important in broadening and deepening industrial competence. Export activity made it possible to start new industries much earlier than they could otherwise, and without sacrificing economies of scale. In turn, for all industries and for a long time after their inception, export activity

59. Technology diffusion policies are particularly challenging for evaluators, not least because of the multiplicity of objectives involved and myriad of indirect effects on both targeted and non-targeted firms/organizations. Technology diffusion initiatives are highly contextual to the institutional framework and market environments in which they operate.

60. SMEs in general lack the competence to judge the merits of an innovation, and rely on personal relations or on business relations with those who are perceived to have knowledge and experience with the relevant technology and its possibilities given their specific conditions. Public research institutes and academic institutions for technology transfer are perceived to have little competence to judge applicability and priority in the specific SMEs. Adoption of new technology is never a goal in itself: its goal is to yield improved or newly developed processes or products. The mission of RICs is to stimulate SMEs to engage in the adoption process, and to guide or to support them in this process where necessary. The problems are not necessarily the same for all types of SMEs in the target group. Different SMEs may need help in different stages in the adoption process. The target group should be segmented according to their needs for guidance in the adoption process and their responses to actions that RICs may take.

61. Public-private intermediaries such as science and technology parks, technology incubators and technology transfer agencies play an important brokerage role.

was added to technological capability, reflected in a wide variety of minor technological changes. Export promotion had been a strategy as much for the developing industry as for capitalizing on industrial competence. But the strategy did not wholly conform to theoretical prescriptions. Government intervention exceeded the level generally held to be appropriate. Only in the late 1970s had industrial policy begun to emphasize generalized liberalization as a central objective.

At the end of each decade when Korea faced weakening competitiveness of export industries and deteriorating balance of payments, the government conducted bold policy shifts to facilitate the industrial transition needed to sustain high growth. The Economic Planning Board (EPB) may provide a good model for an effective planning agency for developing countries. It was responsible not only for development planning but also for budgeting and performance evaluation. Moreover, the Minister of the EPB was concurrently the Deputy Prime Minister and could preside over the Economic Ministers Meeting for more effective coordination of economic plans and policies. The annual planning system combined with the budgetary process may provide another useful model for developing countries. It had been used to revise or update plan targets and to readdress policy directions once every year in view of changing external and internal conditions. It had become very useful and effective since it was supported by the instrument of budgetary control. The adoption of a medium-term fiscal planning system by the Bureau of Budget had increased the link between the development plan and the annual budget, thereby ensuring successful implementation.

It was widely accepted that Koreans were better in implementation than in planning and policy-making. Korea's strong capability to successfully implement economic policies seemed to stem partly from the system of performance monitoring and evaluation. A good plan does not produce anything if it is not effectively and efficiently implemented. One weakness of the Korean system of economic planning and policy making seemed to be related to the lack of a consensus building procedure in the country. In Korea, important policy decisions were often made by a limited number of bureaucrats or government officials without much public debate or real participation by civilian experts. The system had been effective, if not efficient, in bringing about rapid growth and development. However, it should be emphasized that the economic success was strongly related to political leadership. Since the Korean system had typically been very centralized, it could not bring about economic success without the top policy-maker's commitment to the attainment of high economic growth. In the past, the political leader's commitment did not extend much to other objectives, including an equitable distribution of growth benefits, price stability and political stability.

What may be learned from Korea's experiences is not the highly discretionary industrial policies in the 1960s and 1970s, which are simply not feasible under the WTO regime,[62] but the institution building for indigenous efforts to develop technological capabilities, which include the Korea Institute of Science and Technology (KIST), the Korea Advanced Institute of Science (KAIS), Small and Medium Business Corporation (SBC), National R&D programs such as the industry-based Technology Development Projects, Industrial Technology Infrastructure Building Projects, the Korea Institute of Industrial Technology (KITECH), the University Technology Forces (UNITEF), the Regional Consortium for Technology Development Among Industry, Academia and Research Centers, regional innovation centers such as the Technology Innovation Centers (TIC) and Techno-Parks, and the Small and Medium Business Administration (SMBA).

Outward-looking strategy and government policies had been effective in facilitating the process of technological learning. This had been also the case in Asian NIEs. They exhibited the same pattern of structural change. They were in the convergence process, in which the lagging countries had been catching up with the leaders. There were strong reasons to expect a convergence of productivity levels, and the convergence process lasted for several decades. If the lagging countries followed an appropriate policy mix, they should be able to increase productivity gains at a faster pace than the leader countries. They could enjoy certain benefits for backwardness, in that over a considerable range of technology, they could emulate the leaders and achieve a given amount of growth with less expenditure on R&D. Without running into diminishing returns, they could push the rate of capital formation per worker faster, and structural change was rapid. Manufactured goods produced in Asian NIEs thus could compete in world markets in price and quality. This increased competitiveness resulted from learning new technologies and upgrading the industrial structure year after year to achieve a higher level of technological content.

62. For the purpose of Agreements on Subsidies and Countervailing Measures, a subsidy shall be deemed to exist if: (i) a government practice involves a direct transfer of funds (e.g., grants, loans, and equity infusion), or potential direct transfers of funds or liabilities (e.g., loan guarantees); and (ii) government revenue that is otherwise due and foregone or not collected (e.g., fiscal incentives such as tax credits). The following subsidies shall be prohibited: (a) subsidies contingent, by law or in fact, upon export performance; and (b) subsidies contingent upon the use of domestic over imported goods. Subsidies are specific to certain enterprises (an enterprise or industry or group of enterprises or industries), when access to the subsidy is explicitly limited to certain enterprises. The following subsidies shall be considered non-actionable: (a) subsidies that are not specific; and (b) subsidies that are specific but meet certain conditions. These non-actionable subsidies include: (a) assistance for research activities conducted by firms or by higher education or research establishments on a contract basis with firms. The assistance covers not more than 75 percent of the cost of industrial research or 50 percent of the cost of pre-competitive development activity; (b) assistance to disadvantaged regions; and (c) assistance to promote adaptation of existing facilities to new environmental requirements imposed by law and/or regulations. The term "industrial research" means planned search or critical investigation aimed at discovering new knowledge, with the objective of that knowledge being useful in developing new products, processes or services, or in bringing about a significant improvement to existing products, processes or services.

Technological learning involves substantial and deliberate effort and investment on the part of firms. Technology is a resource embodied not only in physical capital but also in human skills, institutions (especially firms) and social structures. Technology represents the capacity to create and extend the existing pool of industrial skills and knowledge. Technological learning refers to the mechanisms and processes by which technological progress is brought about. Learning enables firms to build up their knowledge about products and manufacturing processes, and to develop, deploy and improve the skills of their workforce. The learning process is idiosyncratic in nature, cumulative in effect, and uncertain in outcome.

The channels of learning foreign technology evolved through time. In the early stage of development, these channels usually involved foreign firms in contractual arrangements in return for a particular service, such as low-cost production. FDI and joint ventures were an important starting point for electronics, sparking new export lines and leading to subcontracting and original equipment manufacturer (OEM) status. Foreign firms acted as role models for local firms to imitate, and some assisted local firms to grow through subcontracting and licensing arrangements. Many foreign firms hired and trained locals in their subsidiaries. While the contribution of FDI to capital formation was small, it accounted for a large share of electronics exports and employment. TNCs trained local firms to supply goods under subcontracting relationships. Local firms gained direct access to training and engineering support under joint ventures.

Under licensing arrangements, local firms paid for the right to manufacture products usually for the local market, and the TNC transferred the necessary technology for manufacturing. Generally, licensing required a larger technical capacity than a joint venture, where often the senior partner trained the local firm to manufacture. Many licensing agreements included formal technology transfer clauses. Foreign buyers (U.S. retail companies, Japanese manufacturers, etc.) were an important source of technology and market information. Many firms initially sold their goods to large buying houses from the U.S. and Japan. Foreign buyers often placed orders for more than half the annual capacity of exporting firms in sectors such as clothing, electronics and plastics. The buyers enabled many firms to expand their production capacity and obtain credit against guaranteed forward export orders. Foreign buyers assisted local firms into export markets and supplied technology in various forms. Often from their own local offices, foreign buyers provided Korean companies with information on product designs as well as advice on quality and cost accounting procedures. The largest buyers visited factories frequently and supervised the start-up of new operations. Some of them assisted with the purchase of essential materials, capital goods and components. Around 50 percent of Korean firms benefited directly from buyers through plant visits by foreign engineers and visits by Koreans to

overseas factories. The buyers provided local firms with blueprints and specifications, information on competing goods and production techniques, as well as feedback on design, performance and quality. About 75 percent of firms received assistance with product design, style and detailed specifications. In electronics, U.S. retail chains and importers were the most important buyers during the 1970s in Korea.

OEM (a specific form of subcontracting) evolved out of the joint operations of buyers and local suppliers and became the most important channel for export marketing during the 1980s. Under OEM, Korean firms produced a finished product to the precise specification of a foreign TNC. The TNC then marketed the product under its own brand name, through its own distribution channels (thereby capturing the post-manufacturing value added), enabling Korean firms to circumvent the need for investing in marketing and distribution. Under early forms of OEM, the supplier was confined to value-added related to assembly services. OEM often involved the foreign partner in the selection of capital equipment and training of managers, engineers and technicians as well as advice on production, financing and management. OEM was sometimes linked to licensing deals. Successful OEM arrangements often involved a close long-term technological relationship between partner companies, because the TNC depended on the quality, delivery and price of the final output.

ODM (Own-design manufacture) evolved from OEM during the 1980s. Many of the electronic systems purchased under OEM began to be designed and specified, as well as manufactured, by Korean firms rather than by the TNC. In the late 1980s, this system began to be called ODM in Taiwan. Under ODM, Koran firms carried out some of the product design and process tasks needed to make a product according to a general design layout supplied by the foreign buyer (often a TNC). In some cases, the buyer cooperated with the supplier on the design. In other cases, the buyer was presented with a range of finished products to choose from, defined and designed by the supplier with its own knowledge of the international market. The goods are then sold under the buyer's brand name as in OEM. ODM signifies the internalization of system design skills, and sometimes complex production technologies and components design abilities on the part of the supplier. ODM offered a mechanism for the supplier to capture the value added while still avoiding the risk of launching its own brand of products. Under ODM, the supplier adds value in production engineering and product design. ODM indicates an advance in technological competence, although it is applied mainly to incremental (follower) designs rather than leadership product innovations based on R&D.

Strong R&D capabilities in the industrial conglomerates combined with cooperative research programs helped Korean industry adapt and take advantage of foreign technologies in the 1990s. Latecomer firms from other Asian NIEs hoping to become leaders may face somewhat different challenges from those in Korea. In China, there may be a greater role

for TNC investments and joint ventures in the transition process than has historically been the case in Taiwan and Korea. In Singapore and Malaysia, which have depended on a catch-up process within exporting TNC subsidiaries, the intra-firm relocation of product design and R&D capabilities from headquarter to subsidiary locations may be an important part of the transition process.[63] The particular external circumstances facing different firms, as well as their own distinctive histories, strategies and cultures, will shape the transition challenge in the NIEs as they approach the technology frontier (Mathews and Cho, 2000).

Since the early 1990s, TNCs have penetrated global markets and integrated their world-wide operations, broadening and deepening the economic interdependence of nations. Trade and technology transactions take place more and more within TNCs rather than in the market. TNCs are responsive to differences in regional conditions, and relocations are becoming more strategically motivated. Governments compete with each other to attract and retain higher value-added activities of TNCs. An increasing number of developing countries have been actively participating in globalization. However, not all countries are benefiting equally. Sustainable development requires the ability to conform to high standards for domestic policies and institutional practices and the ability to upgrade from labor-based FDI to skill-and-technology-based FDI through the building of technological capabilities.

Globalization is defined as the pervasive decline in barriers to the global flow of information, ideas, capital, skilled labor, technology and goods. Globalization in the late 20th century was increasingly in sub-components and services. Since the 1980s, low-cost sources of supply grew for buyers procuring on a global stage. Entry into global markets which allows for sustained income growth requires an understanding of dynamic factors within the entire value chain. The key policy issue is not whether to participate in global markets, but to do so in a way that provides for sustainable income growth. If countries continue to specialize in highly competitive markets, they will be increasingly subject to the erosion of their returns due to falling terms of trade. Value chain analysis explains the distribution of benefits to those participating in the global economy. It helps to identify which activities are subject to increasing returns, and which are declining returns, thus making it easier to identify policies for sustained income growth over time. Participation in global markets reflects the strategic decision of lead firms in the value chains. The lead firms may have made a strategic decision to locate their activities in a particular country or region. Particular forms of connectedness affect the extent to which local producers can upgrade. The large volume U.S. buyers are very reluctant to work with low-cost manufacturers that

63. In smaller economies, promoting inward FDI and trade has represented a traditional solution to accessing knowledge and technology from abroad. In countries such as Canada or the Netherlands, imports account for up to 50 percent of acquired technology. The globalization of R&D has become an important vehicle for diffusing technology, especially in Belgium, Ireland, the Netherlands and the Nordic countries.

are developing the capacity to design and to market, which the buyers see as their source of competitive advantage and their rents in the value chain. The decline in the terms of trade of LDC's manufactured exports has been significant, particularly since China's entry into global markets in the mid-1980s. Participating in global markets that allows for sustained income growth requires the capacity to learn and upgrade.

Trade in the elements technology enables developing countries to develop industries through any possible combinations of local and foreign technological capabilities. Trade in the elements of technology takes many transactional modes, including turnkey project contracts, trade in capital goods, licensing, foreign direct investment (FDI), international subcontracting, and technical agreements. However, trade in the elements of technology transfers only the elements, not the capabilities. The local technological capabilities can be developed only as a result of purposeful indigenous efforts to assimilate technology.

Strategies for developing technological capabilities can be discussed in terms of a sequence for selecting the technological capabilities to be acquired.[64] Sequencing is not simply a matter of the particular industry in which technological capabilities are acquired. It involves deepening and broadening capabilities either to achieve greater proficiency and increased differentiation of existing capabilities, or to attain new technological activities in established industries. Technological capabilities can be employed not only in import substitution, but also in adaptation – and can be the base from which additional capabilities are acquired.

Technological capabilities develop gradually with increasing depth, widening scope and enlarging complexity, from production capability to investment capability, and then to innovation capability. Production capabilities are developed in advance of investment capabilities. Production capability tends to expand and to deepen through continuous adaptation of products and processes to changing market conditions, which is typically implemented through trial and error testing or modification. Experience-based technological efforts to adapt production technology provide part of the understanding that is composed of investment and innovation capability. However, capabilities in capital goods manufacturing, basic plant design, or the assimilation of sophisticated technology tend to be developed in specialized entities, such as capital goods producers, engineering firms and research institutes. Patterns of specialization shift over time within and among entities, with increasing depth and broadening scope of technological capabilities. Such

64. Technological development is mostly import substitution to replace foreign capability with local capability related to local production. Cost and benefit that are necessarily foregone by dedicating scarce resources to develop specific capabilities must be evaluated for efficiency in technological development. Considering the technological advancement, efficiency in local technological development implies continued imports of many elements of technology, though the pattern of imports shifts as local capabilities replace foreign ones, and as new industries are developed.

institutional change is accomplished through investments that are embodied in the form of organizational structure, codified knowledge, and customs that govern behavior within and among entities.

In the context of developing economies, the central policy issue is about how to achieve and sustain indigenously driven processes of rapid technical change. The results of R&D must pass through a wide range of design and production engineering activities before they result in commercial, productive use of technology. Without any direct inputs from R&D, those design and engineering activities are frequently sufficient in their own right as sources of technical change in production—especially as generators of the continuous process of change that is often described as technology diffusion. In the process of continuous change, workers, whose primary task is ongoing operation and maintenance of the existing production systems, may also make significant contributions to the process of technical change. Continuous changes in the various organizational dimensions of production technology may be important sources of productivity growth, while the competitiveness of products may be substantially enhanced by continuous improvement in their specifications and quality. The central issue is about how to strengthen these change-generating activities. The investment problem at the heart of the key technology policy issue is therefore not simply about investment in fixed capital that embodies new technology. Nor is it even about investment in R&D to create new knowledge. Instead, it is about investment in creating the whole spectrum of human and institutional resources for generating and managing technical change.

In technologically dynamic industries, the users of technology play two roles in changing the industry: they directly generate a host of improvements and modifications in the production systems they use (an activity that has often been heavily disguised under the academic label of learning by doing); and they make creative contributions to technical change through their technology-centered interactions with machinery and other suppliers, consultants and research institutes. A pre-requisite for playing these roles is substantial investment in the accumulation of change-generating human resources within the technology-using firms themselves. In the process of industrialization, such investment is often the basis for the development of more specialized local suppliers of inputs to technical change: enterprises producing engineering services and capital goods frequently emerge out of such explicit investment in change-generating knowledge and human capital on the part of technology-using enterprises. More generally, technical change is generated out of complex structures of interaction between firms, and sometimes between firms and supporting infrastructural institutions. Those supporting institutions can rarely generate technical change on behalf of industry without significant innovative activity on the part of industrial firms themselves. They may play important complementary roles in relation to innovation taking place in industry, but they can rarely act as a substitute for it.

The development of change-generating human capital in industry requires at least two fundamental changes in conventional perspectives on human resource development. (1) The issue must not be seen simply in terms of strengthening infrastructural institutions outside industry—universities, technical colleges, and training institutions. These are obviously important. But just as important is the role of industrial firms themselves. The issue is not just about human resource development for industry. It is about human resource development by industry. (2) The significance of explicit investment in these human capital assets needs to be given much greater prominence. Relatively costless forms of learning-by-doing obviously remain important; but, as the change-intensity and underlying knowledge-intensity of industrial production rises, more deliberate and costly forms of investment in change-generating skills and experience also become more important.

An important aspect of different affiliate roles is their indirect developmental effects through external linkages with host economies. The main benefits to local economies are related to different types of intra-TNC competition.[65] It is the tangible and intangible, direct and indirect benefits associated with winning new mandates or capabilities that may produce long-term economic development, and these are the most sought-after by the institutions of host economies. Mandates are relatively immobile since developing capabilities entails considerable sunk costs associated with accumulated labor skills, management practices, and the like. Parent-led open competition is most closely associated with the branch plant, where the internal economy of TNCs precludes viable local external linkages. Intermediate products and services are the most mobile and contestable by a wide range of affiliates since they can often be uncoupled from vertically related production processes, and since the location decision is one that often centers on cost reduction. Although the winning of component responsibilities can lead to jobs and even the prospect of increased skills at affiliate companies, these benefits may be short-lived. Activities won solely on the basis

65. Activities of a TNC are potentially mobile or contestable by other affiliates in different local settings. These activities include technology-intensive activities, such as research, development, and design. Competitive processes can be led by the parent company or initiated by affiliates. Intra-TNC competition may lead to incremental development at individual affiliate operations. The gaining of regional product mandates is not simply a result of parent company decisions but can involve considerable affiliate initiative. Such affiliate initiative has been classified into attempts to defend, retain, and build local domains within global parent company organizations. Of particular interest is the entrepreneurial (or subversive) behavior of affiliate managers as they seek to contest their affiliate position and status within established parent company hierarchies. There has been a shift from the push of parent-led competition among affiliates towards the pull of host country affiliate initiatives, coupled with increased efforts by national institutions to embed TNC affiliates. National policy stances toward inward investment provide the context for more specific localized efforts at aftercare and the embedding of TNCs. Local initiatives include policies aimed at the development of specific local labor skills, local suppliers, and technology transfer opportunities between universities and industry. Support for the entrepreneurial or subversive activities of local affiliate management through fact-finding and lobbying at the parent company appears to be an increasingly important aspect of the aftercare of overseas companies in host economy settings.

of relative labor and other costs can be the subject of intense competition among affiliates, benchmarking, and deliberate strategies of location switching by parent companies. At the other extreme, affiliates may seek out important local external linkages to contribute to the competitive processes that they themselves have initiated. The desires of parent companies to take advantage of the competitive advantages drawn from diverse local settings mean that new and repeated investments by TNCs now involve bargaining not just over direct financial incentives, but also incentives in kind.

The role of R&D in NIEs is not one of Research and Development, but of Development and Design. Focusing on the dual role of the R&D function in followers, efficient frontier-following and effective design leadership, provides the potential for firms in NIEs to move substantially up the value chain of global manufacturing. The innovation task in technology-follower firms should aim to approach and follow the frontier as efficiently as possible, with the objective of moving the firm up the value chain of global production by increasing productivity and making higher value products. R&D units in firms can become the location for organized learning, the problem-solver of last resort in production, the in-house knowledge store and gatekeeper, and the focus for independent design and product development capacity.

If R&D is overwhelmingly in technology-leading countries,[66] then it should be so in technology-following nations as well. Increased focus on R&D in NIEs can pay rich dividends. The type of R&D and its focus is far more critical to the success of industrial innovation than the level of R&D spending, until firms become concerned with pushing forward the leading edge. Industrial R&D must be done in firms, not autonomous laboratories. It is not research that is needed but development. The role of R&D activity in follower firms has to be fundamentally rethought, learning from the recent work of technology-leaders. R&D's role is to effectively support the follower's quest for long-term competitiveness in manufacturing, which involves solving shop-floor problems and fostering learning across the firm. Doing so involves recognizing the importance of design, and the distinction between design and technology. It is the role of R&D in followers to push out the design frontier while following the technology-frontier.

The combination of technology acquisition and learning and the sequence that runs from imitation to creativity are two sides of the same process. Efforts to imitate depend on internal capabilities: the initial stage of development and the catching-up process depend on absorptive capability. To monitor knowledge developed elsewhere, firms invest in basic

66. Technology-leader countries are those that collectively define the technological frontier at any point in time, and move it forward. Successful innovation in technology-leader countries requires first a commercially correct definition of the new frontier, and second the activities involved in reaching it. There is uncertainty in both these tasks.

research (an entry ticket for a network of technological and scientific information). Internal capabilities are prerequisites to imitate and absorb knowledge from advanced countries. During the initial phases of development, scientific institutions are necessary mainly for the learning side of innovative process. The necessity of scientific institutions to support learning processes and diffusion of technologies is greater now, since the technological paradigms are more science-based than those in the past, and current technology depends more heavily on science. Over time, as a country develops, the mix between learning and innovation leads to R&D process changes.

The indigenous process of technical advances has not always been seen as the key policy problem by those directly concerned with technology policy to support industrialization. The central technology policy issue has often been seen in terms of questions like: how to create a structure of local R&D institutions, and how to ensure that those institutions are actually used after they have been created. These questions are quite different from how to achieve and sustain indigenously driven processes of rapid technical change. The problem at the heart of the issue is not simply about investment in R&D to create new knowledge. Instead, it is about investment in creating the entire spectrum of human and institutional resources for generating and managing technical change. Over time, the focus of policy attention shifts from the supply side to the user-side, and the issues of how to link the two.

The mode of SME support has been geared towards collaborative networking projects, such as research associations, technology transfer centers, and science and technology parks. They are all based on the principle of coalitions of firms, with participation by universities and public research institutes and joint funding by industry and government. Cooperative research associations overcome market failure in industries where the threshold cost of R&D and other S&T services were too high for SMEs. Research associations are actually used intensively by SMEs because the associations have their own in-house R&D. They are an important ancillary and complementary source of S&T information rather than a substitute for in-house R&D. Research associations are a means for sharing the cost of acquiring technical information, testing facilities, pilot plants and prototype development.

Governments, together with chambers of industry and trade, industry associations, and regional assistance agencies, have initiated innovation consultancy programs, which can stimulate technology transfer, create innovative awareness amongst SMEs, encourage semi-public organizations to offer innovation counseling services, develop and test user-oriented consultancy procedures, motivate commercial consultants to offer adequate consultancy services, and broaden the information base of government and industry on innovation barriers in SMEs. The longer an innovation counseling office is successful in operation, the more integrated it becomes in regional and local networks of contacts and information exchange, and the more it can rely on local or regional experts.

Awareness of the problems arising from the differences between the fundamental characteristics of universities and SMEs has led to the development of intermediary structures, which would translate the expertise and know-how of universities into language more easily understood by SMEs. Technological adviser networks, scientific and technological parks, technological transfer centers, and incubators for enterprises are examples of such intermediary structures. The experience of transfer cooperation at universities has given impetus to the development of training programs to meet the needs of SMEs. Innovation-management, market-oriented product development, and financing innovations are examples of themes applied to training programs for university graduates and staff at SMEs.

Most SMEs lag behind in the diffusion process, and the transfer of technology to SMEs should be stimulated. Technology transfer centers are instituted for this purpose. The centers should be located regionally and should concentrate on an intermediary role between SMEs and sources of technical expertise. In view of the generally low level of formal education and experiences with advanced technologies, the stimulation of technology transfer requires considerable missionary work to create awareness and receptiveness. The main task perceived for transfer centers is to focus on the target group, to generate awareness and receptiveness on their part and to establish links with suppliers of technology and other specialists or advisers. SMBs are likely to vary in their needs and capabilities even within the target group. Thus it is important for technology transfer centers to be close to SMEs. Geographical and technical proximity will breed more quickly the confidence needed for an efficient transfer. Technological information must be as perfectly tailored and close as possible to individual SMBs, must be addressed to the owner/director, and must fit into his information network.

Technology extension (TE) organizations help SMEs to access sources of technology. TE services reflect the needs of SMEs. Industrial extension (industrial modernization) is referred to as a broader domain of assisting SMEs with technological assistance, business planning, strategic direction, manufacturing processes, accounting and financing and marketing research. Industrial extension programs typically focused on the deployment of known technologies and proven business practices and training methods, rather than creating new technologies. TE organizations were becoming increasingly proactive in reaching out to the SMEs that are so important to their local, regional or national economies. The term technology extension reflects a type of proactive attitude and behavior. The basic model of TE service is such that its role between the sources of technology and the SMEs can range from being a reference source to being a broker, and then to directly consulting on the client's problem.

Some regional governments have moved towards an active regional policy. Regional efforts initiated by national governments carry some inherent risks. National programs may fail to reflect the diversity of needs and conditions among local areas, essentially precluding

the possible benefit that local initiatives and experimentation would identify more effective linkages between SMEs and universities. Moreover, inflexibility and bureaucratic management can lead to the promotion of safe regional activities of only marginal relevance to local industry, accompanied by considerable administrative and monitoring costs. A laissez-faire regional policy without any involvement of the national government also has potential deficiencies. Financial dependence on local industry could shift the research of universities to largely applied work geared to the immediate and specific needs of local industry. Similarly, education could become biased towards satisfying those same narrow needs. Such parochialization of the system, while useful in dealing with present local needs, may be poor preparation for meeting broader objectives and future needs. Instead of employing strictly central government-directed policies or local laissez-faire policies, a partnership between the two levels of government may be more effective for successful regional development, in addition to being more consistent with national interests. The partnership, characterized by consultation and negotiation rather than surveillance and coordination, should allow for local initiatives and diversity.

Table 2-8 | Target Group of Regional Innovation System

	Supplier-dominated	Specialized supplier
Typical core sectors	Textiles, footwear, foods	Machinery, instruments
Sources of technology	Suppliers' research, extension services, big users	Design/development, users
Means of appropriation	Trademarks, marketing advertising, aesthetic design	Design know-how, knowledge of users, patents
Technical innovation	Process innovation	Product innovation

Specialized-suppliers are the main target group of RICs, followed by supplier-dominated firms.[67] Active consultancy should aim in particular at specialized-suppliers and supplier-dominated firms. Specialized-suppliers appear to constitute the core target of RICs. They

67. Scale-intensive industries (e.g. assembly, bulk materials) clearly do not belong to the target group of RICs. Science-based industries (e.g. specialized chemicals, pharmaceuticals, biotechnology, and electronics) may not belong to the target group in that firms in these industries are technology-driven firms: they are small firms but their knowledge is hardly tacit, and their capabilities of search and absorption are generally high. Science-based industries need help in finding the proper sources of information on patents and patent acquisition, but these might be obtained without any problems through the market and through standard available institutions. Innovation-related collaboration with customers, competitors, and government agencies is likely to be limited. In view of the importance of product innovation, we would expect a relatively high need for strategic/commercial guidance, but this is not the primary task of RICs. This does not mean that no contact with this segment is required, but that such contact is desirable as a source of technology for the target group rather than a target for technology transfer. See Pavitt, K. (1984), Sectoral patterns of technical change: towards a taxonomy and a theory, Research Policy 13, 343–373.

have innovative potential, but their challenges lie in a lack of knowledge and limited capabilities for search and absorption. In-house capabilities significantly contribute to both product and process innovations. There is a positive association between product innovativeness and collaborative linkages with customers. Because of the focus on performance improving product innovation, there seems to be the scope for customers to play a key role in product design and specification activities. In contrast, suppliers and public knowledge infrastructure are liable to play a limited role. But governments may provide support to develop the innovativeness of lower tier suppliers as a means to strengthening the supply chain and improving competitiveness. These external linkages seem to be complemented by internal resources, in the form of limited R&D expenditure and employment of qualified scientists and engineers. There are arguments that guidance is less critical than one might first think: much of the necessary awareness and technological know-how may already flow from the customers, to the extent that they belong to scale-intensive or science-based industries. However, tacit knowledge vis-à-vis the more formal and specialized knowledge of customers is likely to present a problem. An important task of RICs may be to play an intermediary role in the relations of specialized suppliers with the sources of technology. Group discussions between colleagues may be very effective in generating awareness and interest and to facilitate evaluation and adoption. And because the details vary from case to case, getting colleagues together for a group discussion may be less problematic and more rewarding. Links with trade associations may be useful for providing tests and demonstrations, and possibly the development of technical norms for the sake of standardization.

Supplier-dominated industries may not belong to the target group of RICs in that innovative potential is limited, and the link with suppliers alone may be sufficient for adopting the required technology. Furthermore, these SMEs are costly to access. Yet it seems inappropriate to dismiss them as non-technological. Whether for commercial reasons or for the protection of the environment, nowadays, few sectors will be able to avoid having to adopt some new technology (ICT, new materials, new adhesives and surface treatment, etc.). And if wide diffusion of technology is the goal, this segment merits attention if it could be approached at an acceptable level of cost and effort.

The innovation focus of supplier-dominated firms is thought to be concentrated on cost-reducing process technologies to meet the demands of highly price-sensitive customers. A limited association between internal resources and innovation would be anticipated. Given the generally weak in-house R&D and engineering capabilities, suppliers are the likely source of new or improved process technologies. Despite the relative emphasis on process innovation, general sources of technology (including those that lead to product innovations) are liable to include government financed research extension services and,

less frequently, large users. Competitor collaboration, although difficult, is still possible. It may be worthwhile to gain access through middlemen such as accountants or branch offices of banks, particularly during the stage of generating awareness. Subsequent stages of interest and evaluation may be supported by demonstration and trial programs set up in cooperation with appropriate trade organizations. Subsequently, trial and adoption may be promoted through the suppliers that dominate the introduction of new technology. RICs may play an intermediary role in the feedback on various issues, ranging from the needs and experiences of users to design and development on the part of suppliers. Such a combination of approaches with different intermediaries for different stages of the adoption process may be both effective and efficient.

Supplier-dominated firms are initially approached through intermediaries such as accountants, banks, trade associations or suppliers. Specialized suppliers are approached more directly at an earlier stage and more on an individual basis. The first step in initiating contact with supplier-dominated firms or specialized-suppliers is ascertaining or generating awareness. Supplier-dominated firms are often approached in groups through presentations and demonstrations, which are set up in cooperation with trade associations or suppliers. For specialized suppliers, interaction is sought in small-group, discussion-based sessions. Strategic/commercial issues come up more with this group than with the supplier-dominated firms. For supplier-dominated and specialized-suppliers, more emphases must be on building networking capabilities.

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