South Korean Technology Policies for the Industrial Competitiveness
Between Japan and China

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Submitted to the Department of Urban Studies and Planning
In Partial Fulfillment of the Requirements for the Degree of Master of Science in Technology Policy of
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Abstract

In Korea, as in many developing countries, government has played a major role in leading technological development. The technology policies of this government have been aiming to increase the competitiveness of local companies.

However, as the new trade system represented by the World Trade Organization (WTO) emerged and Korean companies quickly grew, the Korean government had difficulties in keeping pace. Furthermore, the government began to feel a mismatch between its technology policies and the demands of private companies. For example, in the past, Korean companies had asked the government to make a new exclusive market for their initial products through governmental procurement. However, in order not to violate the new international trade rules, the government could no longer do this. Some say that government should not intervene in private business but let companies make their own decisions, according to market signals. On the other hand, in spite of the bureaucracy they entail, government policies are still necessary as long as the policies are implemented at the right time and in the right direction.

This paper will analyze the changes of relationships between the Korean government and private companies in terms of technology policies. In addition, this paper will propose new technology policies for Korea in order to secure its position as a leader in the information technology (IT) industry, particularly in the context of its relationships with Japan and China. Lastly, this study recommends that the Korean government foster entrepreneurs to create novel global IT businesses and keep pace with the United States regarding technology development and learn from Japan regarding globalization experiences. This study also suggests that the Korean government focus its research and development (R&D) funds on making electronic materials to enhance competitiveness of domestic IT companies.

Thesis Supervisor: Alice H. Amsden
Title: Professor of Political Economy

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Thank you very much.

List of Abbreviations

ATSC	Advanced Television Systems Committee
CDMA	Code Division Multiple Access
EMS	Electronics Manufacturing Service
ETRI	Electronics and Telecommunications Research Institute
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GRI	Government R&D Institute
GSM	Global System for Mobile Communications
IP	Intellectual Property
IPR	Intellectual Property Right
IT	Information Technology
MIC	Korean Ministry of Information and Communication
MOCIE	Korean Ministry of Commerce, Industry and Energy
MOFE	Korean Ministry of Finance and Economy
MOST	Korean Ministry of Science and Technology
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
R&D	Research and Development
SME	Small and Medium Sized Enterprise
STEPI	Korean Science and Technology Policy Institute

TD-SCDMA	Time Division - Synchronous Code Division Multiple Access
TDX	Time Division Switching System
TFT	Thin Film Transistor
TRIPS	Trade-Related Aspects of Intellectual Property Rights
WAPI	WLAN Authentication and Privacy Infrastructure
WIPI	Wireless Internet Platform for Interoperability
WIPO	World Intellectual Property Organization
WLAN	Wireless Local Area Network
WTO	World Trade Organization
1G	First Generation
2G	Second Generation
3G	Third Generation

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1. Introduction

The technology policy of a country is one of the major tools for promoting industrial development, particularly in the developing world. The Republic of Korea (hereafter "Korea") is no exception. Since the 1960s, the Korean government has designed very effective technology policies incorporating international trends and the capabilities of domestic companies. According to the "Support Programs for Technology Innovation Report" of the Korean Ministry of Science and Technology (MOST), the Korean government had 165 programs for technology innovations in 2002. Furthermore, Man K. Lee (2004) writes in his report "Should National R&D Projects be Driven by Private Sectors?" that Korea spent US $17.3 billion on research and development (R&D) in 2002. The R&D budget was approximately three percent of the Korean gross domestic product (GDP); the average ratio of the Organization for Economic Cooperation and Development (OECD) countries was 2.2 percent (p. 2).

However, with the emergence of the World Trade Organization (WTO) in 1995 and rapid globalization of Korean companies, the Korean government had difficulties in keeping pace. Furthermore, the government began to feel a mismatch between its technology policies and the demands of private companies. For example, in the past, Korean companies had asked the government to make a new exclusive market for their initial products through governmental procurement. However, in order not to violate the new international trade rules, the government could no longer do this. Some say that government should no longer intervene in private business and should let companies make their own decisions, according to market signals. On the other hand, in spite of the

bureaucracy they entail, government policies are still necessary as long as the policies are implemented at the right time and in the right direction.

The Korean government faces challenges in three areas. The first challenge arises from external factors such as the effects of globalization and dynamic relationships with neighboring countries Japan and the People's Republic of China (hereafter "China"). In fact, Korea has been sandwiched between Japan's high-tech products and China's commodity products. The second challenge comes from an internal factor that is the growth of Korean firms. Some of these firms are more closely linked with international markets than with domestic markets. Thus, they have become more independent of governmental influences. The third challenge is a scarcity of fundamental technologies in the electronic materials. Korea must still import many electronic materials such as silicon wafers.

This paper begins by outlining typical government technology policies and evaluating successful cases of Korean technology policies in digital telephone switching systems and code division multiple access (CDMA) cell phones. Then the paper will analyze the challenges Korea has been faced with. Lastly, the paper will propose new technology policies for the Korean government. These policies are that the Korean government should 1) encourage entrepreneurs to create novel IT businesses, 2) keep pace with the United States regarding technology development and learn from Japan regarding globalization experiences, and 3) focus its research and development (R&D) funds on making electronic materials to enhance competitiveness of domestic IT companies.

2. Typical Technology Policies of Government

Generally, technology policies can be classified into five groups: 1) supply policy, 2) demand policy, 3) diffusion policy, 4) forecast policy, and 5) protection policy, as shown in Table 2.1. Developing countries have a tendency to execute the first three policies to catch up with the technology level of developed countries. On the other hand, some developed countries have emphasized the last two policies in order to maintain their technology superiority against latecomers.

The supply policy refers to helping national companies to access technology resources such as high-level engineers and capital equipment. This policy includes inviting engineers from abroad, reverse-engineering high-tech goods, licensing foreign technologies, acquisitioning high-tech companies, attracting foreign investments, and encouraging internal research and development (R&D) activities. The demand policy, which can be a part of industry policy, refers to trying to create a pilot market for the initial products of national companies. This policy includes governmental procurement and national implementation plans such as information broadband network plan and mobile telecommunication service plan. The diffusion policy refers to promoting the exchange of both information and tacit knowledge among companies, universities, and government R&D institutes (GRIs). This policy includes building industry clusters with relevant firms, making standard specifications, and establishing non-profit associations. The forecasting policy refers to using expert groups to try to predict future technology and market trends. Sometimes, based on the forecast, a government selects a target industry in which to invest its R&D funds and human resources. This policy includes surveying advanced institutions and consulting industry pioneers. The protection policy

refers to establishing a legal framework to protect intellectual property (IP) inside and outside of the country. This policy includes establishing IP relevant laws, eliminating piracy products, and joining international IP organizations such as the World Intellectual Property Organization (WIPO) and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO).

Table 2.1 Types of Government Technology Policies

Technology Policies	Main Aim	Program Examples
Supply	To generate technologies	Inviting engineers from abroad Reverse engineering Licensing foreign technologies Acquisitioning high-tech companies Attracting foreign investments R&D projects
Demand	To create market To monitor rivals	National industry plans Meetings between firms, GRIs, and government
Diffusion	To spread out technologies	Establishing associations Holding seminars Establishing technology standards Building techno-market
Forecast	To select technology and Market	Consulting experts Surveying foreign companies
Protection	To protect intellectual property	Legislating IPR relevant laws Campaigning for IPR

3. Patterns of Korean Information Technology Policies

This chapter analyzes supply and demand policies applying the Roberts and Berry's Familiarity Matrix (1985) in their article, "Entering New Businesses: Selecting Strategies for Success." When the Korean government planned ambitious projects, it was

always faced with shortages of human resources, a lack of management skill, and a scarcity of fundamental technology as well as the uncertainty about the market.

Thus, taking digital telephone switching systems and mobile telecommunication devices as examples of Korea's successful cases in the information technology (IT) area, this chapter evaluates how the Korean government tackled these problems. This chapter examines time division switching systems (TDX) when Korea was in the catch-up stage in the 1980s, and focuses on code division multiple access (CDMA) cell phones in the 1990s when Korea began to emerge as a technological front runner in the world. These two projects have decisively contributed to founding the IT industry in Korea.

3.1 Korea's Technology Policies to Develop Digital Switching Systems

Until the 1980s, Korea did not possess any telephone switching technology, so Korea had to import all its telephone switches from abroad, mainly from the United States and Belgium. According to "The Korean Information Technology History in the Twentieth Century" of the Korean Ministry of Information and Communication (2001), during the 1970s, the huge demand for telephone services overwhelmingly exceeded supply; in every year, approximately one million new subscribers were waiting to get telephone service. This demand pressed the government, which used to own the national telephone service company, to take measures. Finally, in 1976, the Korean government announced its intention to develop a telephone switching system by itself. In 1981, the Korean Ministry of Information and Communication (MIC) established an adventurous and ambitious R&D project for its own digital switching system called the time division switching system (TDX).

At this time, Korean manufacturers -- Samsung, LG, and Daewoo -- bought foreign telephone switching systems and re-sold them to the national telephone service company, Korea Telecom. For these manufacturers, the telephone switching market was *new familiar* but hard to provide after-service to the domestic market because they did not have their own technologies. The switching technology was totally *new unfamiliar* for these companies. Therefore, as shown in Figure 3.1, the TDX could be laid on the cross section of *new unfamiliar* along the technology axis and *new familiar* along the market axis. To overcome these *unfamiliars*, the Korean government, under the auspices of the MIC, systematically approached the TDX projects in both ways, i.e., technology and market.

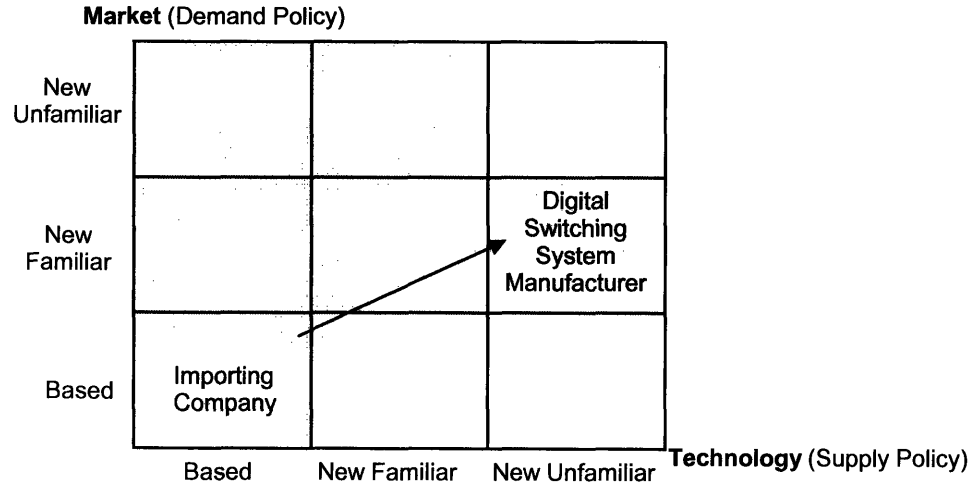

Figure 3.1 The TDX Familiarity Matrix

In the 1980s, when the MIC designed R&D plans for the TDX, switching technology was evolving from analog to digital. In spite of the difficulties of this new digital technology, the MIC set up the R&D plans aiming to develop the digital

technology based on its forecast. The MIC adventurously allocated a large number of research funds to a government R&D institute, Electronics and Telecommunications Research Institute (ETRI). ETRI led the projects under collaboration with both the national telephone service company and telephone switch manufacturers. Although they were unfamiliar with the switching technologies, with reverse engineering, they managed to follow a best practice in the current market. Korea also made best use of available experts, especially those who had working experiences in Bell Labs in the United States[1].

Concerned about tough competition with foreign manufacturers in the domestic market, the Korean Ministry of Information and Communication (MIC) tried to link the big demand, about one million new subscribers waiting for telephone service annually, with output of this project. According to Jung U. Seo (2004), a TDX project manager, the MIC endeavored to coordinate pilot TDX products with the telephone service company's purchases, i.e., the MIC tried to connect supply policies with demand policies before the WTO emerged. After the telephone service company's first purchase of the pilot TDX products, Samsung, LG, and Daewoo -- who used to import switching systems -- participated in the TDX projects more actively.

According to "The Korean Information Technology History in the Twentieth Century" of the MIC (2001), four years after MIC's decision in 1985, Korea succeeded in implementing the TDXs in working telephone networks and gained supremacy over foreign brands in the domestic market. Six years later in 1991, Korea was able to export TDXs to the Philippines and other developing countries by using the Korean foreign

[1] ETNEWS (2005). The Korean Telecommunication History with Bell Labs

assistance funds. Since 2000, Korea has exported TDX series to about sixty countries in the world.

As a result of TDX's success, the Korean companies could acquire tacit technologies in telecommunications and in computers. These tacit technologies enabled Korea to advance to the next innovations such as mainframe computers, semiconductors, and CDMA devices.

3.2 Korea's Technology Policies to Develop CDMA Cell Phones

Until the early 1990s, Korea did not have any cell-phone manufacturing companies. Now, after 15 years, leading Korean cell-phone manufacturers such as Samsung and LG are ranked third and fifth in the world respectively. Although these companies possessed some digital telephone switching technologies, they were basically home-appliance providers having little to do with the cell-phone business. Thus, the rapid progress of becoming world competitors was very remarkable for these companies, as well as for the Korean government.

In the early 1990s, a migration strategy from the first generation (1G) cellular system to the second generation (2G) was intensively discussed between telecommunication companies including manufacturers and service providers and the Korean government. Because the 1G analog cell-phone system in Korea was dominated by foreign companies such as Motorola and AT&T, both the technology and market were totally *new unfamiliar* to Korean manufacturers in the Roberts and Berry's Familiarity Matrix.

As shown in Figure 3.2, this *new unfamiliar* is very usual for developing countries. Because of the risk of *new unfamiliar*, if it were not for the governmental supportive framework, these manufacturers could not advance into the mobile telecommunication world.

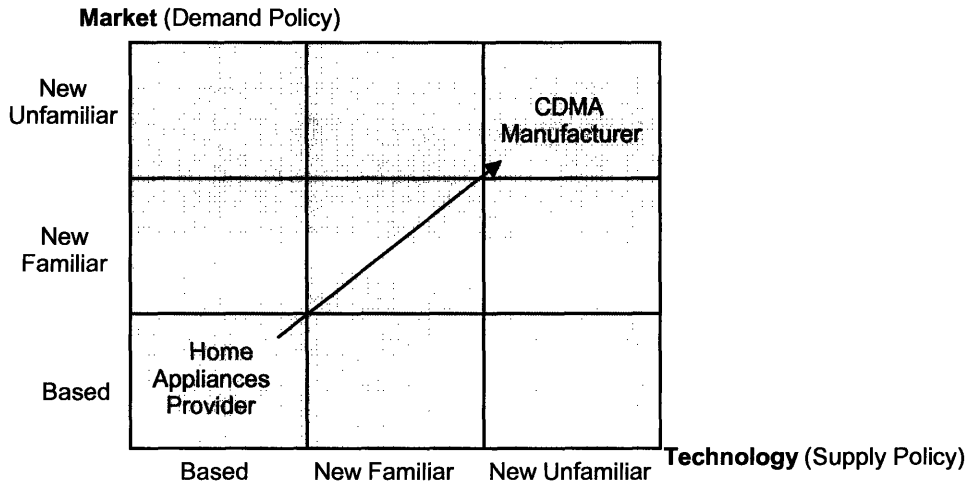

Figure 3.2 The CDMA Familiarity Matrix

The first barrier was technology. The Korean government's wireless policies had tended to discourage the public from enjoying wireless services until the late 1980s because of concern about possible eavesdropping from the North Korean regime. Such a strict regulation made Korea's commercial wireless technology obsolete.

Thus, Korea had no choice but to decide to import a fundamental mobile telecommunication technology, code division multiple access (CDMA), from Qualcomm, an American company. Some experts, who insisted on adopting global system for mobile communications (GSM) or time division multiple access (TDMA), criticized the

government's decision. They argued that the CDMA technology was not commercialized at all in any country at this time, i.e., CMDA was not a proven technology.

According to "CDMA Development and Commercialization" by Chun S. Park (2005), Electronics and Telecommunications Research Institute (ETRI) contracted a CDMA license with Qualcomm in 1992. This contract resulted in readily diffusing CDMA technology to private manufacturers. ETRI launched R&D projects to develop both CDMA equipment and cell phones with Samsung, LG, Hyundai, and Pantech. These Korean companies succeeded in commercializing CDMA services in 1996. They were able to occupy the domestic market rapidly, and stepped out toward the international market gradually.

The second obstacle was the market. The MIC literally created a training market for Korean firms by adopting a relatively new digital technology, CDMA, as its second generation (2G) digital mobile service. This market enabled Korean companies to sell their initial cell phones without strong rivals such as Nokia and Motorola because Korea was the only country besides Hong Kong to adopt CDMA technology at this time. In addition, this exclusive market helped Korean firms to accumulate marketing experience, which in the future became a crucial weapon in competing with international rivals. With this marketing experience, the Korean firms were capable enough of developing their own brand names such as Samsung "*Anycall*" and LG "*Cyon.*"

Korean companies fully digested CDMA technology through the domestic and international markets; their world market share of CDMA handsets has accounted for more than 50 percent since 1998. As a result of the success of CDMA, Korean CDMA manufacturers diversified their position to the GSM market, which is much bigger than

the CDMA market. According to the Roberts and Berry's Familiarity Matrix, the GSM fell into the *new familiar* category for the Korean CDMA manufacturers. The CDMA experience made the Korean companies strong enough to compete with foreign GSM manufacturers without such government supports.

According to "Achievement and Expectation of the Mobile Telecommunication Industry" of the MIC (2003), the export volume of GSM handsets has surpassed that of CDMA since 2000. In 2002, the Korean manufacturers' world market share of both CDMA and GSM cell phones rose to 26.5 percent that year. The innovation of the cell-phone case has been a typical example for both the Korean government and private entrepreneurship in the 1990s.

3.3 Common Factors of the Success Projects and Emerging Mismatches

There are several outstanding similar factors involved in the two projects, as shown in Table 3.1. The most important common factor making those projects successful was the perfect match between supply policies and demand policies, i.e., developing technologies and creating a market for these technologies. Another factor was the driving force of the government in maximizing utilization of limited domestic resources. These two policies and government leadership can be compared to a two-wheeled cart and its puller. The size of these two wheels should be the same; the rotating direction and rotating speed of these wheels should be the same, too; the puller of the cart should have confidence when pulling the cart.

In addition, the rapid change in information technology (IT) was also a factor in making these projects succeed. Radical technology-transition periods such as that from

analog to digital, where there is no backward compatibility, can be an opportunity for latecomers to catch up with advanced companies. Even firms in developed countries had to develop new products from the ground level. Thus, firms in developing countries could start projects at the same time as incumbent advanced companies without accumulated technologies.

Table 3.1 Comparisons of Korea's TDX and CDMA Cases

		TDX	CDMA
Periods		1980s	1990s
Aims		Substituting imported goods and Exporting	Substituting imported goods and Exporting
Technology Trends		Analog → Digital Selecting future digital technology	Analog(1G) → Digital (2G) Selecting future digital technology
Technology Source		Reverse engineering Engineers having worked in the US Domestic R&D	Licensing technology Domestic R&D
Marketing	Domestic	Creating a market by coordinating local purchase	Creating a new market with a novel US technology
	International	Utilizing foreign assistance programs	Utilizing inter-government meetings

In spite of these successes, the Korean government has recently questioned the effectiveness of its current technology policies. As the WTO emerged and Korean companies quickly grew, the Korean government had difficulties in designing well-working technology policies. The government began to feel a mismatch between its technology policies and the demands of private companies. For example, in the past, Korean companies had asked the government to make a new exclusive market for their

initial products through governmental procurement. However, the government could no longer do this, since that would violate international rules for member countries of the WTO. Furthermore, according to a recent Korean Ministry of Finance and Economy report "Analysis on the Productivity of the Korean R&D" (2006), although Korean R&D investments have continuously increased in quantity, these R&D investments do not contribute to the Korean industrial growth efficiently. This contribution of Korean R&D is very low, only 10.9 percent compared with 40.2 percent in the United States. Many Koreans still think that the government has to coordinate all the industries. In reality, the Korean government has had difficulties in finding the contact points with Korean companies.

Thus, some argue that government should not intervene in private business and should let companies make their own decisions according to market and technology trends, since government policies cannot follow the speed of the market and technology. They also criticize bureaucratic slowness along with its occasional tendency toward overly hasty changes. On the other hand, in spite of the bureaucracy, government policies are still necessary as long as the policies are implemented at the right time and in the right direction.

4. Challenges of Korean Technology Policies

This chapter analyzes challenges that the Korean government has been confronted with when designing technology policies. The Korean government faces challenges mainly in three areas. The first challenge arises from external factors such as the effects of globalization and dynamic relationships with neighboring countries Japan and China.

These two countries and the United States are the most important trade partners for Korea. In fact, Korea has been sandwiched between Japan's high-tech products and China's commodity products. The second challenge comes from internal factors such as the globalization of Korean companies. Some of these companies are more closely linked with international markets than with domestic markets. Thus, they have become more independent of governmental influences. The third challenge is a scarcity of fundamental technologies in electronic materials. Korea must still import many electronic materials such as semiconductor substances, insulator substances, dielectric substances, and magnetic substances.

4.1 Acceleration of Globalization

Globalization can be defined as an economic phenomenon in which economic activities of a country extend beyond its borders. The World Bank (2000) states that modern globalization has been happening since the end of the nineteenth century and has facilitated the growth of the world economy by promoting free trade in the world. The factors helping globalization can be said to be development of transportation and advancement of telecommunications as well as the establishment of legal frameworks such as the World Trade Organization (WTO).

Even though the WTO system could give export-oriented Korean companies a bigger market, the WTO system has coerced Korea to remove its traditional technology policies that are closely coupled with private companies. According to Chung and Branscomb (1996), in their article "Technology Transfer and International Cooperation," government policies such as industrial subsidies and protection programs against foreign

goods may be in violation of WTO rules. They point out that learning through imitation and reverse engineering from advanced countries' products will not be useful any more under the WTO system. They also insist that the Korean government should now reassess its assistance programs so as not to violate new international trade agreements stipulated in the General Agreement on Tariffs and Trade (GATT). Lastly, they recommend that the Korean government emphasize basic or academic R&D (p. 222~225).

As a result of these changes, the Korean government sometimes wonders how to implement technology policies that promote domestic industries without international conflicts. Hae K. Jung (2004) says that Korea had filed 11 disputes and 11 disputes against Korea had been filed by trade partners to the WTO as of October 2004, as shown in Table 4.1. In fact, most of the trade strains have been found in semiconductors, mobile phones, automobiles, shipbuilding, and steel industries, which are very typical Korean export products.

Table 4.1 Korea's Disputes in the WTO as of October 2004

	Panel/Appellate Body			Consultations		Total
	(Partial) Won	Lost	Pending	Finished	Pending	
Filing	5	0	3	2	1	11
Being filed	1	3	1	5	1	11
Total	6	3	4	7	2	22

Source: Negotiations to Reform the WTO Dispute Settlement Processes, Hae K. Jung (2004)

Furthermore, when Korea imitated or assimilated foreign technologies in the 1960s, 1970s, and 1980s, Korea learned technologies by studying the United States or

Japanese models. However, having started to innovate technologies without references since the 1990s, it has become harder for Korea to understand technology trends.

4.2 Changes in Manufacturing Production Processes

Changes in production processes refer to detaching manufacturing functions from integrated production processes of manufacturing companies. In the past, manufacturing companies directly operated all the production processes from R&D to marketing within the same companies. However, big computer companies such as IBM started to change their production processes by separating the factory process from their production processes. Particularly, IT companies have shown a strong tendency in outsourcing manufacturing facilities. These companies wanted to focus on R&D and marketing and tried to minimize risks in maintaining factories because of IT products' short lifespan.

Globalization has also helped IT companies, which are looking for low-wage workers and low-priced real estate abroad, to separate their factories from their traditional production processes. By outsourcing manufacturing functions, companies in developed countries can concentrate on more specialized value-added work such as R&D, design, and world marketing. On the other hand, companies of developing countries have a chance to grow as sub-contractors or original equipment manufacturers (OEMs) by taking the manufacturing function from advanced companies.

According to "Electronics Manufacturing Service Strategy of Advanced Firms" of Gun D. Kim (2001), American IT companies that gave up manufacturing began to appear in the 1990s. Such changes enabled start-up firms having ingenious business ideas to enter the market relatively easily. Also, these changes triggered the birth of electronics

manufacturing services (EMS) that are specialized in making electronic goods. Kim emphasizes that excellent manufacturing capability does not guarantee the countries' competitiveness any longer because manufacturing technologies tend to be commoditized.

As shown in Figure 4.1, the value of R&D and marketing in the IT production processes is high while the value of manufacturing is low. For the same reason, advanced IT companies in the United States heavily utilize EMSs to minimize investment risks in maintaining factories.

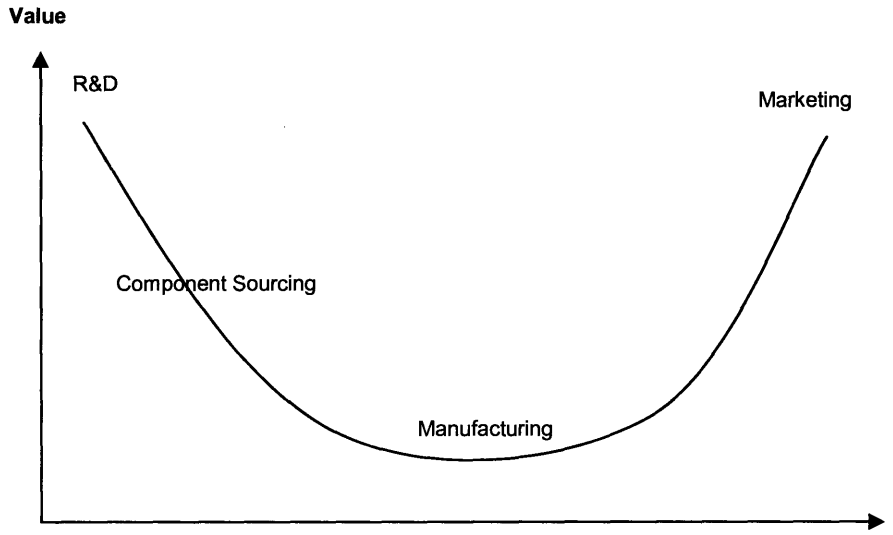

Figure 4.1 The Value Changes in Production Processes

Source: Japan Science and Technology Institution (2001)
(Cited from EMS Strategy of Advanced Firms, Gun D. Kim)

For example, IBM, HP, and CISCO have been slimming their manufacturing departments by contracting with EMSs such as Solectron[2], a US EMS company that has 48 factories all around the world. Kim also insists that 60~80 percent of electronic goods will be

[2] Solectron has factories in Japan and in China but not in Korea.

produced by EMS factories located in developing countries in the near future. Thus, strong Korean manufacturing competitiveness might disappear in the future.

However, Korean technology policies have still mainly focused on helping to increase a company's manufacturing capability because the manufacturing industries have been responsible for Korea's economic development. According to an OECD report (2002), the Korean manufacturing industries accounted for a high portion of the GDP, 34.5 percent, compared with the other members, for example, 23.5 percent for Japan. Therefore, the major questions of the Korean technology policy have been usually first, what do we have to make -- for example, digital TV sets, thin film transistor (TFT) displays, home-network systems, and intelligent robots[3] -- and second, how can we make them fast, good, and cheap.

Now, the Korean government should shift its R&D targets to creating basic intellectual properties, promoting standardization activities, and assisting in novel entrepreneurships instead of focusing on helping private companies to upgrade their manufacturing skills.

4.3 Changes in Competitiveness of Neighboring Countries

Economically, the total economic size of Korea, Japan, and China is responsible for approximately one-fifth of the world economy, which is comparable to that of NAFTA and the EU. In terms of GDP, Korea Institute for Industrial Economics and Trade (2005) says that Japan is ranked second in the world; China seventh; and Korea eleventh in 2004. Regarding electronic industries including the IT industry, the

[3] According to the next generation Korean growth engines of the Korean Presidential Advisory Council for Science and Technology (2003)

production of electronic goods in this region accounted for 27.6 percent of the world production in 2000, according to Jung M. Gho (2001) (p. 3). Korea, Japan, and China have occupied a large portion of the world economy.

With respect to industrial cooperation among the three countries, Korea has provided high-intermediate technologies and capital in this region; Japan has provided high technologies and capital; China has provided low-wage workers, markets, and factories. Evidently, complementary cooperation between Japan and China is stronger than any other combination, for example, the cooperation between Korea and China. In spite of this inferior Korean combination with China, Korean investments in China have been increasing rapidly, as shown in Table 4.2.

Table 4.2 Korea's and Japan's FDI to China (Unit: US $ Billions)

Year	Korea	Japan
1990	0.01	0.05
1995	1.04	3.11
2000	1.49	2.92
2001	2.20	4.35
2002	2.72	4.19
2003	4.49	5.05

Source: Ministry of Commerce of the People's Republic of China (english.mofcom.gov.cn)

Furthermore, the relative competitiveness of the neighboring countries has begun to change. Japan, which used to be a model for Korea, now regards Korea as its competitor. Having ambition to become a technology leader, China is catching up with

Korea and Japan quickly. In fact, Korea's intermediate technology is almost surpassed by that of China. In the high-technology area, Korea might be surpassed by China in five years. According to "Analysis on Technology Competitiveness of Korea, Japan, and China" of the Federation of Korean Industries (2003), Korea is behind Japan by 3.36 years in industry technology; Korea is ahead of China by only 3.08 years, as shown in Table 4.3.

Table 4.3 Comparisons on Technology Competitiveness of Korea, Japan, and China (Unit: Percent, Korea=100)

	Total	Design	Materials	Components	Assembly	Process Management	Developing Speed	Gap (year)
Japan	125	126	126	123	122	124	121	3.36
China	80	78	78	79	82	79	94	-3.08

Source: Federation of Korean Industries (2003)

Thus, before Korea surpasses Japan, China might surpass Korea. If China should excel at the level of Korean technology, the competitiveness of Korean industry will vanish from the world markets.

In addition, since China gained access into the WTO in 2001, Korea has had to prepare for severe competition with Chinese low-priced products in the domestic market as well as in the world market. Meanwhile, Korea may be faced with a variety of trade disputes over intellectual property rights (IPR) with Japan, unless Korea fosters domestic R&D capabilities.

Ultimately, the WTO system tends to increase the degree of competition among Korea, Japan, and China. As shown in Table 4.4, China's growth can be partly interpreted as Korea's stagnation and Japan's shrinking in the US market, the most

important exporting market of these three countries. If Korea wants to catch up with Japan while maintaining the gap with China, the Korean government should endeavor to find new technology strategies to make Korea well-matched between the neighboring two big powers, Japan and China.

Table 4.4 Market Share in the US for Korea, Japan, and China (Unit: Percent)

Year	1988	1990	1995	1997	2000	2001	2002
Korea	4.6	3.7	3.3	2.7	3.3	3.1	3.1
Japan	20.4	18.1	16.6	13.9	12.0	11.0	9.6
China	1.9	3.1	6.1	7.2	8.2	10.8	11.0
Total	26.9	24.9	26.0	23.8	23.5	24.9	23.7

Source: Korea International Trade Association (www.kita.net)

4.3.1 Difficulties in Learning from Japan

To find a short cut to become a member of a technologically leading group, Korea has studied Japanese cases as practical models since the 1960s. As a result, industry patterns and corporation structures of Korea are very similar to Japan's. For example, like Japan, Korea has giant corporations -- which are called *chaebols* -- vertically integrated corporations, and Korea has full-ranged domestic industries from agriculture to high-tech industry.

However, as Japan suffered from a long recession in the 1990s, Japan began to lose its strong competitiveness in the manufacturing technology that was an engine for the Japanese economic growth. Furthermore, the Japanese high technologies have been challenged by Korea. As a result, Japan has been less likely to transfer technology to

Korea. According to a survey conducted by the Korea-Japan Economic Association (2003), Korean companies complained that more than ninety percent of the Japanese technologies, which Japan sold to Korea, were either outdated or already popularized in the West. On the other hand, Japanese companies complained about Korea's strong desire for technologies.

In spite of the difficulty in importing technologies from Japan, Korea has no choice but continuously to import industrial materials as well as factory machinery from Japan. This importation is a core reason for the huge deepening Korean trade deficits with Japan, as shown in Table 4.5. In addition, this dependence on Japanese materials and machinery also makes competitiveness of Korean companies weakened against Japanese companies in the international market.

Table 4.5 Korea's Trading Statistics with Japan (Unit: US $ Millions)

Year	94	95	96	97	98	99	2000	2001	2002	2003	2004
Export	13,523	17,049	15,767	14,771	12,238	15,862	20,466	16,506	15,143	17,276	21,701
Import	25,390	32,606	31,449	27,907	16,840	24,142	31,828	26,633	29,856	36,313	46,144
Total Trade	38,913	49,655	47,216	42,678	29,078	40,004	52,294	43,139	44,999	53,589	67,845
Balance	-11,867	-15,557	-15,682	-13,136	-4,602	-8,280	-11,362	-10,127	-14,713	-19,037	-24,434

Source: The Korean Ministry of Foreign Affairs and Trade (www.fta.go.kr)

In addition, the Japanese government has emphasized protecting Japanese intellectual property (IP) against foreign piracy. The Japanese government strongly executes its IP protection policies against imitation and reverse engineering in developing countries. According to Woo J. Kim (2004), Japanese companies try to make high-tech

intermediate components as a black-box module in order to hide their core technologies from reverse engineering. Thus, it has become almost impossible for Korea to learn core technologies from Japan.

4.3.2 Emerging China with Unique Technologies

It has been fourteen years since Korea normalized diplomatic relations with China in 1992. Before 1992, for political reasons China had diplomatic relations with North Korea exclusively in the Korean Peninsula. However, trade between Korea and China has explosively expanded, as shown in Table 4.6. Korean companies have been able to advance into the vast Chinese market, while China has benefited from Korean companies by obtaining the capital, technology, and experience needed to further develop the Chinese industries.

Table 4.6 Korea's Trading Statistics with China (Unit: US $ Millions)

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Export	6,203	9,144	11,377	13,572	11,944	13,685	18,455	18,190	23,754	35,110	49,763
Import	5,463	7,401	8,539	10,117	6,484	8,867	12,799	13,303	17,400	21,909	29,585
Total Trade	11,666	16,545	19,916	23,689	18,428	22,552	31,254	31,493	41,154	57,019	79,348
Balance	740	1,743	2,838	3,455	5,460	4,818	5,656	4,888	6,354	13,201	20,193

Source: The Korean Ministry of Foreign Affairs and Trade (www.fta.go.kr)

China has sustained energetic growth in its economy at an annual rate of 7~8 percent since the late 1990s. In 2003, China became the world's fourth largest trading country after the United States, Germany, and Japan. China has now emerged as one of

the leading world economies by utilizing its potential market, the third largest market in the world and the biggest one in Asia. In addition, China is expected to be the market for Asian developing countries instead of Japan.

Until the mid 1970s, China was influenced by the former Soviet Union to emphasize heavy industry in order to raise military power. According to Pingyao (2003), although China had a communist organized economic system, China announced that it would "Reform and Open up to the World" in 1978. The Chinese government adopted a strategy to foster its manufacturing industries, which has contributed to China being today the "world factory." As shown in Table 4.7, China has induced foreign direct investments (FDIs) to get capital and technologies. To realize this strategy, the socialist Chinese government established many foreign-favored policies, for example, tax incentives, financial assistance, and factory-land assistance. As a result, China has been solidified as the world's manufacturing foundation.

Table 4.7 FDIs to China (Unit: US $ Billions, Percent)

Year	79-85	86-90	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Capital	4.2	14.2	4.3	11.0	27.5	33.7	37.5	41.7	45.2	45.4	40.3	40.7
Rate	-	-	25.2	152.1	150.0	22.7	11.1	11.2	8.5	0.5	-11.1	0.9

Source: China, Ministry of Foreign Trade and Economic Cooperation (2001)

Although these FDIs have been major sources for developing Chinese technologies, the Chinese government came to recognize the limitation of technological growth through FDIs. In addition, the Chinese government has been concerned about the domestic market being dominated by foreign technologies. For these reasons, the Chinese

government has been trying to develop its unique technologies to compete with advanced foreign companies in the domestic market.

The Chinese government has begun to make national standards with its own technology particularly in the IT industry. According to "China's Post-WTO Technology Policy" of Richard P. Suttmeier and Yao Xiangkui (2004), China has been promoting its own technical standards to support national interests, for example, WLAN Authentication and Privacy Infrastructure (WAPI) standard in 2003 for wireless local area network (WLAN) security, and the TD-SCDMA (Time Division - Synchronous Code Division Multiple Access) standard in 2006 for third-generation mobile telephone services.

This Chinese situation makes it more difficult for Korea, which has usually adopted the US or Japanese technologies, to select technologies. As China has emerged as Korea's first largest export market since 2003, Chinese technology policies, particularly standard technology, directly affect relevant Korean industries. Thus, the Korean government should consider the Chinese standard policy regarding Korea's export to China.

4.4 Growth of Korean Companies

Korea launched its economic development plans in 1962 when it was one of the poorest countries in the world. After forty years, Korea placed its economic position at twelfth in the world. In the 1980s, the Korean companies dashed out to the world economy particularly after the Seoul Olympic Games in 1988.

Big Korean companies have been eager to expose themselves to the world market with their own brand names. In the mid 1990s, in spite of opposing opinions from the

financial sector, the Korean government reiterated its desire to be the second country after Japan in Asia to become a member of the Organization for Economic Cooperation and Development (OECD). As a result of joining the OECD in 1996, Korean companies were able to do their businesses in the world market more freely without governmental interventions.

In spite of the Asia Economic crisis in 1997, some Korean companies such as Samsung, LG, and Hyundai were able to succeed in having their own brand names known world wide. These companies came to regard the international market more crucially than the domestic market. As shown in Table 4.8, Samsung, LG, and Hyundai all have high proportion of their sales and assets abroad. Samsung became not only a verically integrated company in Korea but also a globally well organaized company.

Table 4.8 The International Activities of Major Korean Companies

	Sale (US $ Billions)			Asset (US $ Billions)		
	Total	Abroad	Abroad/Total	Total	Abroad	Abroad/Total
Samsung Electronics	43.6	34.2	78.5 %	41.6	3.8	9.2 %
LG Electronics	20.2	15.4	76.2 %	20.3	11.5	56.9 %
Hyundai Motors	25.0	14.3	57.4 %	33.2	3.2	9.7 %

Source: Business Report of Each Company, UNCTAD, World Investment Report (2003)
(Cited: Strategy of Enhancing Korean Entrepreneurship, Jong N. Kim)

This situation means that these companies might be sometimes reluctant to follow government directions, if the governmental direction did not match with their world business strategies. In addition, since the beginning of the 2000s, Korean companies have emerged as key players in domestic R&D activities by investing more funds than the

government. They have accounted for more than seventy percent of total Korean R&D activities, according to Man K. Lee (2004). The big Korean companies have the ability to decide their technology plans by themselves. It has become increasingly difficult for the Korean government to coordinate R&D strategies with private companies to maximize the effects of technology policies.

When Korea imitated foreign technologies, the technology capability of an individual Korean company was small. Such a company was not deeply interlinked with the international market. Thus, the Korean government relatively easily coordinated private firms' technology orientations. The Korean government could maximize a vector summation between each company's technology direction and governmental policy direction, as it did with supply and demand policies in the past. However, as companies became large, being coupled with foreign influence, the government could almost not maximize the vector summation with each private player within its territory.

For example, in the second generation (2G) of the mobile system, all the Korean companies followed governmental guidelines. They had chosen CDMA standards, in spite of some opposing opinions. However, in the third generation (3G), some companies had preference to cdma-2000, others W-CDMA. In this time, the Korean government failed to make one technological specification for its 3G cell-phone standard. As a result, the Korean government had difficulties in implementing technology policies based on mutual interests among private companies.

4.5 Scarcity of Electronic Materials

In spite of these changes analyzed above, there is one thing that does not change

at all. This constant factor is the lack of fundamental technology resulting in licensing core technologies and importing industrial materials.

Korea's technology strategies intently focused on making final products, meaning that Korea has imported both industrial materials and core components, which are hard to develop in a relatively short period. For example, Korean semiconductor companies have imported 300mm silicon wafers, and made and exported memory chips such as RAMs. As a result, Korea saved time in building its manufacturing industries but lost an opportunity to develop fundamental technologies stemming out of industrial materials.

In fact, quite a number of fundamental technologies come out in the process of researching materials. Many basic R&D programs are needed to make pure material in a reasonable size and to verify the quality of the material. These technologies related to this process themselves usually become fundamental technologies.

According to "*Gamawoojee* Economy" by Chul Y. Lee (2006), Korean electronic industries have been heavily dependent on Japanese materials and core components. For example, during 2000~2005, Korea has accumulated huge trade deficits with Japan (US $103.9 billion) where materials and components accounted for 76.4 percent (US $79.4 billion). In addition, high-tech products tend to be more dependent on Japanese materials; for example, semiconductors (78.8 percent), TFT-LCDs (67.7 percent), wireless communication gadgets (66.8 percent), and computers (50.9 percent).

In fact, Korea did not have room to develop such electronic materials, because it took several decades to develop basic materials for industrial purposes. Korea has no time to wait for output of basic R&Ds. By importing materials, Korea is able to save time;

however, its industrial competitiveness becomes weak at a certain point. This situation will make it more difficult for Korea to compete with developing countries in the future.

5. Emphasized Technology Policies for the Future Korea

This chapter represents three policy recommendations for the Korean government based on the analysis from previous chapters: 1) the Korean government should foster entrepreneurs to create new IT businesses, 2) the Korean government should keep pace with the United States regarding novel technology development and learn from Japan regarding globalization experiences, and 3) the Korean government should focus its R&D funds on making electronic materials to enhance competitiveness of domestic IT companies.

5.1 Fostering Entrepreneurship

Korea has been dependent on big conglomerates in sustaining its competitive entrepreneurship. According to the Korea Chamber of Commerce and Industry (2005), in the 1970s, Korean entrepreneurship was very high owing to national economic development plans. This entrepreneurship developed in the capital-intensive industries, such as electronics, steel, shipbuilding, and automobiles.

Over time, traditional Korean entrepreneurship became low. In the wake of the economic crisis in 1997, Korea had new experiences with entrepreneurship in the IT industry that were expected to be responsible for one part of Korean economic growth. However, Korea could not connect this start-up entrepreneurship with sustainable economic growth.

There were mainly two sources of the entrepreneurs. The first entrepreneur group came from current companies that restructured their employees. The other group came from universities. Although the latter group had good ideas, this entrepreneur group did not know how to succeed in business. Because of not having ideas or business experiences, unfortunately, many entrepreneurs could not survive in the real business world. After the venture boom in 2001, as shown in Table 5.1, this entrepreneurship plummeted and was blamed for a variety of corruption. This phenomenon demonstrates absence of preparation for new entrepreneurship based on ideas or novel technologies in Korean society.

Table 5.1 The Number of Korean Start-up Firms (Unit: Number)

Year	1998	1999	2000	2001	2002	2004.4
Number	2,042	4,934	9,827	11,392	8,778	7,607

Source: The Small and Medium Business Administration (www.smba.go.kr)

According to the Korean Science and Technology Institute (2004), Korea has many creative people, but the social atmosphere would not adopt their new ideas. Some Korean venture capitalists constantly asked creative entrepreneurs to reference models because of Korea's experience following the best practices. In addition, most relevant laws were designed for traditional small and medium sized enterprises (SMEs) that are subordinates of big companies.

In the light of these issues, the Korean government should nurture entrepreneurship that may contribute more to the Korean economic growth than big

companies will in the future. The Korean government should restrain itself from intervening in private businesses while raising entrepreneurs who understand both globalization and technology trends. Considering the lessons from the entrepreneur failures in the late 1990s, well-qualified business education programs are needed for inexperienced entrepreneurs. In fact, everyone can have a business idea; however, making it into a real business is a totally different story.

Thus, the Korean government should promote its educational institutions developing management courses for mid-career people, especially those who have a technological background. The Korean government should encourage its young entrepreneurs to go abroad to get knowledge and establish human networks, rather than attract foreign R&D centers. In addition, the Korean government should abolish barriers between businesses, for example, the barriers between telecommunication and broadcasting. The Korean government should draw an outline for new industries by abolishing barriers in its regulation systems and then encourage its ingenious people to create business. Both are very important to advance in the future.

5.2 Pacing with the United States in Technology Developments And Learning Globalization from Japan

Many developing countries have tried to learn technologies from developed countries. In fact, there is a fundamental question in their catching-up strategies: which technology should a country learn or follow? Because there are several alternatives, selecting technology is not simple for developing countries to connect with their

industrial performance. If a developing country misses the right technology, the country will lose a chance to catch up and waste its few valuable resources.

When selecting technology, a country should deliberate on incumbent competitors, market size, intellectual property right (IPR) ownership, and standards trends. For example, regarding mobile telecommunication technologies, there are three major second generation (2G) technologies: GSM, TDMA, and CDMA. If a country chooses GSM technology, its cell-phone manufacturers might compete with the number one cell-phone maker Nokia, and they might have to pay royalties to Nokia; however, they have a chance to enter the biggest cell-phone market.

Although there are many competitors and royalties, Korea usually selects US technologies in order to enter the large US market. As a result, Korean technological standards tend to be established by following the US standards, such as Advanced Television Systems Committee (ATSC) for digital TV. However, in 2003, China emerged as the biggest export market for Korea. Furthermore, China started to make its own standards with domestic technologies. The Chinese government has also encouraged its institutes to develop its own standards. According to Suttmeier and Xiangkui (2004), Chinese industrial leaders often state that "third-class companies make products; second-class companies develop technology; first-class companies set standards."

However, the Chinese WLAN Authentication and Privacy Infrastructure (WAPI) standard might induce trade disputes between China and its major trade partners especially the United States, because WAPI could be used as a technical barrier to trade. The United States has also emphasized technical compatibilities with either international standards or the US technologies. For example, the Korean "Wireless Internet Platform

for Interoperability" (WIPI) standard -- a Korean unique technology for downloading software applications from the Internet onto cell phones -- was a big trade dispute between Korea and the United States. The Korean WIPI case is very similar to the Chinese WAPI case in terms of national uniqueness. The United States was very concerned about the Korean WIPI case being a precedent to deal with similar issues in China. On this, United States Trade Representative Robert B. Zoellick (2004) said, "This week marks a number of key trade successes for the United States high tech industry. China took a significant step in embracing technology neutrality in its telecom policy. Based on the deal we reached with Korea, American telecommunications companies can now be assured of unimpeded access to this important market. American businesses and workers will continue to provide cutting-edge products and services to the growing Asian market."

In addition, a new technology itself cannot guarantee business success in the world market. Even, some excellent Japanese technologies failed in the world market, for example, hi-vision for HDTV and personal handy-phone system (PHS) for mobile telephone. The Korean government, therefore, should be very cautious when developing its original technologies or devices. The United States has been very good at controlling emerging businesses that have novel technologies. Thus, Korea should reference a country that has the ability to create a new world market with a new technology. For this reason, the Korean government should keep pace with the United States in terms of IT trends. In addition, Korean companies should actively discuss technology development with the United States companies.

In addition, some Korean experts have argued since 2000 that Korea no longer has anything to learn from Japan, and Korea should learn from European countries or the United States directly. However, Korea still has much to learn from Japanese experiences especially since the 1990s. Korea should study Japanese globalization, i.e., how Japan has changed its economic structure, how Japan has changed companies' structure, and how Japan has prepared for its aging population. For example, Sony, which was a strongly vertically integrated company, is trying to change its structure to cope with globalization trends. Currently, Samsung and LG are relatively successful. However, in two or three years, they will be confronted with the same challenges that Sony is facing. There might be answers in the Japanese experiences. Therefore, Korea should still learn from Japanese cases and study implications of the Japanese technology policies.

5.3 Developing Electronic Materials for Basic R&D

An industrial material is not only directly related to fundamental technologies but also is a starting point to create values in any industry. Industrial materials are made into a variety of components. These components are also assembled into a variety of final products. Therefore, the quality of final products directly depends on the quality of materials. For the same reason, electronic materials are one of the key bases of the IT industries.

According to Sang G. Lee (2004), when materials are changed into components, new value is created. The average price of the components is about ten times higher than the price of the materials. In addition, when components are assembled into final products, the average price of the products is also about ten times higher than the price of

the components. Therefore, when materials shift to final products, their value increases one hundred-fold, according to Sang G. Lee's "the hundred times material law on creating value" in the material industries. Therefore, if a country manufactures materials, it can reap significant benefits. A country that has good material industries can easily promote components industries resulting in enhanced competitiveness of final products.

However, Korea currently has weak material industries. As a result, Korea has no choice but to constantly buy most industrial materials from foreign countries, particularly Japan. Korea has been unable to develop material technologies thus far, because materials are directly linked with basic R&D activities. In the past, Korea could not afford to encourage basic R&D. However, present-day Korea can invest in basic R&D to secure its industrial competitiveness. Also, Korea has big manufacturing companies that can provide potential material companies with a stable market. By using the demand of domestic manufacturing companies, the Korean government should design long term, at least ten-year, basic R&D projects to make essentially needed electronic materials. If Korea succeeds in promoting material industries, these material industries will become a very important tool to upgrade the Korean competitiveness versus Japan and China.

6. Conclusion

The Korean government has been executing a variety of technology policies based on its capital capability, human capability, and company capability over time. Japan started its technology policies during the Meiji Restoration (1825-1868), and the Japanese government's comprehensive technology policy enabled Japan to become the

first developed country in Asia. China has also been eager to become a leading country based on the Chinese government's master plans since the 1970s.

Through their long history, Korea, Japan, and China exchanged many technologies in such areas as in ceramics, paper, and printing. Until the sixteenth century, generally, technology transfer among the three countries was unilaterally flowing from China via Korea to Japan (sometimes from China to Japan directly). In 1592, a big historic event that might have affected this technology flowing broke out: Japan invaded Korea to obtain a path to China. Through this war, tremendous technology exchanges happened in this region. After the war, Korea and China gradually experienced their national power shrinking. Ultimately, Korea was colonized by Japan in 1910, while Japan became a technologically advanced country. Through such historical events, the Korean government has realized how technology is important to keep its own position between such strong neighbors.

However, with the new international rules of the WTO and rapid globalization of Korean companies, the Korean government has had difficulties in designing effective technology policies since the 1990s. Furthermore, Korea has been sandwiched between Japan's high-tech products and China's commodity products. In spite of these situations, many Koreans still think that the government has to coordinate all the industries like a well-tuned orchestra against international pressure. In reality, the Korean government is confronted with many challenges from both inside and outside of its territory.

Therefore, it is time for Korea to upgrade its technology policy scheme as well as to reform some of its bureaucratic attitude. With regard to the technology policy scheme, the Korean government should encourage entrepreneurs, particularly when they fail at

innovative business. The Korean government should look to US technology trends and study Japanese experiences including failure cases. The government should also secure its material industries through basic R&D programs. In addition, with regard to reforming bureaucratic attitudes, the Korean government should eradicate its impatience for results and the redundancy in R&D evaluation systems. The Korean government should no longer project confusing attitudes, for example, the tendency to demand creative and innovative solutions while remaining attached to previous models.

By executing these new policies and reforming bureaucratic attitudes, Korea can carefully maintain its competitiveness and find its place with regard to the two big powers of Japan and China. Otherwise, Korea may fall behind as a marginal country alienated from the leading economic powers of the world and repeat its old history again.

Appendices

1. Cooperation Cases among Korea, Japan, and China

- The ministry level meeting on information telecommunications (August 1996)
- Economic organizations' meetings to discuss industrial cooperation (July 1997)
- APEC summit meeting and ministry level meetings to discuss an Asian funds (November 1997)
- Research institutions' forum to enhance regional cooperation (April 1984)
- Ministry level meeting on an environmental issue, sand winds from China (January 1999)
- Asian economic leaders' meeting to discuss a Northeast Asia cooperation (May 1999)
- Summit meeting of ASEAN+3 to discuss an East Asia meeting (November 1999)
- Summit meeting to enhance economic cooperation (November 1999)
- e-Commerce leaders' meeting to establish a hub site for e-Commerce (November 1999)
- Financial leaders' meeting to discuss currency exchange rate (February 2000)
- Assembly leaders' meeting to discuss establishment of regular meetings among Korea, Japan, and China (September 2000)
- IT standard leaders' meeting to cooperate IT standards activities (May 2002)

Source: The Korean Ministry of Information and Communication (www.mic.go.kr)
The Korean Ministry of Science and Technology (www.most.go.kr)
The Korean Ministry of Commerce, Industry and Energy (www.mocie.go.kr)
The Korean Ministry of Environment (www.me.go.kr)

2. A Brief History of Korean Science and Technology Policy

Period	Industrialization	Technology Policies
1960s	▫ Develop import-substitution industries ▫ Expand export-oriented light industries ▫ Support goods producer	▫ Strengthen S&T education ▫ Deepen scientific and technological infrastructure ▫ Promote foreign technology imports
1970s	▫ Expand heavy and chemical industries ▫ Shift emphasis from capital import to technology import ▫ Strengthen export-oriented industrial competitiveness	▫ Expand technical training ▫ Improve institutional mechanism for adapting imported technology ▫ Promote research applicable to industrial needs
1980s	▫ Transform industrial structure to one of comparative advantage ▫ Expand technology-intensive industry ▫ Encourage manpower development and improve productivity of industries	▫ Develop and acquire top-level scientists and engineers ▫ Launch the national R&D projects ▫ Promote industrial technology development and industrial labs
1990s	▫ Promote industrial structure adjustment and technical innovation ▫ Promote efficient use of human and other resources ▫ Improve information networks	▫ Reinforce national R&D projects ▫ Strengthen demand-oriented technology development system ▫ Globalize R&D systems and information networks

Source: the Korean Ministry of Science and Technology (www.most.go.kr)

3. Korean Technology Imports and Exports

Korean Technology imports began by enacting the "Foreign Capital Inducement Law" in 1962. Imported technologies played a vital role in the industrialization process in the 1960s and 1970s. From 1962 to 1995, Korea imported 9,526 cases of technologies, for which Korea has paid US $11,130 million as royalties.

▫ Technology Imports from 1962~1995 (Unit: Number, US $ Million)

	The U.S.	Japan	Germany	France	The U.K.	Others	Total
Cases	2,682	4,568	540	379	368	989	9,526
Royalty Payments	5,441	3,621	479	378	229	982	11,130

Source: the Korean Ministry of Science and Technology (www.most.go.kr)

Korea exported its technologies during the period from 1987 to 1995 amounted to 661 cases. The major exporting technologies are oil refinery and chemical technologies, electric and electronic technologies, mechanic technologies, ceramic technologies, and drugs. The royalties from technology exports amounted to US $483 million during the same period.

▫ Technology Exports from 19973~1995 (Unit: Number, US $ Thousand)

	Saudi Arabia	Indonesia	Canada	The US	Malaysia	Japan	China	Others	Total
Cases	24	66	4	11	33	19	202	302	661
Receipt	95,353	44,859	48,809	14,747	23,770	17,178	44,591	36,414	483,222

Source: the Korean Ministry of Science and Technology (www.most.go.kr)

4. Trade Status of Korea, Japan, and China

▫ Korea's major trade partners in 2003 (Unit: US $ Billion)

Rank	Export (193.8)	Import (178.8)
1	China (35.1)	Japan (36.3)
2	The US (34.2)	The US (24.8)
3	Japan (17.2)	China (21.9)
4	Hong Kong (14.6)	Saudi Arabia (9.2)
5	Taiwan (7.0)	Germany (6.8)

▫ Japan's major trade partners in 2003 (Unit: US $ Billion)

Rank	Export (469.8)	Import (381.5)
1	The US (115.4)	China (75.1)
2	China (57.2)	The US (58.6)
3	Korea (34.6)	Korea (17.8)
4	Taiwan (31.1)	Indonesia (16.3)
5	Hong Kong (29.7)	Australia (14.9)

▫ China's major trade partners in 2003 (Unit: US $ Billion)

Rank	Export (438.4)	Import (412.8)
1	The US (92.5)	Japan (74.1)
2	Hong Kong (76.3)	Korea (43.1)
3	Japan (59.4)	The US (33.9)
4	Korea (20.1)	Germany (24.3)
5	Germany (17.4)	Hong Kong (11.1)

Source: Korea International Trade Association (www.kita.net)

Japan External Trade Organization (www.jetro.go.kr)

5. International Trade Status of Korea, Japan, and China

▫ World Market Share of Korea, Japan, and China (Unit: Percent)

	Korea		Japan		China		Total of K.J.C.	
	Export	Import	Export	Import	Export	Import	Export	Import
1998	2.5	1.7	7.2	5.0	3.4	2.5	13.1	9.2
1999	2.6	2.0	7.5	5.3	3.5	2.8	13.6	10.2
2000	2.7	2.4	7.5	5.7	3.9	3.4	14.1	11.5
2001	2.4	2.2	6.6	5.4	4.3	3.8	13.3	11.4
2002	2.5	2.3	6.5	5.0	5.1	4.4	14.1	11.7

Source: Korea International Trade Association (www.kita.net)

6. Korea's Trade with Japan and China

▫ Korea's Main Trade Goods with Japan in 2004 (US $ Millions, Growth Rate Percent)

Main Export Goods	Main Import Goods
Petroleum Chemical Products (941, 42.5%) Industrial Electronic Products (2,136, 43.4%) Electronic Parts (4,028, 8.8%) Semiconductors (3,544, 11.0%) Iron and Steel (2,193, 60.0%)	Agro-fishery products (400, 10.1%) Chemical Engineering products (7,224, 24.2%) Iron and Steel, Metal (7,483, 43.5%) Machinery (10,965, 31.2%) Electronic and Electrical Products (15,324, 14.9%)

Source: The Korean Ministry of Commerce, Industry and Energy, www.mocie.go.kr

▫ Korea's Main Trade Goods with China in 2004 (US $ Millions, Growth Rate Percent)

Main Export Goods	Main Import Goods
Electronic Parts (5,701, 58.3%) Industrial Electronic Products (9,591, 32.8%) Semiconductors (3,278, 98.3%) Computers (5,346, 45.0%) Textile (2,764, 4.2%) Iron and steel (3,838, 29.1%)	Agro-fishery products (2,480, -13.3%) Mine products (2,782, 30.9%) Chemical Engineering products (2,405, 33.4%) Textile (3,450, 10.5%) Machinery (5,936, 27%) Electronic and Electrical Products (10,665, 41.4%) Semiconductor (1,392, 33.8%)

Source: The Korean Ministry of Commerce, Industry and Energy, www.mocie.go.kr

7. Comparison on Competitiveness between Korea, Japan, and China

▫ Comparisons on Industry Competitiveness (Unit: Percent, Korea=100)

		Total	Design	Materials	Components	Assembly	Process Management	Developing Speed	Gap (year)
Automobiles	Japan	126	123	125	123	123	125	118	4.10
	China	76	73	69	73	79	74	99	-3.17
Shipbuilding	Japan	120	110	115	120	110	110	110	3.30
	China	80	75	75	85	80	90	105	-7.67
Electronics	Japan	121	124	125	120	125	125	120	2.53
	China	80	77	75	73	85	81	91	-3.06
IT	Japan	117	121	112	119	121	117	120	2.57
	China	88	83	93	92	93	91	108	-2.05
Machinery	Japan	137	138	138	138	133	125	127	3.23
	China	83	85	85	80	78	78	93	-2.78
Construction	Japan	106	106	106	106	102	104	104	2.30
	China	78	78	84	84	84	74	80	-4.5
Iron & Steel	Japan	125	130	130	122	117	115	116	3.53
	China	83	85	85	85	85	85	102	-1.8
Ceramics	Japan	130	125	135	130	140	130	130	6.67
	China	55	55	70	65	55	55	70	-6.0
Petrochemistry	Japan	128	130	129	125	118	128	128	3.32
	China	88	85	85	84	85	82	88	-2.15
Textiles	Japan	119	119	116	120	115	125	128	0.97
	China	78	69	74	78	85	80	92	-2.53
Food	Japan	123	129	131	120	120	132	118	3.92
	China	86	88	91	91	83	83	85	-2.25
Pharmacy	Japan	134	138	140	128	128	127	126	5.25
	China	74	69	69	68	72	72	93	-5.17

Source: The Federation of Korean Industries (www.fki.or.kr)

▫ Comparison on R&D Environment (Unit: Percent, Korea=100)

		Labor	CEO	S&T	Infrastructure	Collaboration Industry & Academy	Government
Japan		125	126	131	126	123	122
China	Big Companies	91	95	90	80	83	94
	SME	96	103	96	87	89	99

Source: The Federation of Korean Industries (www.fki.or.kr)

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