AN ANALYSIS OF CHANGES IN THE COMPETITIVENESS PARADIGM: KOREA'S SCIENCE AND TECHNOLOGY POLICY

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Abstract: The growing competition in the global economy prompted increasing concern among government officials, business leaders, and policy analysts about the state of Korea's technological competitiveness, its implications for the nation's long-term economic health, and the government's possible role in fostering a more competitive industry. This study examines the process of industrial transformation and focuses on Korea's technological path.

INTRODUCTION

In an information and knowledge-based economy of new millennium, science and technology policy calls for a new governance of public-private-globalization partnerships. The rapid advances in information technology (IT) quickly turned the global economy into a "knowledge-based economy" where information and knowledge are the prime sources of value-added. Therefore, a nation's competitiveness is much dependent upon a conscious policy of assisting its technological transformation so that the country can export competitive products. In recent decades few Asian countries built up technological competence through learning experience gained from production. The major feature of the Korean technological path was the fostering of indigenous technology by absorbing imported technologies into its own R&D efforts. On the other hand, some Latin American countries pursued technological innovation policy, focusing on raising the level of local technological research to create new industries.

The central element in the new paradigm of competitiveness is an institutional mechanism that will integrate the stages of a sectoral transformation strategy. Whereas the factor endowments are sufficient for early stages of industrialization, industrial upgrading and skilled manpower require a strategy for channeling and diffusing technology. Differences in technological efficiency between countries arise not only from factor endowments but also from differences in accumulated technological capability. Accordingly, the success of transformation partly depends on the creation of the institutional mechanism.

This study examines the process of industrial transformation from the system-institutional framework through the South Korean (hereafter Korea) experience in the field of information technology (IT): electronics and telecommunications. It focuses on how the institutional interaction between the government and industry has helped to overcome externalities, risk bias against infant industries, and capability constraints often associated with developing countries. The system-institutional approach illuminates similarities among nation-states that have experienced rapid, successful development. It also identifies the comparative advantages and disadvantages under-

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lying different types of strategies. Although the focus of the study is on Korea's technological path, it will compare and contrast relevant features of industrial policies among other industrially advanced developing countries.

A SYSTEM-INSTITUTIONAL FRAMEWORK OF INDUSTRIAL TRANSFORMATION

Industrial transformation is the process in which an industry changes its production technology, product scope and market distribution due to the influence of contextual changes in internal and external factors. Given the information and capability constraints in most of developing countries, much debate has been over the question of whether the market mechanism is sufficient or government intervention is necessary to facilitate the decision-making process for the successful transformation (Haque, 1991: 10~12).

The system-institutional approach suggests that industrial transformation is the result of a continuous decision-making process by both industry and the government. In making strategic choices, they must respond to capability constraints and information inputs by making various investment and policy decisions. In terms of capability constraints, Lawrence and Dyer (1983: 297) identify factor supply or resource constraints that are important in the process of industrial adaptation. Information is another category of inputs. Generally, the information concerns of industries are market demand, factor supply, and technological requirements of the market that have the direct bearing on a firm's strategic planning. Besley and Case (1993: 399) suggest that lack of information about technology and the profitability of an investment often lead to hesitation in technology adoption. And that has implications for the ability to have domestic resources supplant foreign resources in successive investments.

The government, by contrast, has different process and output. Its major concern is to oversee public interests and ensure that there are net social benefits from the process of industrial transformation. The system-institutional perspective assumes that social costs and benefits, along with political risks and benefits, are defined by the institutional setting of the government. Korea and Taiwan exemplify success in adopting interventionist policies to help create comparative advantages. The Korean government used subsidized credit and rationed it in a highly selective manner to favor sectors and companies. Taiwan, on the other hand, depended more on fiscal incentives to promote specific industrial policies. These governments thus played a fundamental role in the conversion of productive activity.

Korea and Brazil's positions in the world economic order have been reversed since the early 1980s. The critical difference between East Asian success stories of industrial growth and Latin American failures is due to the adoption of appropriate policies by the respective governments, thus creating an environment where barriers to innovation could be overcome. Korea and Brazil had interventionist policies but of a different type. The Korean government policy was primarily oriented toward improving the productive capabilities of companies for the export market. Only after building a technology base Korea moved toward longer-range innovation strategies of attempting to develop its own technologies with a focus on the external market. Brazil, on the other hand, attempted to create a local capacity for innovation and production based upon older imported technologies for internal use because of the larger domestic market.

Moreover, Brazilian policy was predicated on Sabato's 'triangle' thesis. The cooperative linkages formed between academia, government, and industry were expected to serves as efficient mechanism

to drive technological innovation. The government was envisioned as the dominant partner, exerting determining influence. In this case, when each vortex of the triangle was examined in order to determine the flow of information and orders from one vortex to the other, the lines of the triangle were absent (Sabato, 1994: 105~114). Communications about the innovation may be informal or formal, and how they are transmitted and processed impacts the extent and rate of diffusion and innovation. Policies do not implement themselves. Governments must therefore adopt a positive approach to the dissemination of information regarding new initiatives and be willing to allocate sufficient resources to this end.

In Korea, the government and industry are closely linked in the institutional decision-making process to an extent that an industry may have members in government representing its interests. Regular meetings, circulation of reports, and policy conferences between business leaders and politicians can enhance the communication and understanding between government and industry. Through these institutional linkages, the interests of business and conversely, business' evaluation of benefits, costs, influence the government's assessment of social benefits and government officials alter costs and risks. The impact of these policies and investment decisions is re-evaluated by industry and government through an interactive institutional decision-making process.

STRATEGIC CHOICE FOR GLOBAL COMPETITION

For the past decade, there has been much debate as to whether the market mechanism is sufficient, or whether government intervention is necessary to secure successful industrial transformation (Haque, 1991: 10~12). From the system-institutional perspective, the debate surrounds one particular issue - whether the government is needed by industry to facilitate the decision-making process. If the government can facilitate information flows, intervention is desirable. On the other hand, if the government does not have the institutional capability to reduce the constraints for its industries, and its policies will confuse and degenerate the information flows in the market, government intervention should be kept to a minimum.

Most comparative studies of industrial transformation emphasize the importance of state autonomy in the policy-making process. However, Evans (1995) argues that state involvement in industry transformation is inevitable, asking not how much intervention a state will effect, but what form it takes. In the context of most developing countries, government intervention is necessary for several reasons. First, an uncertain environment and a lack of technological know-how make businessmen reluctant to invest in upgrading an industry. Such risk barriers lead to limited entries of firms into the technology- and capital-intensive sectors. The vicious cycle of under-investment constrains the potential "learning externalities" (Stiglitz, 1989: 200) that are important in the process of industrial transformation. Given the lack of expertise in evaluating many types of intangible investments required to improve productivity of an industry (Page, 1990: 122), governments may be in a better position to alleviate capability constraints, because they have the capacity to use long-term debt financing with lower interest costs. Hence, "state-created rents" are necessary to lessen the risk burden, thereby stimulating private investment (Chang, 1993: 144~145). Second, the justification for government intervention concerns the nature of information related to technology. As technology information exhibits characteristics of "publicness" and "non-appropriateness," private investors may under-invest in obtaining such information (Besley and Case, 1993: 399). This implies the loss of learning externalities. Therefore, non-market institutional remedies are needed to com-

plement the market mechanism to appropriate information to the industry. Third, the government can alleviate the stringency of capability constraints on an industry through a series of tax and industry promotion incentives.

During the late 1970s and the 1980s, the Korean government helped strategic industries, the electronics industry in particular, to overcome the problems of information externalities and capability constraints successfully by establishing the mechanism for better integration of R&D information into commercialization processes. Strategic decision-making is problematic in this kind of environment not only because change is so dramatic, but also it is difficult to predict the significance of a change as it is occurring. However, in this environment, the "wait and see" strategy may result in failure, as competitive positions change and windows of opportunity close. Although some scholars suggest that the market mechanisms were the major reason why Korea was so successful in its industrialization (Das, 1992: 75; Kim, 1988: 8), this study contends that it is the institutional network between the Korean government and the IT industry that made the rise in the world market possible.

ROLE AND DIRECTION OF SCIENCE & TECHNOLOGY POLICY

From the early stages of economic development in the 1960s, policy-makers recognized the role of science and technology (S&T) as an essential element of industrialization. However, S&T policy played a very limited role during the take-off stage. The technological capability needed for labor-intensive export industries in the 1960s and for heavy industry and chemicals in the 1970s could be easily acquired from foreign sources. Technology transfer was obtained through imports of capital goods, reverse engineering, foreign direct investment, and technology licensing. Domestic technological capability building was mainly for adoption and assimilation of imported foreign technology.

In the late 1960s, Korea began to develop its electronics industry that can be characterized by labor intensive, limited in technological sophistication, and low in capital requirements. It was not until the early 1980s that the country emerged in the world electronics market. Products were no longer predominantly integrated circuits or transistors, but consumer electronics products of higher values. By 1990, they had about 4 percent of total world exports in digital computers and 9 percent in electronic microcircuits, and by 2000 Korean electronics companies have become major players for high-value added products in the world market. LG and Samsung Electronics have become the world's largest makers of CD-ROMs and monitors. Samsung has become the world's leader in the electronics industry whose three main business units are Digital Media, Semiconductors, and Information & Communications Business (Korea Newsworld, September 2000: 50).

Significant changes occurred in the late 1980s. Many Korean export industries shifted from producing for original equipment manufacturers (OEM) and began to market internationally under their own brand names (e.g., Goldstar and Samsung). Although price was the key component in their competitive strategy, Korean firms realized the importance of product differentiation and quality improvement as they matured in their product development.

This transition called for in-house research and development (R&D) capability. Changes in firms' competitive strategy created new challenges for S&T policy. In the past, S&T policy had been supply-oriented. The objectives of S&T policy then were to strengthen S&T education and to provide foundations for adopting foreign technology, whereas national R&D programs, inaugurated in the 1980s, were designed to create new industries, and focused on computer components, semicon-

ductors, and telecommunications sectors which are complementary to the IT industry. As industrial policy becomes more science and technology-oriented, a new model for institutional innovations was sought.

Industrial Transformation and Institutional Linkage

An important contribution of the Korean government in facilitating the transformation of the strategic industry was the establishment of close linkages between firms and the government (Leipziger and Petri, 1993: 35). Other policy instruments included: mandates and incentives for private R&D, public-private collaboration and direct public investment in R&D, and encouragement of the cooperation between domestic and foreign firms. Hence, accumulated technological capability that has occurred through imitation of the production processes of foreign firms, has enabled Korea to assimilate, use, adapt or create technology and develop new products and processes for the global market (Amsden, 1989: 3).

The Korean experience demonstrates that competitive advantage in the innovation-led stage is based on advanced factors as opposed to basic factors. There are two kinds of factors: basic factors and advanced factors. Basic factors are nothing more than the inputs (labor, land, and capital) necessary to specialize in the production of the commodities that can yield comparative cost advantage (Todaro, 1994: 420~421). Advanced factors include educated manpower, research institutes, and data communication infrastructure (Soh, 1997: 63). As industries mature and become knowledge-intensive, the importance of the basic factors in terms of competitive advantage decreases. Their competitive advantage begins to shift to more advanced factors.

The Korean government established a number of organizations to assist the needs of various industrial sectors. Under the Ministry of Science and Technology, there are the Information and System Development Bureau, the Technical Cooperation Bureau, the Technology Transfer Center, and the Korea Electrotechnology and Telecommunications Research Institute. They not only cooperated with private business to execute special research projects, but also facilitated technology transfer from abroad and forged strategic alliance agreements with foreign companies.

The Korean government maintained close communication with the private sector through intermediate associations. The Korea Electronics Industry Promotion Society (KEIPS) is one example. It was established for two main reasons. One was to disseminate information from the Ministry of Trade and Industry (MTI), and other key economy-related governmental agencies to the electronics industry. The other was to lobby the government on behalf of the industry. KEIPS' members were executives from electronics firms to promote their interests. It communicated industry concerns and exchanged industry information with the government. KEIPS successfully galvanized the efforts among the government, science and technology experts, and the business community to create a political environment for continued government support in science and technology (Shin, 1993: 117~120). The information network among firms and between the government and the industry was essential in order to enhance learning externalities in the process of industrial transformation. With the government as the coordinator, the network reduced costs of communication and strategic behavior (Watkins, 1991: 95).

The strategic influence afforded to KEIPS can also be seen in the development and implementation of Korea's export and industrial policies. KEIPS played a coordinating role in processing information to enhance Korea's strategic capacity. It served as a bridge, enabling firms to understand governmental strategies, to get a sense of emerging opportunities and to be ready to rapidly respond to

them. By consulting with intermediate organizations on an institutionalized basis during decision-making phases, the government benefited from closer proximity to information regarding present industry situations. As a provider of information for both government and industry, KEIPS acted essentially as a public entity, without being a part of the official bureaucracy (Shin, 1993).

The collaborative linkages between the government and industry have taken many forms (World Bank, 1993: 359). In 1993, the Korean Ministry of Trade, Industry, and Energy and the U.S. Department of Commerce agreed to establish a private sector-led industry advisory group consisting of subgroups in nine high-tech industry sectors that included semiconductors and telecommunications equipment among others. Strategic alliances between business firms from the two nations were forged as a result of the cooperative efforts. The case of the semiconductor industry is particularly illustrative in terms of expanded cooperation. While U.S. firms have primarily been systems builders, Korean companies have focused on components manufacturing. Similar types of industrial cooperation can be found in electronics, telecommunications, and aerospace industries. Although the U.S. does not maintain an overall industrial policy like most industrial powers, it too collaborates domestically with such key sectors as defense and aerospace industries.

Brazil, India, Singapore, and Taiwan have actively promoted their information (formerly electronics) industries. Each of these countries adopted industrial policies and targeted the microcomputer industry for development. Singapore teamed up with the multinational corporations; Taiwan orchestrated the efforts of its small firms through government-run institutes. Though Taiwan enjoyed the initial success, Korean chaebol (conglomerates) in the IT sector have leaped ahead of Taiwan because of the economy of the scale. India's policies were of a much different nature. The country is generally closed to open trade and investment except for the software industry. Brazil and India had no working institutional linkages between the different electronics sub sectors, which made coordination extremely difficult (Mody, 1989). In contrast, Samsung Electronics in Korea initiated the formation of "cooperative companies of Samsung," composed of various sub-contractors for producing parts. Samsung Electronics has provided them with technical advice and training as well as financial support. This initiative reflected the realization by Samsung Electronics that mutual technological cooperation between the parent company and parts producers was essential to the improvement of technological capability and product quality. Thus the coexistence and coprosperity of finished product makers and parts producers are closely related to the success and failure of the electronics industry.

R&D funding measures, in particular, differentiate Korea from such other countries as Brazil, Mexico, and India. The Korean government furnishes considerable funds for academic and government research as well as industrial R&D programs whereas such support has declined in the aforementioned countries. Korea's R&D efforts may well be reflected in aggregate R&D investment trends - R&D expenditures rose faster than GNP, increasing its share of GNP (R&D/GNP) from 0.32 to 1.93% (Kim, 1993: 369). Korea plans to enter the New Millennium investing 5% of its GNP in science and technology whereas Brazil's expectations in better years have never gone higher than 1.5～2.0% of its GNP for this purpose. Not only their strategies and policies have varied but also results have differed.

Another difference is investment in education. Latin American investment in education has been severely curtailed by financial exigencies. Further differences can be noted between Korea and Brazil. Korean social and economic policies included development of educational institutions at all

levels, a high rate of R&D funding and other program initiatives to raise the human capital level, while Brazil pursued intermittent strategies. Brazil typically swung back and forth between 'populist' and 'elitist' human capital strategies. Overall Latin America (Argentina, Brazil, and Mexico) enjoyed less success with economic restructuring than did the Asian industrializing countries, because they had less coherence in state bureaucratic policy and industry was based largely on basic factors. Latin America in general sought an elusive goal of national autonomy through import substitution industrialization (Haggard, 1990: 162～165) while Korea relied on linkages between public and private sectors to promote export-led growth.

Strategies and Incentives for Private R&D

Another role of the Korean government in facilitating industrial transformation was to "pull" technological development by the industry through encouraging and mandating private R&D (Szyliowicz, 1981). Under the Law for the Promotion of Industrial Technology Development, the Korean government required large companies to set up research centers, and encouraged small and medium-size companies to establish research consortia. In the mid-1980s, Korea had 129 private research institutes and 18 research consortia in operation (Kim, 1989). Technological and financial assistance were given to private research centers by government research institutes, the National Council for Science and Technology, Korea Technology Development Corporation, and the Small and Medium Industry Promotion Corporation.

In addition to R&D mandates, the government offered various incentives to companies for conducting private R&D. Thus companies investing in high-tech and large-scale production techniques received tax benefits and other financial incentives. New industries secured tax breaks for the first five years and reduced tax rates in the following three years. Reserve funds that were used for R&D, capital investment, and training expenses were all tax exempt. Policy loans were also made available for investment in R&D and productivity improvement. Foreign R&D personnel could enjoy exemption from individual income tax, and patent payment could receive tax credits (Yu, 1985). Both R&D mandates and incentive policies helped to reduce the problems of "publicness" in R&D information. The mandates ensured that no firms could free ride other companies' R&D efforts, thus reducing the strategic behavior of firms leading to under-investment. Various subsidies and assistance further reduced the costs of R&D. All these measures stimulated the industry to invest in R&D. However, the 1997 International Monetary Fund crisis brought on by the structural dislocations in the Korean economy has not only resulted in R&D budget cuts by both government and industry (see Table 1).

In terms of R&D strategy, the Korean government furthered industrial upgrading and resolved the problems of public goods in R&D through public-private collaboration and investment in research and education. As shown in Table 3, the private sector has played the leading role in augmenting R&D investments rather than the government in Korea. In addition, the proactive R&D strategy led by Samsung Company in Korea is illustrative of its restructuring effort in order to consolidate and systematize the R&D activities that had existed independently in each business sector within the Samsung Company. In 1988 the company's R&D unit was restructured into three integrated research centers for consumer electronics, for information systems and computers, and for semiconductors. This structural adjustment made it possible for the company's heretofore, separate elite R&D professionals to realize the synergy at one of the integrated research centers. In contrast, local industries in Brazil had undertaken no R&D, with the exception of some public enterprises (Schott, 1993: 152). The IT industry

Table 1. Korea's R&D Expenditures by Source of Funds (unit: billion won, %)

Classification	1995	1996	1997	1998
Government	1,780	2,398	2,851	3,052
(increase rate)	(41.2)	(34.7)	(18.9)	(7.1)
Private=Industry	7,660	8,467	9,323	8,276
(increase rate)	(15.4)	(10.5)	(10.1)	(-11.2)
Foreign	1	13	12	8
Gov. Vs. Industry	19:81	22:78	23:77	27:73

Source: Ministry of Science and Technology, "Statistics of R&D in Science & Technology" in Databook, 2000.

Table 2. R&D Budget Level by OECD (unit: % budget amount/GNP)

	1994	1995	1996	1997	1998	1999
USA	1.02	0.98	0.93	0.91	0.89	0.87
(increase rate)	(△2.2)	(0.7)	(0.4)	(3.8)	(2.8)	(2.2)
Japan	0.49	0.52	0.56	0.59	0.61	0.63
	(4.1)	(6.0)	(12.4)	(6.8)	(1.0)	(4.1)
Korea	0.51	0.54	0.61	0.71	0.7	0.72
	(33.0)	(23.1)	(24.9)	(25.8)	(△1.9)	(11.5)
*Taiwan	0.51	0.48	0.52	0.49	0.47	-
	-	(1.8)	(17)	(3.4)	(4.5)	

Source: Ministry of Science and Technology, "OECD Statistics" in Databook, 2000.
Note: Years 1998 and 1999 are estimated values. *Taiwan is not in OECD and non-defense R&D budget only.

Table 3. R&D Investment Expenditure Level by R&D Subject in OECD (unit: %)

Country	R&D Subject	1994	1995	1996	1997	1998
USA	Private=Industry	70.7	71.9	73.4	74.3	75.2
	University	15.9	15.3	14.8	14.4	14.0
	Government	10	9.6	8.7	8.2	7.9
	NGO	3.5	3.3	3.1	3	3.0
Japan	Private=Industry	66.1	65.2	71.1	72	-
	University	20.2	20.7	14.8	14.3	-
	Government	9	9.6	9.4	8.8	-
	NGO	4.7	4.4	4.8	4.8	-
Korea	Private=Industry	72.8	73.7	73.2	72.6	70.3
	University	7.7	8.2	9.4	10.4	11.2
	Government	0	17	16.2	15.8	17.6
	NGO	0	1.1	1.2	1.2	0.9

Source: Ministry of Science and Technology, "OECD statistics" in Databook, 2000.

like IBM and Burroughs in Brazil promoted a Korean-like internationalization but they ran up against her desire to become self-reliant as industrial custodian (Evans, 1995: 104~107). Brazil's strategy, relying upon older production processes in the face of technological advance, resulted in failure.

Another significant move was the establishment

of the Taedok Science Town in Korea to facilitate private-public collaboration. The government offered a low-cost site for many high-tech firms and research institutes to facilitate exchange of technological information and research cooperation. The government-run Korea Advanced Institute of Science and Technology organized advanced research activities and trained top-quality scientists and researchers to serve industrial needs, and promoted basic research. These education and R&D measures of the Korean government helped to release further the capability constraints on the transformation process of the strategic industry.

Such efforts as acquisition of foreign production systems, encouragement of OEM, various incentives for technological cooperation with foreign companies and foreign direct investment have all contributed to reducing the capability constraints as well as enhancing the efficiency and quality of technology information. These measures are indicative of the government's attempts to encourage the utilization of foreign technology and investment to shorten the learning curve of the domestic industry (Enos and Park, 1988).

It is important to note that the Korean government began to shift its development policies from highly interventionist to more liberal from the early 1980s on. The liberal policy reflected a change in Korea's comparative advantage being shifted from labor-intensive goods to capital- and knowledge-entensive goods. Because Korea's future economic development depends on technological progress, the infusion of foreign direct investment plays an important role in the development and application of the new technology. The Korean government offered many incentives for foreign investment and technology transfer. The minimum allowable amount of foreign investment was $100,000. If the investment brought high technology, or was a joint venture with a small or medium-sized domestic company, the minimum amount was lowered to $50,000. As a result of these policies, several Korean firms were able to obtain considerable amounts of cooperation with foreign companies. The noteworthy ones among them included Lucky-Goldstar and AT&T's joint-venture in manufacturing telecommunications products; Samsung and Hewlett Packard's cooperation in computer manufacturing; and Samsung Semiconductor's DRAM technology licensing and its VLSI technology from several firms in the U.S., including Micron Technology and Excel (Schive, 1990; Mowery and Steinmueller, 1991).

Companies must collaborate to remain viable in the global marketplace (Bleeke and Ernst, 1993 : 1). Firms that share costs, benefits, risks, information and technology with their suppliers are able to perform best for both customers and stakeholders. Strategic alliances speed the learning process and intensify competition (Henzler, 1993: 265～268). Three chipmakers from Korea, Japan and Taiwan have formed a tripartite alliance in 2000 to jointly develop a new clean room system for silicon wafers that are larger than existing products in the world market. The Japanese firm designed the equipment, while the Korean company provided machine manufacturing and structuring technology, and the Taiwanese firm offered an automatic control solution. Such cooperation encourages the learning process, industrial innovation, and intensify competition.

The Korean government also encouraged foreign transfer of technology indirectly by relaxing the regulations on overseas investment by Korean companies in the 1980s. At present, Lucky-Goldstar, Hyundai and Samsung have already set up U.S. subsidiaries in Silicon Valley, California and various places in Europe. Foreign subsidiaries allowed Korean companies to utilize the more competent manpower and researchers in other countries. The long-run impact of overseas investment on the domestic industry was significant. When the acquired technology was transferred back to parent companies in Korea, the domestic

industry was transformed in a more efficient and less risky way. Thus overseas investment reduced the risk barriers, information uncertainties, and capability constraints, let alone the transaction costs in transfer technology and learning.

The structural adjustments, under the IMF bailout plan following the financial crisis in December 1997, dictated sweeping changes and policy reforms in Korea's political economy. The policy initiative taken by President Kim Dae Jung was to recognize the provision of advanced technology by foreign firms as a type of investment, and it further ensures foreign investors to launch operations in Korea on an equal footing with local enterprises. The Ministry of Information and Communication has embarked on a set of measures to attract foreign direct investment in the domestic IT industry. These incentives contain provisions of tax breaks to foreign investments in selected high-tech areas, equal treatment of foreign firms participating in domestic R&D projects as nationals, and the establishment of free trade zones (Shin, 1998).

Changes in the Competitiveness Paradigm

It has long been contended that Korea needs to reshuffle or possibly, restructure its key industries. Redundant investment in heavy industries, which form the nation's core industries, such as automobiles, steel and semiconductors, has led to excess supply and, in turn, has become a burden on the economy. In fact, the inundation of production capacity throughout Asia was one of the reasons for the recent economic woes in the region.

There have been concerted efforts by the Korean government to find a new strategic area that could lead Korea into the information and knowledge-based economy of new millennium. One of those areas is the information and telecommunications. Faced with diminishing price competitiveness from other developing countries, the Korean electronics industry took the bold initiative in the early 1990s to invest in information and telecommunications component manufacturing.

Moreover, the globalization of trade and transnational corporate activities have spilled over into the telecommunications sector since the end of the 1980s, thereby creating fundamental changes in the telecommunications paradigm. The new situation has led to the creation of a range of new services and has become a key infrastructure for the industrial economies in which information has taken a new role. In this sense, not only does the telecommunications industry possess high growth potential but it can also create externalities throughout the economy by enhancing efficiency and productivity.

Linked to this is the fact that the telecommunications industry has in itself become a major multinational industry as a result of the increasing number of market opportunities which are emerging through privatization of fixed link operators and through licensing of new mobile networks. The demand for telecommunications services in developed countries is no longer concerned with just obtaining access to a network (in terms of obtaining a telephone line) - in most advanced economies universal services and access have been attained. Rather, the demand is for customized solutions, mobility, flexibility and efficient service offerings at a reasonable price.

Absorptive Capacity and Adaptation of Technology

Absorptive capacity and adaptation of technology are necessary to changing conditions in regional, national, and global environments. It allows national S&T policy makers to map out road plans, pave ways for administrative action, and facilitate innovation in the telecommunications industry with some global standards. Over the last decade the telecommunication sector, once treated as a public service, in OECD countries including Korea has undergone significant regulatory reform to

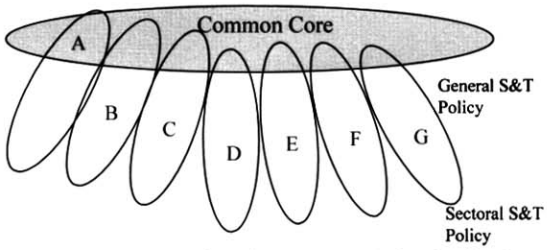
introduce competitive pressure on incumbent telecommunication operators. As early as 1991 ahead of the OECD countries and WTO agreement, Korea introduced competition for international service with liberalization of telecommunication service and equipment markets. This meant that the entry of the private sector into the telecommunications industry, once owned by the government, has changed telecommunications services from public goods to private goods. The blurring of different technologies and networks make the old type of regulation regime virtually obsolete. Mobile networks can easily substitute wired basic telephone service. Additionally, networks can be extended with wireless features (Min, 1996: 28).

Korea embraced Code Division Multiple Access technology (CDMA) - a type of digital transmission technology - for its mobile telephone system in 1993. Advanced, albeit unproven technology invented in the U.S., CDMA was poised to compete with global heavyweights like Lucent Technologies Inc. and Motorola Inc. Adopting CDMA had a strategic advantage for Korea: a chance to lead in a technology rather than follow, if Korea could commercialize CDMA ahead of others, it could solidify its hold on the rapidly expanding domestic market and strengthen their ability to compete internationally as well. In 1992, the government-run Electronics and Telecommunications Research Institute (ETRI) and Qualcomm Inc. of the U.S. that developed the CDMA technology, signed a technology-transfer agreement. The agreement provided for a CDMA system that could handle a multitude of phone calls. About 150 engineers from ETRI were joined by cohorts from Samsung Electronics, Hyundai Electronics Industries Co. and LG Information & Communications Ltd. to work on the development of a commercially viable system. By 1994, the ETRI devised a prototype system and tested it; three companies then used the prototype system to develop their own systems.

In early 1996, SK Telecom in Korea launched its CDMA cellular-phone service, and today it runs the largest CDMA network in the world, with 4 million subscribers by 2000. Exports of mobile phones and related systems, based on CDMA technology, reached a $1 billion mark in 1999. Having succeeded in the development of next generation telecommunication technology, these companies endeavor to muscle into world mobile communication markets. Samsung Electronics Co. signed a contract in 1999 to export Web phones to Telenor, Norway's state-run telecom company over the next three years. The Web phone enables three-way conversations and Internet services, including E-mail and voice mail (Ministry of Information and Communication, 1999). LG Information & Communications has forged a strategic alliance with ADC Telecommunications in the U.S. to jointly develop equipment connecting ordinary phones and data networks to ATM switching. Korea Telecommunications came to develop the ATM-based core switching technology of global service for mobile communication (GSM)-international mobile telecommunication (IMT-2000) in a cooperative R&D effort with the ETRI (Korea Newsworld, 2000). The government continues to encourage and support new technologies in the area of information technology. On march 2000, the Ministry of Information and Communication announced that the developers of the selected technologies would be eligible for a financial subsidy of up to 100 million won for R&D.

Notwithstanding the economic downturn in the latter half of the 1990s, the telecommunications service sector experienced rapid growth at an annualized rate of 12 percent during the period. The increase of the available services stimulated demand for hardware at an annual rate of more than 20 percent. The growth of the telecommunications industry reached 9.2 percent of the nominal gross domestic product in 1998, and has become one of the core industries of Korea.

Figure 1. New Governance of S&T Policy



A=Industry Technology, B=Information & Communication, C=Education, D=Environment E=Health, F=Construction, G=Culture

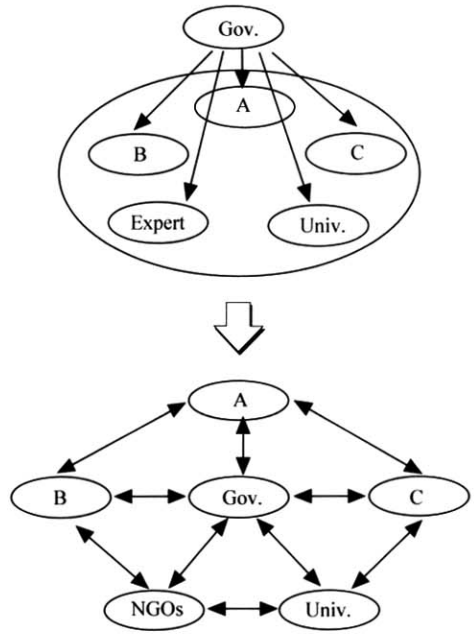
Source: National Consulting Committee for Science and Technology (2000).

New Governance of S&T policy in Korea

Changes in the competitiveness paradigm of the telecommunications industry suggest a new governance pattern of S&T policy. This emerging pattern is depicted in Figure 1. The new science and technology policy is made of two components. They are: 1) general S&T policy and 2) sectoral S&T policy. The general S&T policy component includes inter-agency coordination of S&T development, construction of supportive infrastructures, and performance evaluation of various government R&D projects, whereas the sectoral component includes industrial technology, information and telecommunications, education, environment, health, construction, and culture. The new governance for S&T policy includes, as partners, industry, non-governmental organizations, civil society, citizens alliances, and regional/global alliances. Furthermore, the new governance adheres to the principles of participation, fairness, equity, efficiency, accountability, and transparency (Farazmand, 2000).

As is depicted in Figure 2, the structure of new S&T policy is being transformed into horizontal and open policy network from vertical and closed policy network. The horizontal and open network structure will produce the transparent and participatory S&T policy during the process of the policy formulation, implementation, and evaluation.

Figure 2. Network of S&T Policy



A=government-funded research institute, B=large enterprises, C=small-medium enterprises, Gov.=Government, NGOs= non-governmental organizations

CONCLUSION

A corollary of Korea's determination to lift her productive capacity to a higher plane of technical and commercial competence was the government's awareness of the need to adapt her industrial composition to changes in markets and techniques. Korea did not simply respond to exogenous forces; the government was remarkably successful in anticipating change. In the process of industrial transformation, the common problems facing developing countries are information externalities and capability constraints. Relying solely on the market mechanism fails to deal with these problems successfully as private firms are more concerned with profitability and risks. Remedies for these market failures depended on institutional mechanisms that could appropriate information and make the efficient resource allocation, and they called for the government-business risk partnership.

In Korea, government funding of S&T activities and programs to promote innovation takes place under circumstances different from those of most other nations. Korea's economic growth has been dynamic, a situation that generates more revenues for public investment. It has been guided by an S&T policy that developed indigenous technological capabilities by absorbing imported technologies into its R&D efforts. Although past research suggests that the government can have failures in policy-making and create more costly inefficiencies (Auty, 1995: 197), it can be argued that government action to facilitate industrial transformation is desirable if it can create conditions of competitive advantage. Competitive advantage includes institutional factors, whereas comparative advantage, as used by economists, is based on factor prices (cost). The interactive mechanism can assist in overcoming the problems of information externalities, risk bias against infant industries, and capability constraints.

It is significant to note, however, that the interactive modes between the government and industries change as the contextual factors - social, economic, and political - are being transformed (Bright, 1996: 293～300). Many analysts underestimate the role of societal forces in sectoral shifts from import-substitution to neoliberal policies. For instance, such policy shift left Brazilian industrial policy in a jumble of incoherent doctrine, thus weakening its possibility for institution building (Silva, 1993: 529; Evans, 1995: 153). The interaction mode and degree of government intervention to industry should be considered through the competition policies of both industrial and information societies.

Since the Korean financial crisis in 1997, the process of political democratization and economic reform has eroded the legitimacy of state leadership in directing industrial development. The focus of public investment seems to be shifting to the provision of basic and intermediate R&D activities and education, which demonstrate strong externality effects and non-appropriateness. Furthermore, the nature of interaction between the government and the industry will change from the director-follower relationship to a relationship of information sharing and mutual promotion of market efficiency. In essence, the process of industrial transformation is a continuous decision-making process by the government and industry in response to information inputs and capability constraints. Korea's successful transformation is the result of a coordinated (public and private) national strategy, in which S&T policy has played a key role. This system-institutional model explicate Korea's path towards higher value added, more knowledge-intensive industries.

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