INNOVATION STRATEGY OF SCIENCE AND TECHNOLOGY IN KOREA

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Keywords: *Innovation Strategy, Science & Technology Policy, Korea*

Abstract

Korea has been very successfully transformed from one of the poorest countries to an industrialized one. The rapid economic growth has been considered a direct result of the developments made in Science and Technology(S&T) as well as the increased enthusiasm in education. The innovation policy of science and technology in Korea has therefore attracted much attention from under-developed and developing countries. This paper briefly overlooks the economic, industrial and S&T development of Korea. It also introduces the strategy of S&T innovation, and investigates current challenges and issues regarding economic growth and S&T development

1 Introduction

Within half a century, Korea has transformed itself from being one of the poorest countries in the world, to being the 12th largest economy in the world. Among the many factors, it has been considered that Korea's innovation in Science and Technology (S&T) caused its rapid economic growth.

This paper explains Korea's rapid growth by presenting related statistics, and introduces Korea's policy for S&T innovation which has been led by the Korean National Assembly and the government. This paper also highlights some examples of the current challenges and issues that have been confronted by Korea and/or the global community.

2 The Rapid Development of Korea

2.1 Economic Growth

Korea has taken an extraordinary development pathway for the last four decades. The statistics below (Table 1) shows the enormous quantitative growth. Since 1960, Korea's GDP has increased to almost 400 times its original level. Korea is now ranked as the 12th largest economy in the world.

Table 1. Economic growth of Korea

Year	1960	1970	1980	1990	2005
GDP (bil. US$)	2	8	62	253	791
GDP per capita(US$)	80	248	1632	5,900	17,422
Export (mil. US$)	32	660	17,214	63,124	284,419

2.2 Industrial Development

It is widely acknowledged that the export-oriented strategy adopted by Korea was the main contributing factor for its rapid economic growth. The changes made in exports items illustrate a qualitative transformation in Korean industry. In the 1960s, natural resources accounted for the bulk of export items. Depending upon cheap labor costs, light industries such as textiles, plywood, and wigs dominated in the 1970s. However in the 1980s, as a result of huge investment in the heavy industry sector, iron and steel products, electronics, and textiles led Korean exports. In the following two decades, industries that made semiconductors, LCD displays, mobile phones, shipbuilding, steel and automobiles guided Korea's economic growth.

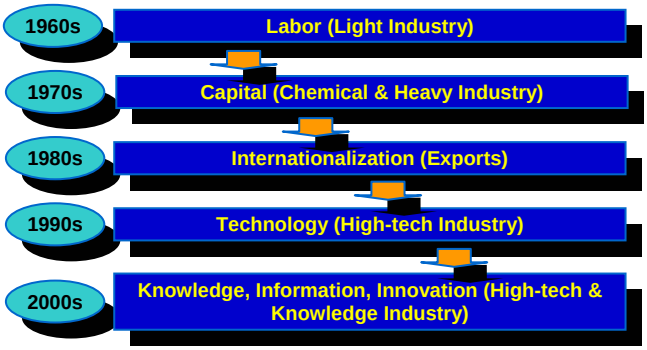

Fig. 1. Main sources of economic growth

Korea experienced financial crisis in 1997. IMF's bailout program contributed to the recovery of the Korean economy. During this time, Korean industry restructured its systems toward a more knowledge-based economy. It is the basis for her being boasted as 'IT Korea' at the moment.

2.3 S&T Development

Korea's R&D power has also expanded enormously over the last 45 years. First, R&D investments increased rapidly. The government budget for science and technology became almost 3 percent of GDP in 2005. A strong emphasis was placed on human resource development. Second, the government took initiatives with regards to R&D until the mid-1980s, but the private sector has dominated since then.

Table 2. Major R&D statistics

	1963	1970	1980	1990	2005
Gross R&D (mil. US$)	4	33	428	4,676	24,160
Gov't vs. Private	97:3	71:29	64:36	19:81	24:76
R&D/GDP	0.25	0.38	0.77	1.87	2.99
Researcher	N/A	5,628	18,434	70,503	234,702

Government-supported research institutes (GRIs) steered R&D until the mid-1980s, when company owned research institutes played an important role in high-tech oriented industries. In 1978, only 48 company owned research institutes existed but that figure had increased dramatically to almost 10,000 by 2003.

Table 3. R&D institutes (%)

	1970	1980	1990	2001
GRIs	84	49	22	13
University	4	12	7	10
Company	13	38	71	76
Total	100	100	100	100

The number of scientific papers and patents has also increased dramatically over the last ten years. Especially for the patents under PCT (patent cooperation treaty), Korea ranked fourth behind the US, Japan, and Germany in 2006, which shows the country's global competitiveness and qualitative improvement.

Table 4. Overseas patents (PCT registration)

	2002	2004	2006
Number	2511	3565	5935
Rank	9	7	4

Subsequently, recent evaluation for the global competitiveness of Korea's S&T has been positive (e.g., by IMD) with further rooms to improve.

3 Innovation Strategy of S&T in Korea

3.1 Strategic Directions

(1) While the applied and process technologies were the key drivers for the fast growth period, the original and basic technologies should be the key driver for the further development in Korea. For this purpose, the budget for R&D increases with faster rate than Defense, Welfare, or Education.

(2) It is necessary to put more emphasis on the qualities rather than quantities for the evaluation of scientific outcomes. Even though the aspects of quantity and volume of patents and papers in science and technology has been dramatically increased, the quality of patents and papers has still come to a standstill and hasn't progressed.

(3) To reduce the polarization between big companies and small/medium sized companies, small/medium sized companies are necessary to change from the domestic demand-based ones into the global innovation-based ones which have a global competitiveness on a specific area.

(4) Although students' evasion of engineering and science schools is a world-wide situation and occurs in most developed countries, without the support of high-quality students in the engineering and science schools, Korea will not be able to overcome the challenges from newly emerging countries and also from developed countries.

(5) For a high-value manufacturing industry which is the goal of Korean manufacturing companies, the quality of human resource is more important than the quantity. Hence, the government policy should focus on the quality of human resource in S&T and provide an attractive environment for the people in the S&T domain.

(6) In a knowledge-based era, the service industry becomes the major value-creating industry as well as a high-value manufacturing industry. Moreover the knowledge on the conversion between several domains and industries will be essential. Therefore the policy for the human resources should reflect these aspects.

(7) The S&T should encourage the elderly to participate in the workplace and society, as the number of elderly people grows fast.

(8) The R&D programs generally have focused on the high technology for the improved

competitiveness of companies and for the growth of the economy. For a long time the technologies for the better quality of life were not being paid enough attention. Now the R&D program should consider the quality of public life as well as the high-technology for the company.

(9) Finally, research ethics should be an integral part of the innovation strategy. The innovation strategy should not harm to society or its people. Committing research misconducts gives rise to mistrust toward S&T. Without civil society's and the government's full support, S&T would hardly achieve financial and social supports.

3.2 Strategic Measures

3.2.1 National Innovation System

Based on the evaluation of the past achievements of the innovation policy and the newly emerging challenges, it was suggested that the further development of S&T would help Korea overcome those challenges and become an advanced country.

An S&T centered society means a society in which S&T development is flourishing, contributing to the enhancement of the quality of life and the national economy. It also encourages a high-degree of innovation to generate a new growth engine, forging an innovation-led economy. Techno-scientific minds should be expanded to all social and cultural realms in this system. Scientists and engineers should be respected. Consequently, this ideal society aims at becoming safe and sound socio-technical system in which citizens enjoy a high quality of life based upon a high-degree innovation system.

To fulfill these ideals, a policy program, called the "National Innovation System (NIS)", was implemented with concrete action plans in 2004. The NIS suggested that the following five areas should be innovated.

(1) Related players - companies, universities, GRIs, and foreign partners - should improve themselves. Companies need to foster R&D activities. Venture startups need to develop innovative skills and products. Universities and GRIs should implement innovation environments.

(2) S&T education should be strengthened. Its prominence should be started earlier such as in elementary or middle schools. Vocational and engineering education should provide people with new programs to adjust to rapidly changing technical systems.

(3) The university-research-industry needs to be effectively clustered to create new technologies, job markets, and profits.

(4) The NIS gears toward a systematic managerial infrastructure to maintain this innovation system. The digitalization of S&T management, the globalization of R&D system, and a mission-oriented evaluation system needs to be established.

(5) Consideration of the cultural and social aspects of S&T is required to create an S&T friendly society.

3.2.2 New S&T Administration System

S&T related administration system was restructured to promote innovation in 2004.

(1) The minister of S&T was promoted to a deputy prime minister and appointed as a vice-president for the "National Science and Technology Council" where the whole government R&D budget is deliberated and allocated. This promotion signifies the importance of the S&T ministry.

(2) The "Headquarter of S&T Innovation" was founded to produce more innovative ideas, programs, and plans. Any government staff or citizen can propose innovative ideas to this organization whose mottos are creativity, openness, and transparency. It also aims to be a model governmental unit in which staffs voluntarily participate in policy roundtables, seminars, and other civil activities to generate and induce innovative policies.

(3) More attention has been being paid to the commercialization of S&T because it is believed that many S&T projects were not closely connected to industrialization. To this end, S&T related ministers gather together every month, discussing which S&T projects can be commercialized in the near future and deciding funding and policy for favorable projects.

(4) The R&D evaluation system has been rebuilt to encourage a more specific mission oriented project rather than liberal and pure research projects. For this purpose, the administration has developed several evaluative indicators to discern which one is more mission oriented.

3.2.3 New Growth Engine

Recently Korea's GDP growth rate has ranged between 3 to 5 percent, which is considered to be very low compared to Korea's past experience. To be a world-class advanced country, Korea still needs to improve GDP, S&T capability, and infrastructure. The major problem is that Korea now must compete against other advanced nations. To fulfill this

purpose, the Korean government implemented the "New Growth Engine Policy." It selected 10 core technologies that Korean scientists should urgently develop in the near future. S&T policy makers chose them in terms of world market size, strategic importance, technology change trend, Korea's competitiveness, and ripple effects on economy and industry.

3.3 Innovation Strategy of Industry, Universities, and Public Research Institutes

3.3.1 Industry

In the past, the Korean industry has heavily relied on the import and assimilation of foreign technologies. However, in the 2000s, the local industrial players, especially the large companies have conducted a lot of in-house R&D to develop their own new products and improve their own existing products. That is, their technology strategies have been changed from the import and improvement of foreign critical technologies to their own in-house R&D to obtain necessary technologies.

These big Korean companies in the various industry sectors including DRAM, TFT-LCD, CDMA cellular phone in the IT sector as well as shipbuilding and steel, have been showing the good performances in terms of revenues, technology innovation, and market shares. Recently, these big companies have been moving their production bases to underdeveloped countries in order to take advantage of cheap labor costs.

Although these big companies have been performing relatively well, the traditional small and medium sized companies in Korea have not developed a strong technological base yet. But, in the 2000s, these companies have started to strengthen their own technological base and capabilities to generate high-tech products.

Since the 2000s in particular, many start-up (small and medium sized) companies have been created in the 2000s, especially in the IT sector. These venture companies have implemented a lot of intensive in-house R&D.

3.3.2 Universities

In the past, the role of local universities has been focused mainly on education rather than research for the high-tech developments. Moreover, the universities have not had sufficient capability to conduct the high technology-oriented research. However, when searching for professional jobs, most of the Korean Ph.D.-level R&D personnel have preferred the universities to the industry, due to the job security and traditional and social value systems such as the superiority of scholars and public officials over business men. This tendency has gradually enhanced the research capability of the universities.

In addition, leading university research labs have continuously participated in the national R&D projects. This on-going participation in the national R&D projects has also supported the improvement of their own research capabilities. As a result, their roles have shifted toward promoting the high technology-oriented research that has required a more advanced basic and generic research. The industry-university research has also been promoted by the national high-tech development programs. Over the last five years, the university labs have strengthened the cooperative research with industrial firms. Based on the national law established in 2003 which promotes the cooperation between company and university, 333 company-university cooperation centers has been organized (See Table 5). In addition, the amount of research funding in these centers has been increased from 1,713,138 million Won in 2003 and 1,798,851 million Won in 2004 to 2,030,059 million Won in 2005 (See Table 6).

Table 5. Company-university cooperation centers

University			Junior college			Sum
Public	Private	Sum	Public	Private	Sum	333
46	133	179	15	139	154	

Source: Ministry of Education and Human Capital, "A Study on the Promoting the Cooperation between Company and University", 2005.

Table 6. S&T research funding in the company-university cooperation centers

(Unit: Million Korean Won)

2003	2004	2005	Sum
1,713,138	1,798,851	2,030,059	5,542,048

Source: Korea Research Foundation, "A White Paper on the Cooperation between Company and University", 2005.

3.3.3 Public Research Institutes

In the past, since the technological capabilities of the local research universities and companies were underdeveloped, the Korean government has needed and established the mission-oriented public research institutes, the GRIs as the primary research agents. The GRIs have played the role of technological cooperators, searcher, mediator, and digester in supporting local companies which have

tried to find and absorb the appropriate global high technologies from developed countries in the past.

In addition, in order to facilitate the cooperative research among the research trinity - the local companies, the GRIs and local universities - the GRIs have played a role in technological coordination and R&D management for the national technology programs. This role has been required to facilitate the sharing of the funds, manpower, facilities and information among the participants as well as to increase the performances of the projects.

However, as the technological capabilities of local companies and universities have been increased, the GRIs have changed their roles in recent years. That is, they have still played the roles mentioned above, but they have primarily pursued the creation of the world class performances (patents, papers, critical technologies, etc.) and the implementation of the national missions such as the development of space satellites and related technologies.

4 Current Challenges and Issues

4.1 Sandwich Situation

Korea encounters the challenges from both developing countries such as China, Vietnam, Brazil, and India, and also from developed countries such as Japan and the USA. Due to the cheap labor and land cost for production facilities, China has become a strong contender against Korea in the world market. In addition, many Korean companies have been searching for and building the factory facilities in the developing countries which has caused the hollow of “manufacturing factories” in Korea.

The competitiveness of the developed countries like Japan has stemmed from the original technology which Korea can not cope with at present.

4.2 Aging Society

The birth rate of Korean hits 1.08 in 2005 which was one of the lowest rates in the world. It is also reported that Korea’s aging population is growing at a fastest rate in the world. The low birth rate and aging population negatively effects the potential growth rate of the Korean economy.

4.3 Human Resource & Education in S&T

In the 1990s, difficulty in recruiting became the main reason for the decrease of high-school students entering engineering and science schools. The percentage of high school students entering engineering and science in university decreased 42.5% in 1998, and 26.9% in 2002. In addition, the number of Ph.D. in engineering and science decreased 1,452 in 1998 and 958 in 2001.

4.4 Free Trade Agreement (FTA)

The Korean government made a deal for the Free Trade Agreement (FTA) with the USA in April 2007. The negotiations for the FTA with the EU, China, and Japan become the new urgent issues for the Korean economy and society. The tariffs and barriers on trade and exchange of products and services will be removed or decreased in the near future as the FTA with these countries reaches an agreement. The FTA can provide both the challenges and opportunity for Korea.

5 Concluding Remarks

Thus far, this paper has examined Korea’s rapid development, current challenges and issues, strategic responses and innovation strategy, which explicates the evolution of Korea’s innovation strategy and S&T policy. Furthermore, despite the differences in technological capabilities and innovation environment among nations, Korea’s situation, which has been explained in this paper, can give valuable lessons to developing countries. The Korean government has initiated the S&T development. With this initiative and support, the Korean private sector has grown and taken leading role since the 1990s.

As in the past, Korea’s innovation strategy and S&T policy is continuously evolving to overcome challenges, and adopting new strategies to readjust to changing environments. Having an open mind and global cooperation with foreign countries, Korea is seeking its position as a valuable and respectable global partner with both developing and developed countries alike.