

Korea as a Knowledge Economy

Evolutionary Process and Lessons Learned

Overview

This Overview summarizes the conference edition of the report on *Korea as a Knowledge Economy: Evolutionary Process and Lessons Learned* (2006). The finalized version of the report takes into account feedback, comments and suggestions from various sources, and was published in August 2007 with updated data, charts and figures.

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Acronyms and Abbreviations

BIS	Bank for International Settlement
BK21	Brain Korea 21
EPB	Economic Planning Board
FDI	foreign direct investment
FTA	free trade agreement
GERD	gross expenditures on R&D
GNDI	gross national disposable income
GRI	government research institute
HCI	heavy and chemical industries
HRD	human resources development
HRM	human resources management
ICT	information and communications technology
ISO	International Organization of Standardization
IT	information technology
K4D	Knowledge for Development
KAIS	Korea Advanced Institute of Science
KAIT	Korea Association of Information and Telecommunication
KAM	Knowledge Assessment Methodology
KAMCO	Korea Asset Management Corporation
KBE	knowledge-based economy
KCC	Korea Communication Commission
KDI	Korea Development Institute
KDIC	Korea Deposit Insurance Corporation
KE	knowledge economy
KEDI	Korea Educational Development Institute
KEI	Knowledge Economy Index
KII	Korea Information Infrastructure
KIS	Korean innovation system
KISDI	Korea Information Strategy Development Institute
KIST	Korea Institute of Science and Technology
KITA	Korea International Trade Association
KOSDAQ	Korea Securities Dealers Automated Quotation
KTA	Korea Telecommunication Authority
MOST	Ministry of Science and Technology

NRDP	national R&D program
OECD	Organisation for Economic Co-operation and Development
PC	personal computer
R&D	research and development
S&T	science and technology
SME	small and medium enterprise
STEPI	Science and Technology Policy Institute
TFP	total factor productivity
USAID	U.S. Agency for International Development
USPTO	U.S. Patent and Trademark Office
WBI	World Bank Institute
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Overview

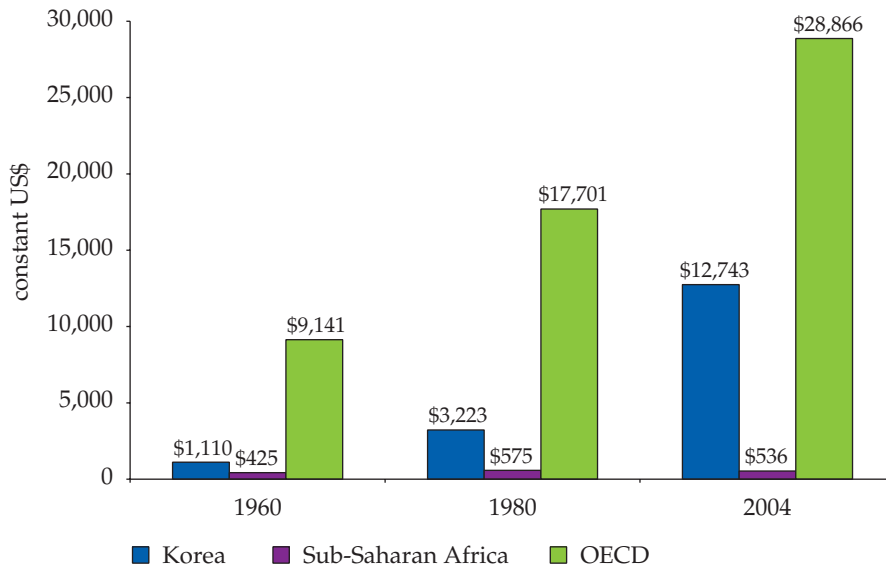
Despite dire initial conditions, the Republic of Korea has experienced rapid and sustained economic growth since the 1960s, resulting in GDP per capita increasing more than 11-fold. This is almost a unique occurrence on the world stage in the 20th century.

The Republic of Korea has experienced rapid and sustained economic growth over the past four decades. In the aftermath of World War II, Korea's GDP per capita was comparable to levels in the poorer countries in Africa (figure 1). Then the Korean War, from which South Korea emerged in 1953, made conditions even worse; Korea was considered by many to be a hopeless case after four years of mass destruction. However, after 45 years, Korea's GDP per capita has increased more than 11-fold, to over US\$12,000, which is on par with the medium economies of the European Union.

Figure 2 presents the decomposition of Korea's economic growth over the past four decades and clearly shows that the contribution of knowledge, represented here by total factor productivity, was a key factor in Korea's miracle of rapid economic growth. By comparison, Mexico's GDP per capita in 1960 was about 2.5 times larger than that of Korea; however, by 2003 Korea's GDP per capita was more than twice Mexico's. Without the contribution of knowledge, Korea's real GDP per capita would still be below that of Mexico. It is this rapid and sustained knowledge-led economic growth that makes the Korean case particularly interesting to analyze. In addition, its journey toward the knowledge economy offers valuable policy lessons for other developing economies that are seeking to make that transition.

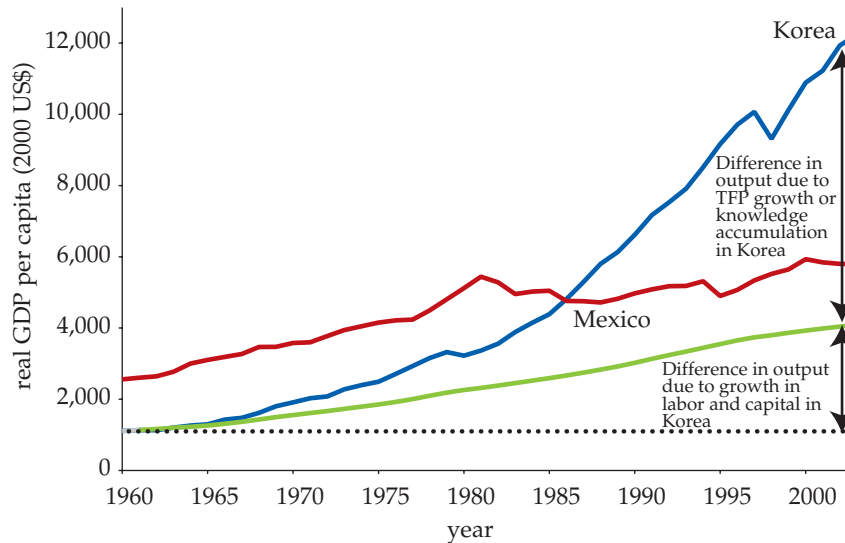
The accumulation of knowledge was the main contributor to Korea's long-term economic growth.

Figure 1 GDP Per Capita: Korea, Sub-Saharan Africa, and the OECD (constant 2000 US\$)



Source: World Bank SIMA database.

Figure 2 Contribution of Knowledge to GDP Growth



Source: World Bank staff estimates.

The Knowledge Economy Framework

An economy becomes a “knowledge economy” when the sustained use and creation of knowledge are at the center of its economic development process. A knowledge economy is one that uses knowledge as the key engine of economic growth. It is an economy in which knowledge is acquired, created, disseminated, and used

effectively to enhance economic development.¹ The successful transition to a knowledge economy typically involves elements such as making long-term investments in education, developing innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to market transactions. The World Bank has termed these elements the pillars of the knowledge economy, and together they constitute the knowledge economy (KE) framework.

Specifically, the four pillars of the KE framework are the following:

- *An economic incentive and institutional regime* that provides good economic policies and institutions, which promote efficient allocation of resources and stimulate creativity and incentives for the efficient creation, dissemination, and use of existing knowledge.
- *An educated and skilled labor force* that continuously upgrades and adapts skills to efficiently create and use knowledge.
- *An effective innovation system* of firms, research centers, universities, consultants, and other organizations that keeps up with the knowledge revolution, taps into the growing stock of global knowledge, and assimilates and adapts new knowledge to local needs.
- *A modern and adequate information infrastructure* that facilitates the effective communication, dissemination, and processing of information and knowledge.

The KE framework thus asserts that investments and interactions among these four pillars are necessary for the sustained creation, adoption, adaptation, and use of knowledge in domestic economic production. The result will be higher-value-added goods and services, which increases the probability of economic success in the current highly competitive and globalized world economy.

The Korean Development Strategy

The economic development of Korea hinged on critical interactions among the four pillars of the knowledge economy.

The Catch-Up Period: 1950–1997

Korea's rapid and sustained economic growth from the time when it was starting out as a low income country was an outcome of the knowledge economy approach, even though an explicit knowledge economy development strategy was not laid out. During this time from 1950 to 1997, Korea's economic development hinged on

1. Contrary to some beliefs, the concept of the knowledge economy does not necessarily revolve around high technology or information technology. For example, the application of new techniques to subsistence farming can increase yields significantly, or the use of modern logistical services can enable traditional craft sectors to serve broader markets than before.

the critical interactions among the four pillars of the knowledge economy, which have evolved together with the various stages of economic development (see table 1). In particular, the pragmatic development strategies focused on achieving sustained productivity growth by consistently increasing the value added of output. These strategies involved intensive learning processes consisting of active technological capability building and complementary human resources development. At the same time, the Korean government assumed the very necessary proactive leadership role of supporting the market and providing an environment that would foster and sustain the transformation.

In the 1960s, Korea embarked on the promotion of both export- and import-substitution industries, starting with subsistence agriculture (rice) and labor-intensive light manufacturing sectors (textiles and bicycles). Considerable capital accumulation and investment in primary education during this period allowed a gradual shift up the value-added chain toward more sophisticated commodities. Key to this shift was also the use of technologies obtained through foreign licensing and adapted for domestic production.

In the mid-1970s, the government's use of a well-targeted industrial policy resulted in a major shift to the development of heavy industries (for example, chemicals, shipbuilding). Along with industrial targeting, policies were enacted to further improve technological capabilities, together with improving access to and quality of technical and vocational training.

In the 1980s, Korea undertook efforts to ensure a market-conducive environment by deregulating various sectors and liberalizing trade. Concurrently, it expanded higher education while investing in indigenous research and development through the establishment of the National Research and Development Program.

Korea continued to pursue high-value-added manufacturing in the 1990s by promoting indigenous high-technology innovation. Domestic wage hikes and the appreciation of the Korean won had resulted in chronic current account deficits, which sparked a series of reforms, including the reform of the financial market. Together with the setting up of a modern and accessible information infrastructure, there was continued expansion of research and development capabilities in Korean industries, which drew on the skilled labor force that had resulted from the government's aggressive expansion of the higher education system.

The central theme of this book depicts the evolution of Korea's economic history through crucial interactions among the knowledge pillars, demonstrating the relevance of the knowledge economy approach to developed countries and to developing and low-income countries.

The Financial Crisis of 1997

There were limitations of the Korean model, especially in the recent era of globalization and rapid technological changes. The mechanism of resource allocation that the government used to wield discretionary power over the market had been effective when the economy was burgeoning. However, it approached its limits as the

Table 1 Korea's Economic Development Strategies, 1960–Present

<i>Development goals</i>	<i>Major policy directions</i>	<i>Macroeconomic policy framework</i>	<i>Human resources development</i>	<i>Science and technology (S&T)</i>
1960s	<ul style="list-style-type: none"> • Build a production base for export-oriented industrialization 	<ul style="list-style-type: none"> • Expand export-oriented light industries • Mobilize domestic and foreign capital 	<ul style="list-style-type: none"> • Prepare legal and institutional bases to support industrialization 	<ul style="list-style-type: none"> • Build scientific institutions' legal and administrative frameworks
1970s	<ul style="list-style-type: none"> • Build a self-reliant growth base 	<ul style="list-style-type: none"> • Promote heavy and chemical industries • Build social overhead capital 	<ul style="list-style-type: none"> • Maximize growth by expanding concessionary loans from the government • Increase government's intervention into the markets 	<ul style="list-style-type: none"> • Decrease illiteracy • Establish a national infrastructure • Increase vocational training • Increase engineering-major college graduates • Set up a scientific infrastructure: specialized S&T institutions, Daeduck Science Town
1980s	<ul style="list-style-type: none"> • Expand technology-intensive industries 	<ul style="list-style-type: none"> • Conduct industrial rationalization • Decrease export subsidy and expanding import liberalization 	<ul style="list-style-type: none"> • Stabilize macro-economy • Enhance private autonomy and competition 	<ul style="list-style-type: none"> • Expand the higher education system • Develop semiskilled human resources • Promote R&D and private research centers • Develop national R&D programs
1990s	<ul style="list-style-type: none"> • Promote high-technology innovation 	<ul style="list-style-type: none"> • Support technology development • Build an information infrastructure 	<ul style="list-style-type: none"> • Liberalize trade and foreign direct investment • Reform financial markets and re-structure the economy 	<ul style="list-style-type: none"> • Develop highly skilled human resources in strategic fields: information technology, biotechnology, etc. • Develop lifelong learning systems • Promote R&D programs on highly advanced technologies

Box 1 Success Factors of Korea's Economic Growth

Nam Duck-Woo, former prime minister, was one of the key policy makers during the high-growth era in Korea. Nam (1997) accounts for the following economic and noneconomic factors that led to successful economic development. Economic factors included (a) an outward-looking strategy, (b) good use of foreign resources, (c) a favorable international environment, (d) education, (e) faith in the free enterprise system, and (f) the activist role of government. Noneconomic factors include (a) ethnic and cultural homogeneity and a strong Confucian tradition that places a high value on education, achievement, and loyalty to the nation; (b) security threats; and (c) political leadership.

economy developed and became larger and more complex. The financial crisis of 1997 manifested the limitations of discretionary resource allocation and underscored the urgent need for widespread economic reform. The old policy framework and institutions that had led Korea in the early high-growth era turned out to be bottlenecks for sustained economic growth in the new economic environment. As such, Korea, with a clear national consensus, implemented a comprehensive restructuring of ailing corporate and financial sectors and undertook reforms in the public sector and the labor market, all of which contributed to overcoming the crisis and ensuring a rapid economic recovery.

The 1997 financial crisis showed the limitations of the government's discretionary resource allocation.

Post-crisis Period: 1998 to Present

In the aftermath of the financial crisis in 1998, Korea officially launched a national campaign to make the transition to an advanced knowledge-based economy in which domestic innovation would thrive, thereby enhancing overall productivity and sustaining economic growth. The initial impetus came from the *Maeil Business Newspaper*, which presented in 1996 a more coherent vision of the future for the Korean economy. Subsequently, economywide action plans were drawn up and implemented through the coordinated efforts of a number of government agencies. Key to the success of the national knowledge economy strategy was the strong political leadership from the Kim Dae-jung government and the national consensus with the private sector and civil society.

Korea's new knowledge-based development strategy was based on the KE framework developed by the Knowledge for Development (K4D) Program of the World Bank.² In particular, the strategy was based on the four pillars of the knowledge economy. Korea's transition toward a knowledge economy has been relatively successful.

2. The report *Korea and the Knowledge-based Economy: Making the Transition*, a joint publication of the K4D program and the OECD, outlined concrete steps for reforms in the various policy domains.

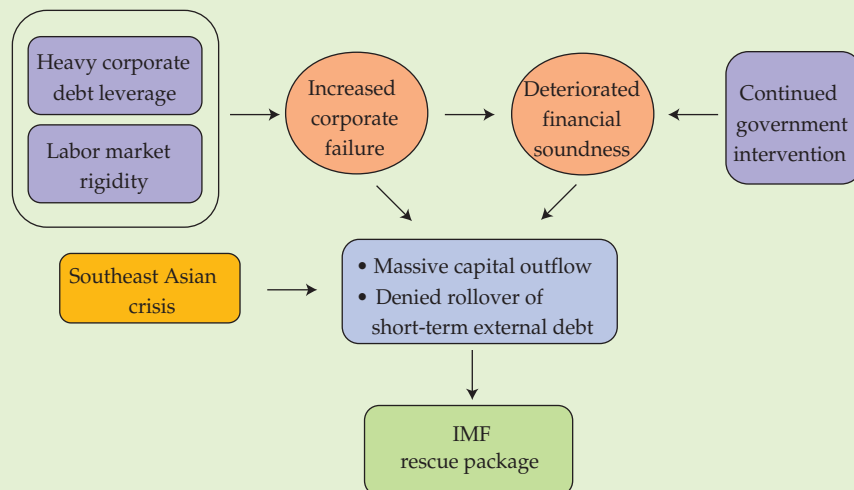
Box 2 Causes of the 1997 Financial Crisis

The direct cause of the 1997 financial crisis was the weakness of the financial institutions. Korea's financial sectors had been regulated by the government so that the financial market liberalization that was pursued throughout the mid-1990s exposed Korea's banking system to outside shocks, without safety mechanisms being put in place. International capital movements in a globalized world can weaken the autonomy of individual countries and their ability to manage domestic financial markets. The problem is worse when the financial institutions have weak risk management. So as economic conditions deteriorated with the October 1997 onset of the foreign exchange crisis in Southeast Asia, the confidence of foreign financial institutions and investors in the Korean economy started to wane. In 1997, many banks and financial institutions became insolvent as they were saddled with the huge unpaid debts of bankrupt *chaebols* (conglomerates).

A more fundamental cause than the financial aspect was the continued erosion of the Korean economy's international competitiveness. The underlying causes of financial insolvency and the bankruptcies of the large firms lie in the deteriorating profitability of businesses, in tandem with rising wages and lowered productivity since the late 1980s. Accustomed to the growth-first strategies of the past and under the patronage of the government, those firms had neglected to change their strategies and upgrade non-price factors of competitiveness. Instead, large enterprises opted to expand their business scale, which was possible through increased borrowing from the banks.

The third cause was the failure of the government to build a new economic system. Under the authoritarian regimes during the 30 years of economic development before the crisis, the government had intervened severely in the market. Despite the government's effort to enhance market functions, the pervasive cronyism between political and business circles had detrimental effects on the economy as a whole. The new government in 1993 tried to introduce several measures, but these were not sufficient to prevent the financial crisis in 1997.

Delayed Economic Reform and the Financial Crisis in 1997



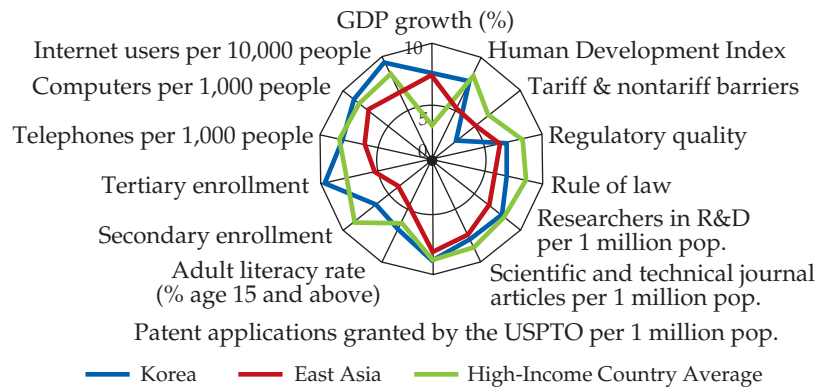
For example, the World Bank's Knowledge Assessment Methodology (KAM) Basic Scorecard,³ which benchmarks countries' overall readiness to use knowledge for economic development, shows that Korea has evolved into a relatively mature knowledge-based economy, performing well above the average country in East Asia and on par with average high-income countries (see figure 3).

The OECD has documented Korea's active investment in knowledge,⁴ which in 2002 was 5.8 percent of GDP, the fourth highest among the OECD countries (figure 4). Moreover, Korea's investment pattern has been changing significantly in recent years, from investment in physical capital such as machinery and equipment to knowledge inputs. Among the OECD countries in 2002, Korea still had the highest ratio of spending on machinery and equipment to GDP, but the ratio is rapidly decreasing. From 1995 to 2002 the ratio decreased by 3.7 percentage points. For the same period, in contrast, Korea's investment in knowledge increased by 1 percentage point.

Meeting Skill and Human Resources Requirements

Education and human resources have been key factors in Korea's rapid economic growth over the past four decades.

Figure 3 KAM Basic Scorecard for Korea, East Asia, and High-Income Country Average



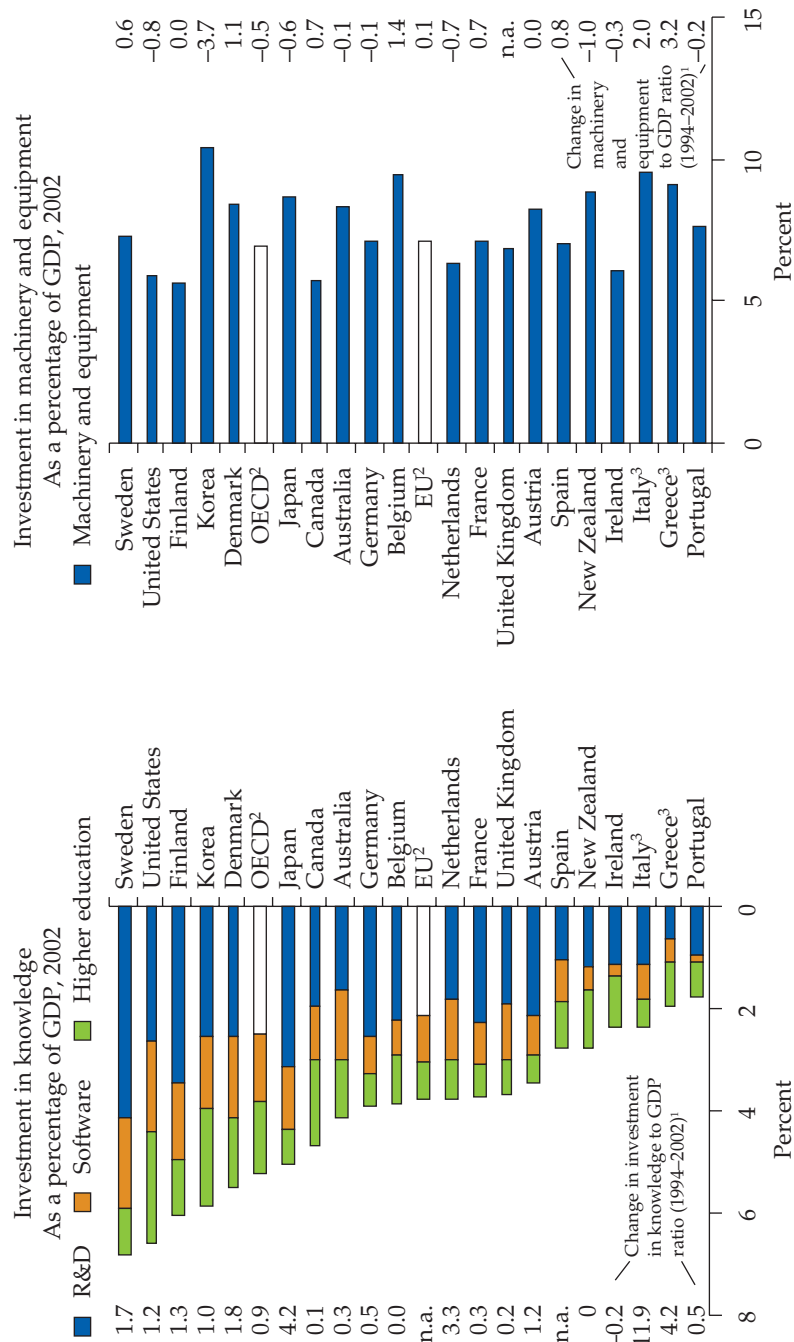
Source: World Bank. Knowledge Assessment Methodology (KAM), March 2006. <http://www.worldbank.org/kam>.

Note: See footnote 3.

3. The KAM Basic Scorecard uses 12 knowledge indicators and two performance indicators to illustrate a country's overall readiness for the knowledge economy. All variables are normalized or rescaled onto a 0 to 10 interval. The center of the illustrated spider chart denotes the minimum normalized value of 0, and the outer perimeter of the chart denotes the maximum normalized value of 10. Thus, a "bigger" or "fuller" spider chart implies that the country or region is better positioned in terms of the knowledge economy.

4. The OECD defined investment in knowledge as spending on R&D, software, and higher education.

Figure 4 Investments in Knowledge and in Machinery and Equipment in OECD Countries, 2002



Source: OECD 2005b.

a. 1994-2001 for Greece and Italy. 1995-2002 for Korea. The EU figure excludes Belgium, Greece, and Italy. OECD figure excludes Belgium, Greece, Italy, and New Zealand.

b. Excludes Greece and Italy.

c. 2001 data.

Korea's education system was developed in tandem with the various stages of economic development, complementing the other knowledge economy pillars.

EXPANDING ENROLLMENT RATES. Korea's educational system has expanded rapidly over the past 40 years (figure 5). Universal primary education was adopted as early as the 1950s, which was instrumental for full-fledged industrialization in subsequent years. The secondary enrollment rate was relatively low in 1970, at less than 40 percent. However, subsequent sharp increases led to secondary enrollment being more than 90 percent in 2004. Similarly, enrollment for higher education has experienced steep increases since 1990 and surpassed 60 percent in 2004, which is the highest level among the OECD countries.

Korea's education system was able to achieve quantitative expansion in tandem with qualitative improvement over the past 40 years.

ENHANCING EDUCATIONAL QUALITY. Korea's education system has also achieved qualitative improvement in tandem with quantitative expansion. Korea ranks very high in various international tests administered in recent years. For example, Korea ranked third for mathematics and fourth for science out of 40 countries included in the OECD's Programme for International Student Assessment (PISA) 2003 survey (figure 6).

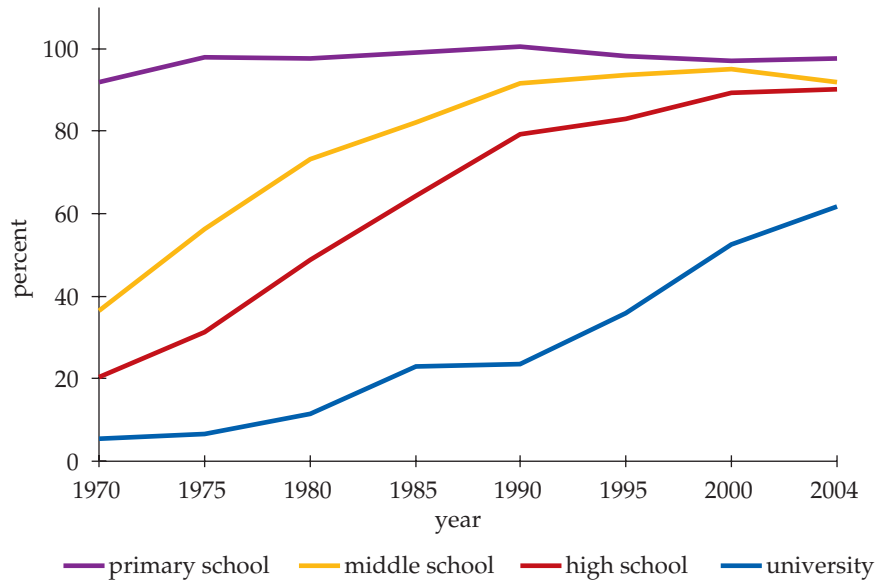
EXPANDING THE EDUCATION SYSTEM IN TANDEM WITH ECONOMIC DEVELOPMENT.

The Korean education system was expanded in accordance with the manpower needs at the various stages of economic development.

Since the 1950s, Korea's educational policy and planning have complemented the government-led economic development plans. Specifically, the education system was nurtured and expanded according to the manpower needs of the economy (see table 2). Hence, in the 1950s and 1960s education policies focused on the expansion of primary and secondary education, which was critical to supply at least a literate workforce to the industries. Vocational high schools were also established in the 1960s to provide training in craft skills for the growing labor-intensive light manufacturing industries. Junior vocational colleges were set up in the 1970s to supply technicians for the heavy and chemical industries. In the 1980s, the higher-education expansion policies adopted by the government were effective in supplying high-quality white-collar workers and R&D personnel that were required as Korea began enhancing domestic innovation.

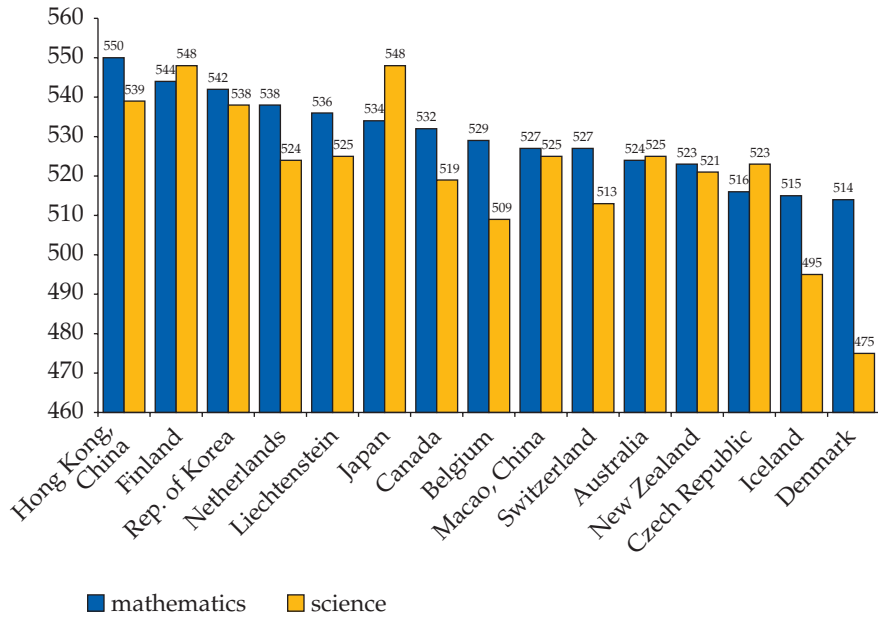
PUBLIC AND PRIVATE EXPENDITURE ON EDUCATION. Korea's emphasis on education and developing a skilled workforce can be seen from the economy's total expenditure on education. In 2002, 7.1 percent of GDP was spent on education, a level much higher than the OECD average of 5.8 percent (figure 7). Only three OECD coun-

Figure 5 Educational Expansion in Korea, Gross Enrollment Rates



Source: Ministry of Education, *Statistical Yearbook*, various years.

Figure 6 Math and Science Scores, Selected Countries, 2003



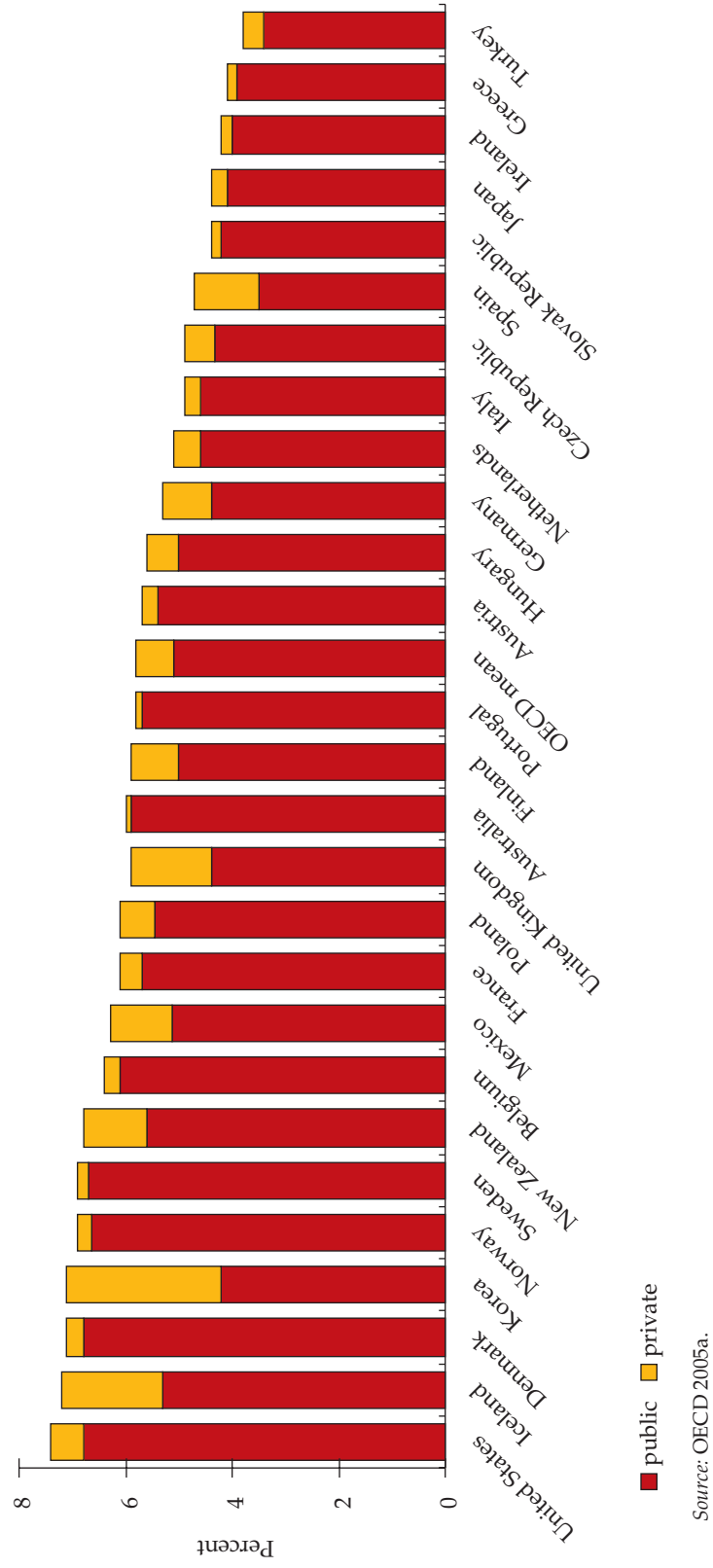
Source: Constructed using data from OECD 2004.

Table 2 *Evolution of the Korean Education System, 1948–present*

<i>Government focus</i>	1948–60	1961–80	1981–2000	2001–present
Challenges at national level Strategy	Establishing a national infrastructure Using a government-initiated approach	Planning education for economic development Focusing on traditional institutions of higher education Continuing the government-initiated approach	Enhancing lifelong learning Reaching out to the nontraditional education sector Using a government-led, partial market approach	Increasing human resources innovation Tightening up the loosely connected system of HR development Using a coordinated gov.-market approach (market influence increased) Improving quality or relevance of university education Increasing research productivity Enhancing the efficiency of the HRD system Enhancing regional development and innovation Restructuring at governmental, system, and institutional levels Using massive financial support from government (Brain Korea 21/Post-BK 21, NURI educational Internet network)
Primary tasks and activities	Building elementary schools Developing vocational schools Developing HR in medicine, engineering, agriculture, teacher education	Improving teaching quality (elementary and secondary education) Increasing college graduates with engineering major Developing medium-skilled HR	Developing high-skilled HR in national strategic fields (IT, BT, S&T etc.) Developing a system of lifelong learning	
Resources (tools)	Using foreign assistance (UNKRA, OEC, USOM etc.)	Increasing educational period for new elem. and second. (2 to 4 years) Creating vocational colleges Mobilizing private resources for expansion of educational sector	Increasing research funds in science and technology Creating diverse types of higher education institutions Introducing credit-bank system	

Note: UNKRA = United Nations Korean Reconstruction Agency; OEC = Office of Economic Coordination; USOM = United States Operation Missions.

Figure 7 Education Spending as a Percentage of GDP, 2002



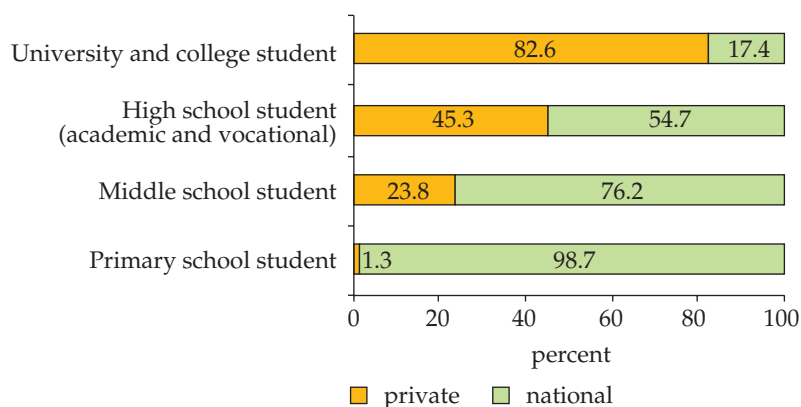
tries—Iceland (7.4 percent), United States (7.2 percent) and Denmark (7.1 percent)—had education expenditure shares that surpassed or were on par with Korea (OECD 2005a). The government’s priority on education can be seen from the growth rates of the public education budget, which have outpaced those of GDP over the past four decades. In particular, for the period of 1963–1995, government spending on education increased more than 27-fold in real terms, whereas GDP increased only 14-fold and the government’s overall budget has increased only 15-fold. Another characteristic of the Korean education system is the unusually large component of private financing. Private expenditures on education account for 2.9 percent of GDP, which is the highest among the OECD countries and far above the OECD average of 0.7 percent.

The Korean government has been successful in encouraging the private sector, either households or private foundations, to bear a significant portion of total education costs. In particular, private foundations have established a number of secondary schools and higher education institutions, in which expenses are paid for by user fees. At the secondary level, enrollment at private institutions accounts for more than 40 percent of total secondary enrollment, whereas private enrollment for tertiary education is over 70 percent (figure 8). On the other hand, primary education in Korea has been treated as a public good and has been mostly publicly funded, with about 99 percent of primary school students in 2005 being enrolled in public schools.

By encouraging the private sector to shoulder a significant portion of total education costs, Korea has been able to offer universal primary education.

The heavy reliance on private funding in secondary and higher education has important policy implications. Inducing the private sector to play a more active role in providing secondary and higher education services has had a leveraging effect where scarce government resources have been spent on key priority areas. More

Figure 8 *Ratio of Enrollment in Private Schools*



Source: MOE & KEDI 2005.

specifically, by leaving higher education to the private sector and targeting public resources for primary education, Korea was able to address one of the main equity issues, basic education for all.

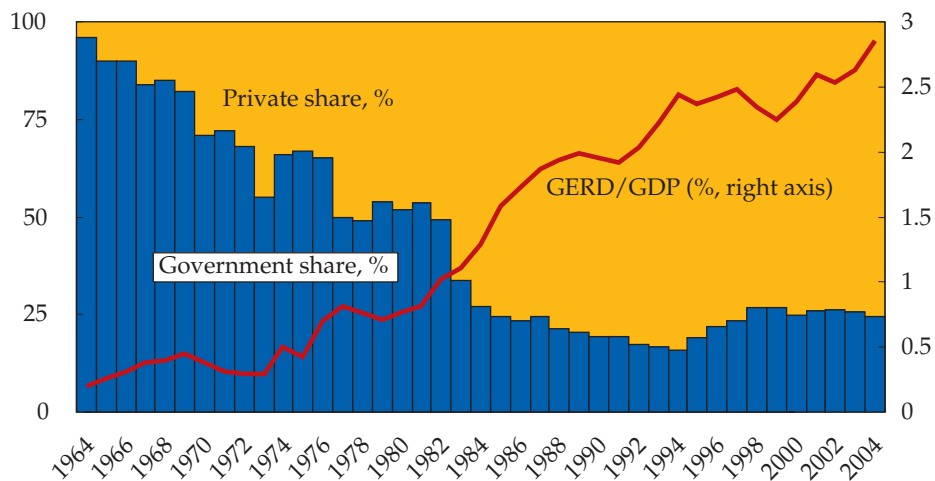
Education has an intrinsic social value in the Korean culture. This cultural factor has contributed significantly to the high propensity for private spending in education.

THE CULTURAL FACTOR. One factor that is contributing to the high propensity for private spending in education is the intrinsic social values that literacy and education have in Korean culture. Indeed, educating children has always been the overriding family task for Korean parents. Coupled with the rising demand for a more educated workforce, a natural consequence of the industrialization process, this cultural factor has greatly contributed to Korean families' willingness to pay for educating their children, and consequently to the rapid increases in school enrollment rates.

Harnessing the Potential of Science and Technology

RAPID DEVELOPMENT OF INDIGENOUS RESEARCH AND DEVELOPMENT CAPABILITIES. Korea has recognized the importance of developing indigenous capabilities in science and technology for successful industrialization and therefore has made building such capabilities one of the key priority policy areas over the past four decades. As can be seen in figure 9, Korea's gross expenditure on research and development (GERD) has grown both in size and as a share of GDP, which increased from 0.25 percent in 1963 to 2.84 percent in 2004. Along with the rapid increase in R&D investment, the number of researchers has also increased more than 100-fold during the same

Figure 9 Gross Expenditure on Research and Development in Korea, 1964–2004



Source: Ministry of Science and Technology (MOST).

period, from 1,900 to 209,979 researchers. The rapid increases in total R&D expenditure have been possible because of active expansion of investment by the private sector. During the earlier years of industrialization, private sector R&D spending was negligible, but rapid economic growth has called for commensurate investment in technology development, resulting in continuous increases in R&D spending by private enterprises over the past four decades. Consequently, the funding sources have also greatly changed: the government's share of GERD has been continuously reduced, with only one-fourth of GERD coming from the government in recent years.

Consistent increases in R&D investment by the private sector over the past 40 years have contributed significantly to the rapid increase in Korea's gross expenditure on research and development.

The rapid increase in R&D investments has led to a corresponding increase in indigenous innovation and adoption of foreign technologies. This can be seen from Korea's improved performance in various international indicators of innovation and technology adoption, such as the number of scientific and technical journal articles written and published by Korean authors,⁵ the number of patents granted to Korean inventors by the United States Patent and Trademark Office (USPTO), and the amount of royalties and license fees paid and received by Korea (figure 10).⁶ According to KAM, South Korea is currently on par with a typically high-income country in many aspects related to innovation and technological adoption (figure 11).

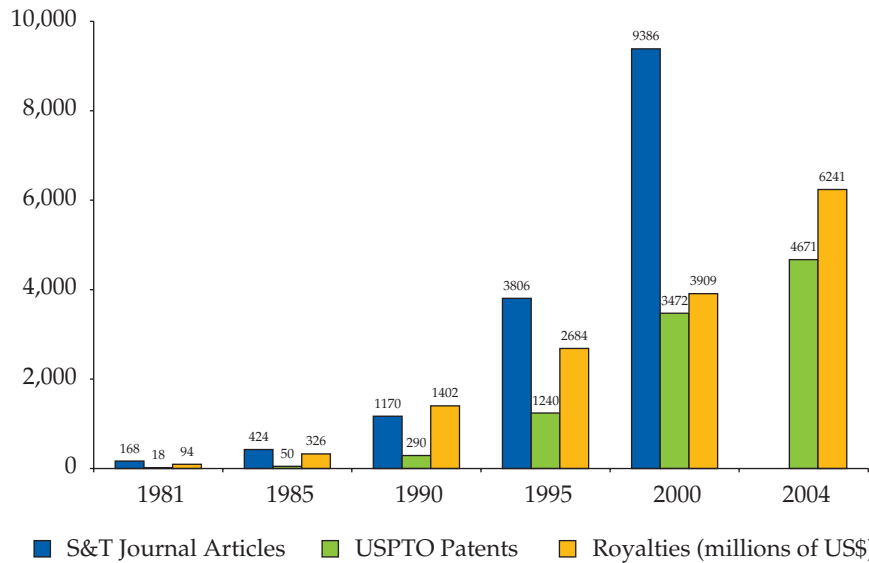
The long-term increases in GERD have led to a surge of domestic R&D capabilities in Korea.

EVOLUTION OF TECHNOLOGICAL ASSIMILATION AND DOMESTIC INNOVATION CAPABILITIES. When Korea launched its industrialization drive in the early 1960s, it had to rely almost completely on imported foreign technologies. By doing so, Korea pursued two key objectives. The first was to promote the inward transfer of foreign technologies, the second was to develop domestic absorptive capacity to digest, assimilate, and improve upon the transferred technologies and to adapt them to

5. Refers to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

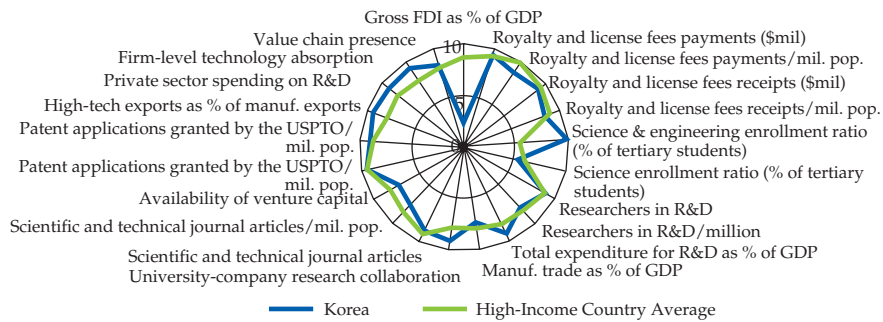
6. Royalty and license fees are payments and receipts between residents and nonresidents for the authorized use of intangible, nonproduced, nonfinancial assets and proprietary rights (such as patents, copyrights, trademarks, industrial processes, and franchises) and for the use, through licensing agreements, of produced originals of prototypes (such as films and manuscripts). Data are in current U.S. dollars.

Figure 10 R&D Capabilities and Technology Adoption in Korea, 1981–2004



Source: Constructed by World Bank staff based on data from U.S. Patent and Trademark Office’s Web site and World Bank SIMA database.

Figure 11 KAM: Innovation and Technological Adoption Indicators



Source: World Bank. Knowledge Assessment Methodology (KAM), March 2006. [http:// www.worldbank.org/wbi/kam](http://www.worldbank.org/wbi/kam).

Note: See footnote 3.

domestic production. The second objective required a relatively skilled labor force, which Korea had because of its concurrent aggressive educational policies. The technology assimilation strategy used various channels, such as original equipment manufacturing, foreign licensing-based production, reverse engineering of imported capital goods, and learning from the building of turnkey plants. These channels of informal technology assimilation enabled Korea to minimize its dependence on FDI, which had become more prominent since the 1997 financial crisis, and to maintain independence from multinational corporations (table 3). The

At the beginning of the industrialization process, when Korea had little in terms of indigenous technological and R&D capabilities, the country actively embarked on a strategy to assimilate foreign technologies.

Table 3 Channels of Foreign Technology Transfer to Korea, 1962–2001
(US\$ millions)

	1962– 1966	1967– 1971	1972– 1976	1977– 1981	1982– 1986	1987– 1991	1992– 1996	1997– 2001
FDI	45	219	879	721	1,768	5,636	8,405	57,851
Foreign licensing	1	16	97	451	1,185	4,359	7,318	13,194
Capital goods imports	316	2,541	8,841	27,978	50,978	120,952	220,843	252,034
Sum of foreign licensing and capital goods imports	317	2,557	8,938	2,8429	52,163	125,311	228,1601	265,228

Source: National Statistical Office.

strategy proved to be a success and Korean firms were able to assimilate technologies rapidly enough to undertake subsequent expansion and improvement with little assistance from foreign suppliers.

Because of its concurrent aggressive educational policies, Korea had a relatively skilled labor force, which was the key to successfully assimilating foreign technologies.

Changes in economic environments in the early 1980s induced Korea to embark on serious investments in indigenous R&D. On the one hand, Korean industrial development had reached the stage at which domestic industries found it more difficult to be competitive in the international market because they were reliant on imported technologies and employed domestic labor that was becoming more and more expensive. On the other hand, Korean industries had grown to become potential competitors in the international market, making foreign companies increasingly reluctant to transfer technologies to Korea; thus, it was inevitable that Korea would have to develop an indigenous base for research and innovation. Meeting the challenge required highly trained scientists and engineers as well as financial resources to support R&D activities, which are by nature uncertain and risky.

With increased technological capability, Korea became a potential competitor in the global market and, consequently, opportunities to assimilate imported technology became less readily available. This necessitated the development of indigenous capability for research and innovation.

THE GOVERNMENT AND INNOVATION IN KOREA. The role of the government in the efforts of developing indigenous innovation capabilities evolved together with the phases of industrial development (figure 12). For example, to enable firms to finance the massive importing of capital goods and the building of turnkey plants in line with its technological assimilation strategy in the 1960s, the Korean government brought in large-scale, long-term foreign loans and allocated them to selected industries. In the 1970s, as the economy had developed and was moving into heavy industries, the government created government research institutes (GRIs) in the fields of heavy machinery and chemicals to compensate domestic industries for their technological weakness. These GRIs, such as the Korea Institute of Machinery and Metals (KIMM) and the Electronics and Telecommunications Research Institute (ETRI), worked with private industry to some extent to enhance technological capabilities for further industrial development.

Korea's export-driven development strategy compelled domestic firms to invest heavily in research and development in order to remain globally competitive, resulting in increases in productivity and efficiency.

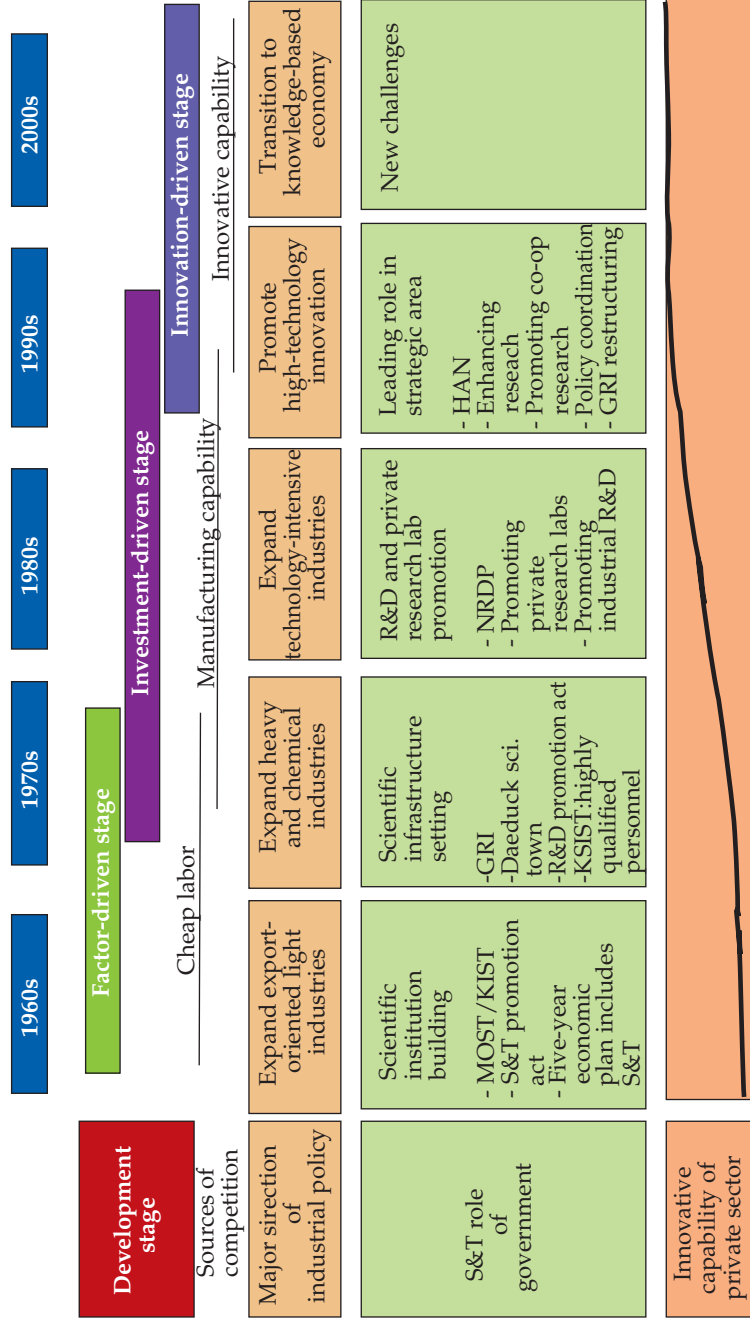
The Korean government has also contributed significantly to the rapid rise in private sector investments in research and development. First, the government's outward-looking or export-driven development strategy forced domestic industries into international markets, exposing them to intense global competition. For these firms to remain competitive, they had to keep pace with technological changes by investing heavily in R&D. Second, the government's industrial policy that favored large firms gave birth to a unique business organization in Korea, the chaebol. Chaebols enjoy greater financial affluence owing to the economies of both scale and scope of their business operations. Chaebols, which are usually big multinational firms, were able to engage in risky and expensive R&D projects. The top 20 firms account for about 57 percent of the total industrial R&D investments in Korea (KITA 2004). Most important, Korea has been able to increase R&D investments at such a rapid rate because it has an abundant pool of highly educated manpower that could meet the increasing demand for R&D services in both private and public sectors.

However, Korea's efforts to build an indigenous innovative service base are not without challenges. For instance, most of the R&D is being performed by the chaebols, and little is being conducted by the universities. This disproportionate distribution of R&D investment is not sustainable for the economy as a whole—insufficient resources are being devoted to R&D in basic sciences, which is necessary for the long-term development of science and technology. Indeed, by using the USPTO count of patents granted as an indicator of R&D productivity, figure 13 shows how Korea has been overtaken by other economies with strong innovation systems.

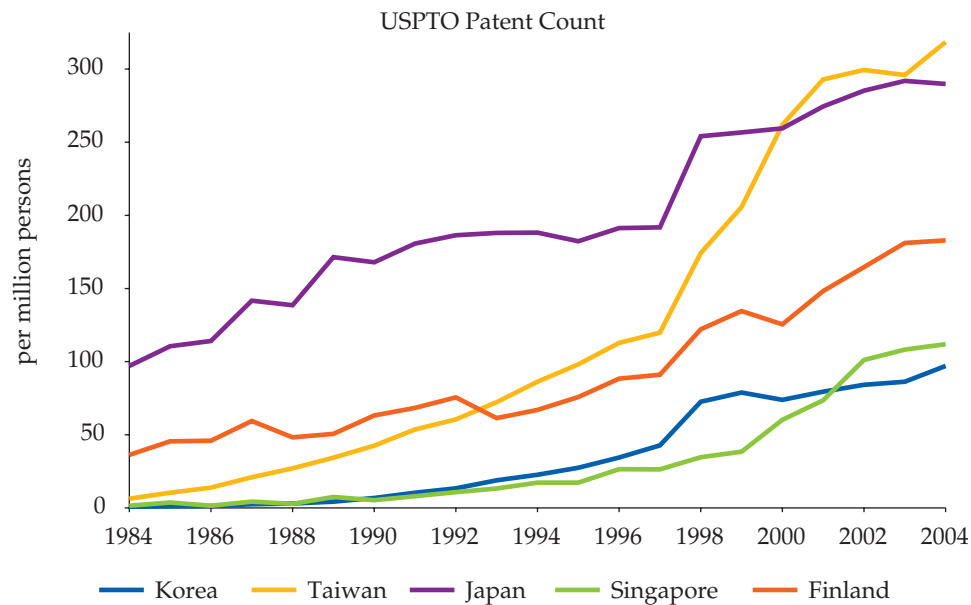
Building Information Infrastructure

In the early 1970s, Korea's information infrastructure was inadequate and the provision of information and communication technologies (ICT) services was insuffi-

Figure 12 Changes in Government Innovation Policy



Source: Adapted from Mitchell 1997.

Figure 13 Number of Patents Granted, Various Countries

Source: Constructed by World Bank staff based on data from U.S. Patent and Trademark Office's Web site and World Bank SIMA database.

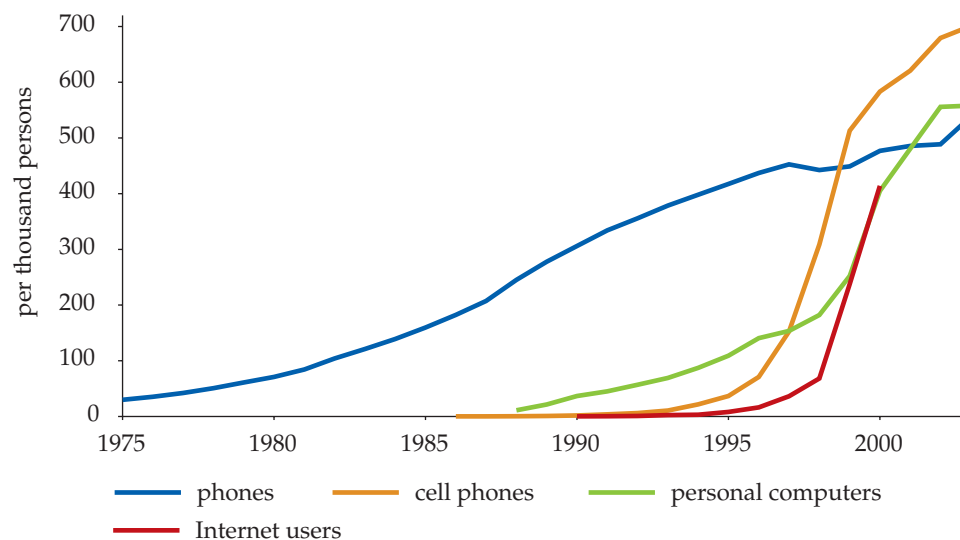
cient and too inefficient to meet the telecommunication demands associated with rapid economic growth. In 1975, only 3 percent of Koreans had a telephone. To improve efficiency in the provision of telecommunication services, the Korean government decided to rely on the invisible hands of the price mechanism and thus focused on introducing competition into the ICT infrastructure sector. As such, a series of sequential but rapid policy measures were implemented for the deregulation and liberalization of the ICT services sector, along with privatizing the government-owned telecom operators (table 4). The Korea Telecommunication Authority was established in 1981 to spearhead this effort.

To increase efficiency in the information infrastructure sector, Korea introduced competition by deregulating and liberalizing the sector and privatizing government-owned telecom operators.

The reform of the ICT infrastructure sector resulted in tremendous improvements in terms of ICT penetration rates. Most noteworthy are the recent penetration rates of cell phones and the Internet. From 1995 to 2003, the proportion of Koreans having a cell phone increased by nearly 20 times, to 70 percent, while the proportion of Internet users increased by a whopping 75 times, to 60 percent (figure 14). Similarly, Korea is currently among the leading countries in the world in terms of the proportion of broadband Internet subscribers (figure 15). The most recent

Table 4 *Introducing Competition in Telecommunication Services*

1981	Korea Telecommunication Authority established
1990	Competition introduced in value-added services Dacom enters international market
1992	Competition introduced in paging services (10 new operators)
1994	Second cellular license issued (Shinsegi Telecom)
1995	Competition introduced in long-distance market (Dacom)
1996	27 new licenses granted: three for personal communication services (PCSs), six for trunked radio systems (TRSs), 11 for second-generation cordless tele- phones (CT-2), etc.
1997	10 new licenses granted: one local operator (Hanaro), one long- distance operator (Onse Corporation), six TRSs, one paging operator
1997	Resale-based competition introduced

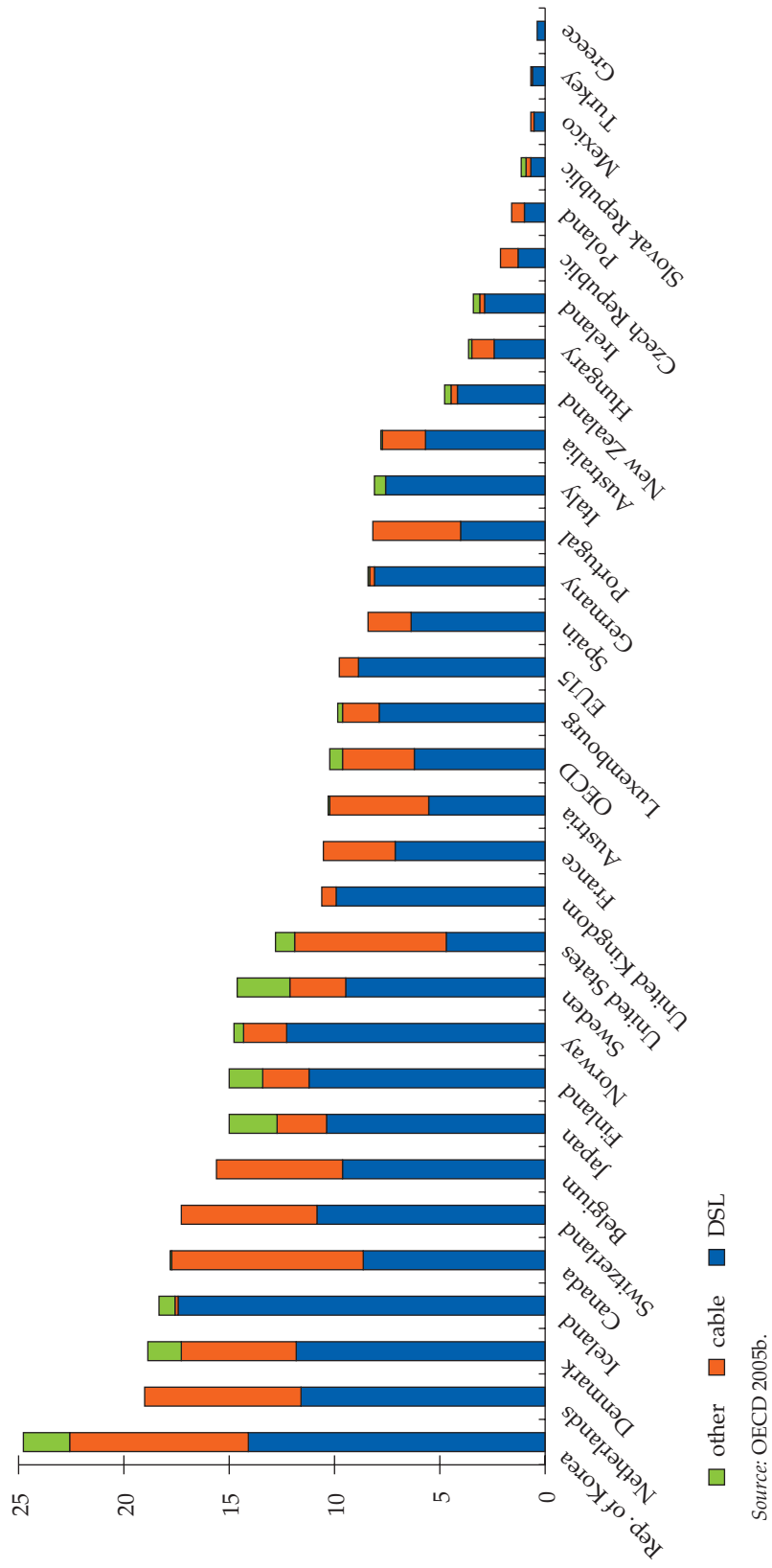
Figure 14 *ICT Density in Korea, 1975–2003*

Source: Constructed from World Bank SIMA database.

data from the World Bank's KAM shows that Korea has succeeded in joining the ranks of high-income countries in terms of its informatization level (figure 16).

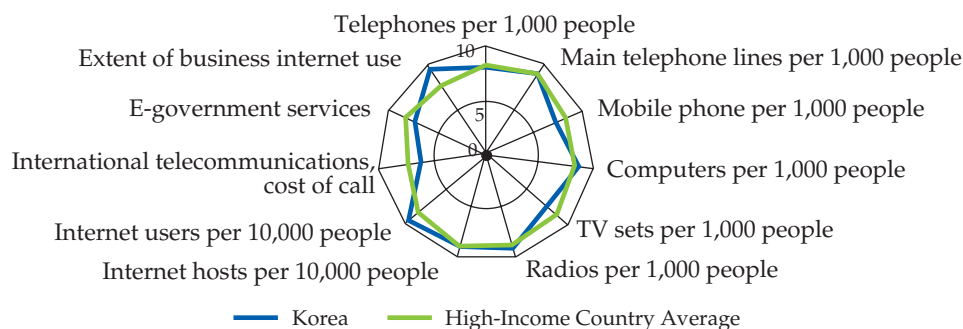
Currently, Korea has constructed ICT networks connecting all 114 areas of the country, and ICTs are used extensively in numerous economic and social activities. The number of individuals using ICT-related services is also constantly rising: the number of subscribers to Internet banking services reached 22.58 million as of March 2005, and e-commerce has rapidly increased from 50 billion won in 1998 to 314 billion won in 2004, which is equivalent to 40 percent of GDP. Led by an e-government initiative, the public sector is also extensively using ICTs. In 2004, about 97

Figure 15 Broadband Subscribers per 100 Inhabitants, by Technology, 2004



Source: OECD 2005b.

Figure 16 Information and Communications Technologies Indicators



Source: World Bank. Knowledge Assessment Methodology (KAM), March 2006. <http://www.worldbank.org/wbi/kam>.

Note: See footnote 3.

percent of documents were dealt with through the e-approval system in the government agencies, compared with only 21 percent in 1998.

The rapid development of the Korean information infrastructure hinged on key government organizations that were responsible for the informatization strategy. These organizations were restructured in the 1990s. They included the Informatization Promotion Committee, chaired by the prime minister; the Informatization Strategy Meeting, chaired by the president; and the Ministry of Information and Communication. Concurrently, the Korean government established three master plans for the development of the information society. In 1995, the Informatization Promotion Act was enacted, and the first master plan for promoting informatization was formulated a year later. In 1998 in the second master plan, Cyber Korea 21 was established to cope with the changing environment that resulted from the Asian financial crisis. And in 2002, when most of the policy goals set up by Cyber Korea 21 had been achieved ahead of the original schedule, the third blueprint, e-Korea Vision 2007 was laid out (table 5).

To build the infrastructure efficiently and economically while actively responding to the technological development and changing demands, diverse implementation methods have been used. Networks in commercial and densely populated areas have been built with optical cables; networks that extend to subscriber premises have been built partly with optical cables and partly by digitizing and enhancing the speed of existing telephone lines or CATV networks or by building new wireless local loops.

Table 5 Master Plans for Promotion of Informatization

Plan	Period	Vision
Basic Informatization Promotion Plan	1996–2000	Attain world-class informatization levels by 2010
Cyber Korea 21	1999–2002	Build a leading knowledge-based society
e-Korea Vision 2007	2002–2007	Build e-Korea as the global leader

Successful promotion of informatization requires government-led large-scale, long-term investments.

In order to finance the investment for the rapid deployment of Korea's information infrastructure, the Informatization Promotion Fund was established as a special vehicle to overcome short-term budgetary constraints. From 1993 to 2002, the fund reached a total of US\$7.78 billion. About 40 percent of that was from government budgetary contributions, 46 percent came from private enterprises (of which licensing fees for new communication services composed major portions), and the remaining 14 percent came from miscellaneous profits and interests. The funds were allocated in a way that would balance development in ICT-related activities: 38 percent for technology development programs (the best known is CDMA wireless technology), 18 percent for human resources development, and the remaining 44 percent for building of infrastructure and diffusion, including standardization. A particularly important purpose for the fund was to narrow the digital divide. Socially alienated groups, such as the aged and rural villagers, have continuously received various supports and assistance, including computer-literacy education.

Designing a New Economic Framework

Korea turned the 1997 financial crisis into an opportunity for major, widespread economic reforms.

The 1997 financial crisis required major economic reforms and also presented an opportunity for the reform of the economic regime. The reforms, which began in the wake of the crisis, have been extensive and substantial, covering most of the areas in public and private domains. The economic reforms since the 1997 crisis had three major objectives:

1. To transform Korea into a market-oriented economy by deregulating across the sectors and thereby promoting competition and entrepreneurship. At the same time, a modern regulatory framework would be set up to support the efficient and equitable functioning of the markets.
2. To improve the institutional regime by improving the rule of law and by having greater transparency, disclosure of information, and accountability on the part of the government as well as the private sector.
3. To continue the transition to the knowledge-based economy by developing a relevant and modern legal and institutional infrastructure in such areas as intellectual property rights, valuation of intangible assets, and laws to cover privacy and security in digital transactions.

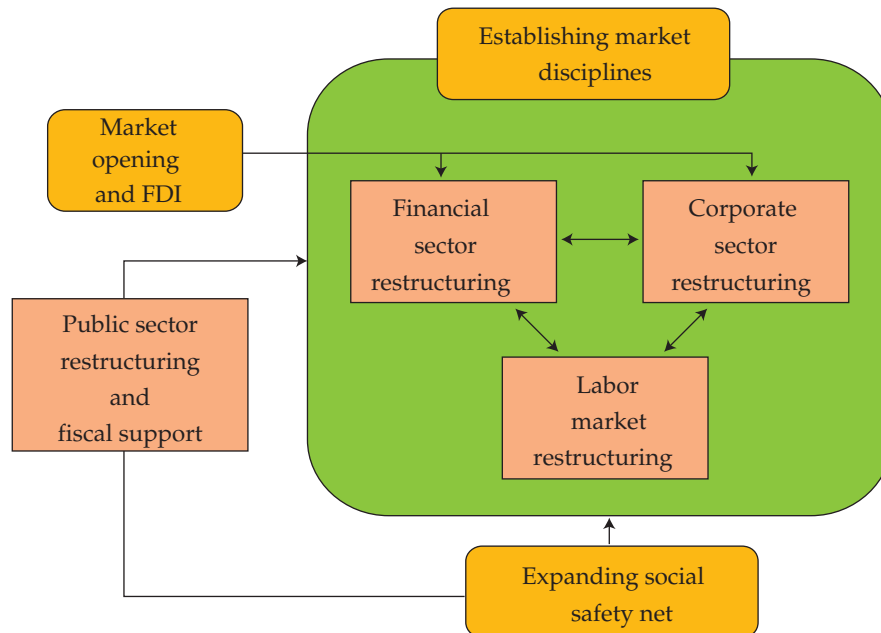
Specifically, major structural reforms included improving the efficiency and soundness of the financial system, creating stable corporate environments to support the entry of new players into the economy, enhancing the flexibility of the labor market, and redefining the role of the government by strengthening the basic

institutional infrastructure and fortifying the rule of law (figure 17). The Korean government also undertook efforts to develop venture business firms that were expected to spearhead innovation and generate employment.

FINANCIAL SECTOR REFORM. Restoring confidence in Korea's financial system was a top priority for the government in the wake of the crisis. In order to rehabilitate the financial system, the government liquidated troubled institutions, removed nonperforming loans, and recapitalized promising financial institutions by injecting public funds amounting to 108 trillion won. Responding to the government's initiatives, financial institutions also adopted stricter standards. These have contributed to increasing the health and profitability of the financial industry. For example, the share of bad loans out of total loans sharply decreased from 11.3 percent in 1999 to 3.9 percent in 2002.

CORPORATE SECTOR REFORM. Reforms in the corporate sector have focused on eliminating inefficiencies and encouraging firms to reorganize themselves based on the strength of their core competencies. Initiatives have been implemented to improve corporate governance systems, revise bankruptcy procedures, and remove anticompetitive regulations. In addition, the Korean government introduced measures to improve financial disclosures and accounting standards and to enhance the quality of corporate governance by guaranteeing the voting rights of the shareholders. As a result of these efforts, Korean firms have begun to exercise a higher degree of prudence in investment decisions as compared with the precrisis period.

Figure 17 *Economic Reforms after the Financial Crisis*



Source: Government of the Republic of Korea 1999, p. 46.

LABOR MARKET REFORM. The Korean labor market has been excessively rigid in the past. Labor legislation, labor relations, and industrial and market structure have contributed to labor market rigidities. Such rigidities hamper the ability of the country to respond rapidly to changing market needs and to opportunities, both those resulting from restructuring pressures and those brought about by the “knowledge revolution.” A number of initiatives have been implemented since the crisis to create more flexible labor markets. For example, labor laws have been revised to legalize layoffs, and a legal framework for manpower-leasing services has been introduced.

ENHANCEMENT OF SOCIAL SAFETY NETS. Besides enacting measures to enhance labor market flexibility, Korea has also begun to strengthen its social safety nets. Unemployment insurance, a well-functioning pension system, and properly targeted poverty programs form part of an overall insurance package. Since the crisis, the benefits structure and coverage of Korea’s unemployment insurance program have significantly improved. Expanded social safety nets have helped in mitigating negative effects of economic restructuring and promoting innovation and entrepreneurship by encouraging risk taking by individuals.

Venture businesses have been seen in Korea as potential the future engines of growth. The Korean government has therefore been actively promoting the formation of a venture capital market, which has been allocating the necessary resources to the industry.

NURTURING ENTREPRENEURSHIP AND CULTIVATING VENTURE BUSINESSES. The development of venture businesses requires a stable supply of concomitant risky capital, which was absent from Korea until the early 1980s. Accordingly, the government actively promoted the formation of a venture capital market, which has grown rapidly since the late 1990s. Korea is now among the leading OECD countries in terms of venture capital investment as a share of GDP. The government recently revised its venture business policy to avoid any direct intervention into the market and thus to improve the self-sustaining capability of venture business. The government now focuses more on the establishment of regulations to maintain a level playing field and on monitoring and supervision to make sure the regulations are observed.

THE NEW ROLE OF THE KOREAN GOVERNMENT. Since the 1997 crisis, the most important change in the role of government was to allow the market mechanism to work and to let the private sector take the lead in spurring economic activity. Through a stream of institutional reforms, the government has since focused on fostering both domestic and foreign competition, encouraging and maintaining market- and innovation-conducive macroeconomic environments, and providing a well-developed framework for a knowledge economy, consisting of a highly educated workforce and a well-established and modern information infrastructure.

Since the 1997 crisis, the Korean government has been allowing the market mechanism to work and the private sector to take the lead in spurring economic activity.

The institutional reforms include deregulation across all sectors, removal of institutions not conducive to market competition, further reductions in tariff and nontariff barriers, and liberalization of foreign investment. The recent liberalization of trade and foreign direct investment, together with the many current regulatory reforms, has significantly increased the potential for foreign competition across the board. It is hoped that these reforms will foster competition in domestic markets, thereby forcing Korean industries to be even more efficient, innovative, and competitive.

Lessons and Continuing Challenges

Korea is an example for developing countries in many ways. Admittedly, there are unique aspects of the country that limit the direct applicability of lessons to be derived: ethnic and cultural homogeneity, a strong Confucian tradition that places high value on education, achievement and loyalty to the nation, a security threat, and political leadership. In addition, some features of the country are typical of the Asian model of development and growth, which cannot easily be replicated in other cultures, among them, a strong state involvement in the orientation and management of the economy, very high saving and investment rates, and an industrial organization well fitted to mass production. A number of key features of the Korean experience help illustrate how a country can gradually build a knowledge-based economy with approaches to follow and pitfalls to avoid.

The knowledge economy approach emphasizes a gradual, step-by-step coordinated and complementary development of the various KE pillars, synchronized with the country's stage of economic development.

SYNCHRONIZING THE KE PILLARS WITH ECONOMIC DEVELOPMENT. Korea has been exemplary in developing each of the pillars of the knowledge economy at the level, type, and pace that complement the other KE pillars, and together the KE pillars complemented the various stages of the economy's development. For example in the 1960s, when the economy was starting out with subsistence agriculture and light manufacturing, the main focus of education was on providing universal primary and secondary education. At the same time, the universal primary and secondary education of the labor force was also critical to the technology assimilation efforts of the manufacturing industries. Similarly, when Korea was deploying world-class industries in communications, information technology, and advanced electronics in the 1990s and beyond, there was the necessary expansion of the higher education system to ensure an ample supply of workers with tertiary education for the intensive research and development programs. At the same time, the modern and high-technology information infrastructure was being established to facilitate the timely and prompt dissemination of information and knowledge from abroad and around the country.

To reiterate, Korea developed the KE pillars by adopting a gradual, step-by-step approach that emphasized coordination and complementarities among the various KE pillars, and also with the country's stage of economic development and indus-

trialization. In the early years, these complementarities took place without an explicit knowledge economy agenda. The KE approach is thus important to minimizing mismatches in terms of quantity and type in any of the KE pillars and, hence, reducing misallocations and wastage of the extremely scarce resources of any developing country.

A market-based development strategy liberates competitive forces that are crucial for mechanics of the knowledge economy.

MARKET-ORIENTED ROLE OF THE STATE. One of the most important lessons to be gotten from Korea's economic development process is the necessity of a market-oriented approach for the transformation to a knowledge economy. Korea's economic success was not based on policies that substituted for the market. Instead, the success of Korea's development policies up to 1997 was the result of policies that complemented and facilitated the functioning of the market. However, a contributing factor of the 1997 financial crisis was the continued discretionary resource allocation on the part of the government in the early 1990s. This had resulted in a very weak financial sector that was saddled with large debts from the bankrupt chaebols. The financial crisis thus showed the limitations of government's market intervention and underscores the importance of a market-based approach for sustained economic development. A market-based approach requires the existence of competitive forces and, as such, policies that in one way or another foster competition. Transparency of financial markets, accountability of the government, a level playing field for all market participants, liberalized trade, and foreign investment regimes are all crucial characteristics of a market-based knowledge economy.

EXPORT-LED INDUSTRIALIZATION. By adopting an outward-looking development strategy, the government exposed Korean industries to competition in the global market, which compelled them to invest heavily in technological assimilation and innovation. This was true in the 1970s and 1980s, when Korea developed its heavy industries. More recently, stimulated by the same strategy, the resulting increases in competitiveness have enabled Korean firms to gain significant shares in global markets in high-technology areas such as telecommunications, semiconductor memory chips, and liquid crystal displays. Protectionist policies may be effective in creating initial market opportunities for domestic industries, but they eventually lead to complacency in terms of innovation because of the lack of exposure to competitive forces.

An effective, visionary government is critical to the implementation of a knowledge economy approach to long-term economic development.

THE PIVOTAL ROLE OF THE GOVERNMENT. The Korean government has played a very significant role throughout the entire development process. Since the beginning of the industrialization process, Korea's visionary government provided

effective leadership that ensured a stable and conducive macroeconomic environment, providing the mass education and training of the population, encouraging the assimilation of foreign technologies and developing a domestic R&D initiative, and establishing an accessible and modern information infrastructure. As the economy developed and became larger and more complex, it was best to leave economic activities to market forces, and the government consequently adopted a less direct interventionist approach and changed its role to that of an architect and regulator.

One characteristic of the Korean government that deserves special recognition is its long-term fiscal prudence, which allowed the Korean government to implement a series of post-1997 economic reforms even though it had incurred astronomical costs. Removing nonperforming loans and recapitalizing financial institutions, establishing social programs such as unemployment insurance, and providing financial support for low-income families all required public funds and contributed to enormous fiscal pressures. However, because of its long history of fiscal prudence and financial credibility, the Korean government was not straddled with public debt and was able to issue new bonds to finance the necessary reforms.

TOP-DOWN AND BOTTOM-UP APPROACH TO BUILD A NATIONAL CONSENSUS. Because the knowledge economy approach is broad—it permeates many areas of the economy and involves many actors—it is important to use both top-down and bottom-up approaches to build a national consensus and to achieve a set of coherent strategies across the different parts of the government, the private sector, and civil society. Top-down and bottom-up approaches are also key for successful reform processes. In the case of Korea, the sensitization of the society as a whole, including opinion leaders and politicians, to the notion of the knowledge economy had begun before the 1997 crisis as a bottom-up initiative of the *Maeil Business Newspaper*, the principal business newspaper in Korea. Prior to the crisis, the paper's management had organized policy forums that introduced the concept of the knowledge economy and highlighted its benefits, and the public was already accustomed to the KE approach. The 1997 crisis may have actually energized existing KE awareness campaigns, which led to the government finally initiating its top-down approach—the government sought policy evaluations and advice from international organizations on the KE approach and then formulated government plans. In a typical Korean manner, all concerned government departments were mobilized to elaborate new policy measures with quantified objectives and budget estimates for implementing those measures.

Indeed, without the resulting national consensus, efforts to reform and restructure the Korean economy would likely have been unsuccessful, as institutional reforms inevitably invoke resistance from vested interests, which frequently retards the reform process. For example, the legalizing of layoffs was made possible only through dialogues among the government, the private sector, and the labor union, all of whom shouldered a portion of the costs associated with the labor reform. No doubt there are specific features of the Korean society that have facilitated its rapid adhesion to the KE concept. However, the general concept of a simultaneous top-down, bottom-up approach is one that warrants the consideration of policy makers implementing economywide strategies.

Continuing Challenges

The Korean education system has yet to evolve to be able to meet the new skill and knowledge requirements of the knowledge economy.

The industrial model of education in the past years faces new challenges as Korea now enters the information and knowledge era. Education and training in Korea are to date still being largely provided in a routine way. Teacher-centered one-way teaching, rote memorization, the lack of diversity of educational programs, and preoccupation with preparing for entrance exams have all left little degree to nurture creativity and initiative, which are necessary qualities of a workforce in a vibrant knowledge economy. This fact is highlighted by recent surveys that show that Korean youth continue to be inadequately creative. Measures were announced in the 2000 KE master plan to reform the education system, but progress so far remains modest. In addition to the lack of creativity, enrollment imbalances among the academic fields pose a problem. Professional schools, including law and medicine, are highly preferred to science and engineering fields, resulting in a serious mismatch between the skills obtained from formal higher education and those demanded by industry. According to a 1995 opinion survey of executives on the usefulness of university education, Korea ranked 52nd out of 60 countries, showing that Korean universities failed to sufficiently meet the needs of the economy (IMD 2005). As a partial consequence of noncreative Korean graduates, strategic partnerships among universities, private corporations, and research institutions are weak, with little participation in joint research projects and a significant loss of opportunity for indigenous research and development.

Korean students have been found to be lacking in creativity and initiative, plus an insufficient proportion of tertiary students are enrolled in science and engineering fields, all of which result in the current shortage of appropriately skilled workers to fuel Korea's knowledge economy.

In order to nurture creativity and independent thinking, Korea needs a more flexible education system that puts an end to rigid government control over higher education's curriculum, examination system, tuition fees, and number of students in each discipline. This change would allow the higher education institutions to become more entrepreneurial, accountable, and responsive to industrial needs. Also, three-party collaboration among government, universities, and industry is needed to encourage universities to proactively respond to the new demands of the economy.⁷ For example, universities should use their specialty areas to develop innovative programs that cater to industrial needs. Another area

7. The New Industry-Academia Collaboration System that is currently being designed is a step in the correct direction.

A disproportionately large amount of Korean research and development is being conducted by the private sector, resulting in too little R&D in the basic sciences and in R&D investment levels that are overly sensitive to the business cycle.

that needs a concerted effort from the government and industry is the establishment of a more efficient system of job training. For workers to stay in touch with rapid technological advances, there formal links are needed between higher education institutions and other forms of education and training, such as adult education, job training, and employer-based training. In particular, lifelong education should be strengthened. Currently only 19 percent of Korean adults participate in lifelong education, which is low compared with the 35 percent average for the OECD countries (OECD 2005c).

Although Korea has experienced dramatic increases in research and development efforts, the innovation system still has significant issues that are yet to be resolved. For example, a disproportionately large amount of research and development is conducted by the private sector, particularly by the chaebols. This has made the innovation system in Korea vulnerable in two ways. First, applied research and development have been overemphasized and insufficient resources have been devoted to R&D in basic sciences, which is a necessary investment for the long-term development of science and technology. Second, private sector R&D investment is too volatile. For instance, the large Korean enterprises responded to the 1997 financial crisis by cutting their R&D spending by about 14 percent, which destabilized the R&D system. This would have had long-term detrimental effects on Korea's innovative capabilities if the crisis had lasted longer.

However, efforts to improve the relevance and importance of the other institutions in the innovation system have not been successful. Government research institutes have not adequately evolved despite repeated attempts to make them more collaborative with industries. Korean universities have also not been able to respond sufficiently to the industries, both in terms of providing appropriate manpower and in terms of relevant and collaborative industrial research. In addition, the Ministry of Science and Technology, which is responsible for ensuring coordination between the different institutions, has difficulty involving other key partners, such as the Ministries of Industry, Labor and Education, in a coherent strategy.

These challenges in the education and innovation pillars of the Korean economy have persisted for some time, and Korea may encounter further difficulties in maintaining its current rate of economic growth if appropriate, concrete steps are not taken to properly resolve these issues.

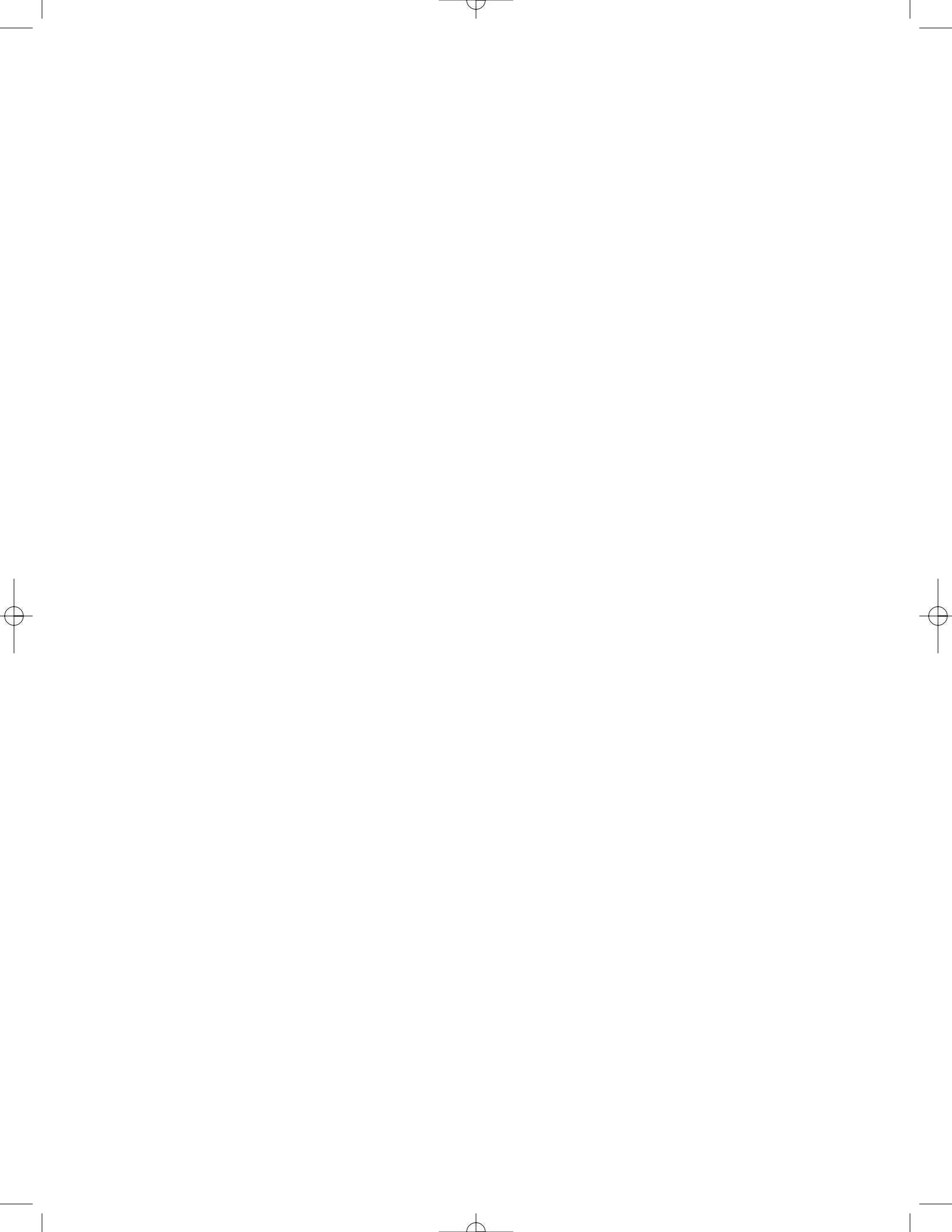
Economic development in Korea has not been balanced across the different sectors of the economy, and the economic benefits have not been trickling down to all household groups, resulting in sharply increased income inequality.

Another challenge facing the Korean economy is that the economic development has not been balanced across the different sectors of the economy, and the benefits of economic growth have not been trickling down to all household groups. Thus, economic inequality among different household groups has increased since the 1990s. This polarization has been amplified by the 1997 recession and takes place in several dimensions. For example, workers in the manufacturing sector are earning significantly more than workers in the service sectors, and workers in the large enterprises (300 or more employees) are economically better off than those in small and medium enterprises. Similar disparities are also observed between workers in the heavy chemical and light manufacturing industries, between those in and those not in the information technology sector, and between permanent and contractual workers. The negative effects of high levels of income inequality on economic growth and political stability have been well documented in the literature; therefore, this social issue needs to be addressed before it becomes a hindrance to long-term economic growth.

Conclusion

Korea's design and implementation of knowledge-based development strategies and the resulting rapid and sustained knowledge-led economic growth over the past four decades provide a wealth of valuable policy lessons for other developing economies. First, and particularly important, are the coordinated and complementary expansion of the four pillars of the knowledge economy framework—economic incentives and institutional regimes, educated and skilled workers, an effective innovation system, and modern and adequate information infrastructure—which evolved with the economy's various stages of development. These pillars provided the economy with the necessary means to effectively acquire and use knowledge to improve productivity and enhance long-term economic growth. Second, the strong and effective leadership provided by the government, which led to the coordinated development of the education, innovation, and ICT pillars, was particularly important during the earlier stages of industrialization when appropriate institutions to coordinate economy-wide development agendas were not yet sufficiently established. The role of the Korean government has appropriately mellowed in recent times to allow the market to further spur economic activity. Third, the economy-wide reforms and the array of policy measures that were implemented after the 1997 crisis serve as good examples of making the best use of opportunities to improve economic conditions. One outcome of those measures was the successful wiring of the Korean economy and the public, resulting in a first-class information infrastructure.

Although Korea has made these advances, it needs to continue to increase efforts to reform its higher education and innovation systems. These pillars have not sufficiently evolved in recent years to meet the demands of the current global economy. In addition, a more proactive policy response is required to achieve more balanced economic development across the different sectors and niches of the economy. Concrete steps to resolve these issues will eventually become critical to Korea's continued transition to the knowledge economy and to sustained economic growth.



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