

STI Policy and Korean Development From Learning to Creating

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KOREA

Land area:
210,000 Km²
(South: 99k Km²)

Population:
70 million
(South: 48 mill)

Economic System:
South: Democracy
North: Socialist



Bordering with world super powers: Major historical changes on the Korea peninsula have been largely the results of rivalries and cooperation among those countries...

Geo-economic features....

- ◆ A country with a small land – app 220,000 square Km or 99,000 square Km, if excluding the northern part of the peninsula, of which $\frac{3}{4}$ is non-arable mountains
- ◆ Very poor in natural resources – no oil reserve, insignificant reserves of coal and other resources
- ◆ Very limited economic interactions with western powers due to geographical remoteness – retarded in industrialization
- ◆ But it has to support a large population – 80 million people

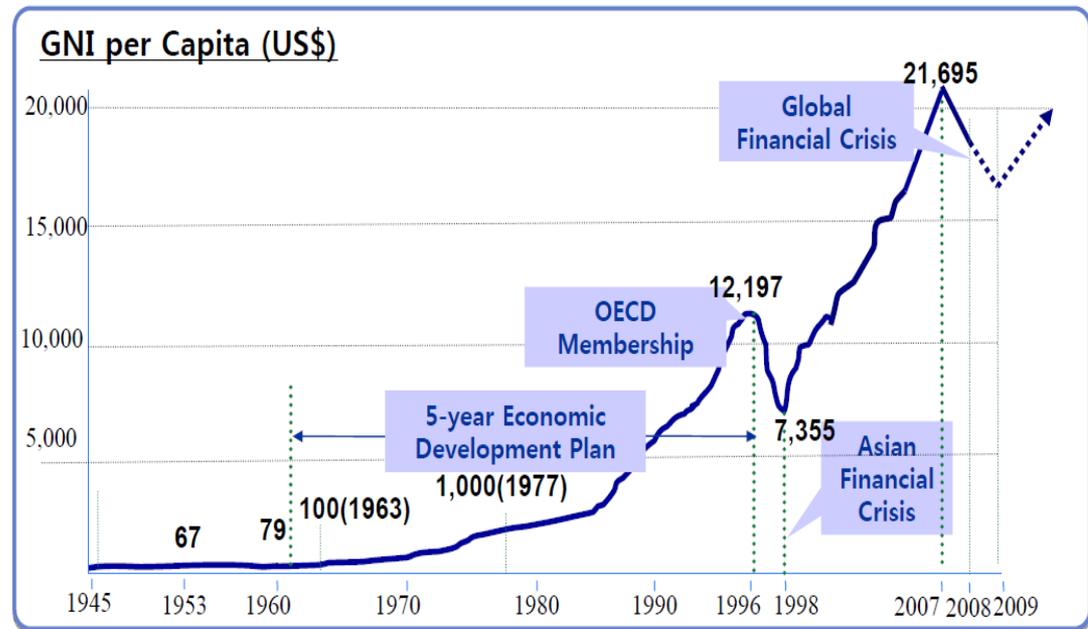
Cultural inheritance....

- ◆ A very uni-cultural society strongly influenced by Confucian tradition
 - ✓ placing highest value on scholarship and education
 - ✓ social order based on vertical relationships – respect for seniors and the elderly
- ◆ Very closely knitted society, where family, school, religious and regional backgrounds are very important determinants of inter-personal relationships
- ◆ Relatively high social mobility – education has been the major vehicle to higher social class

Korean development

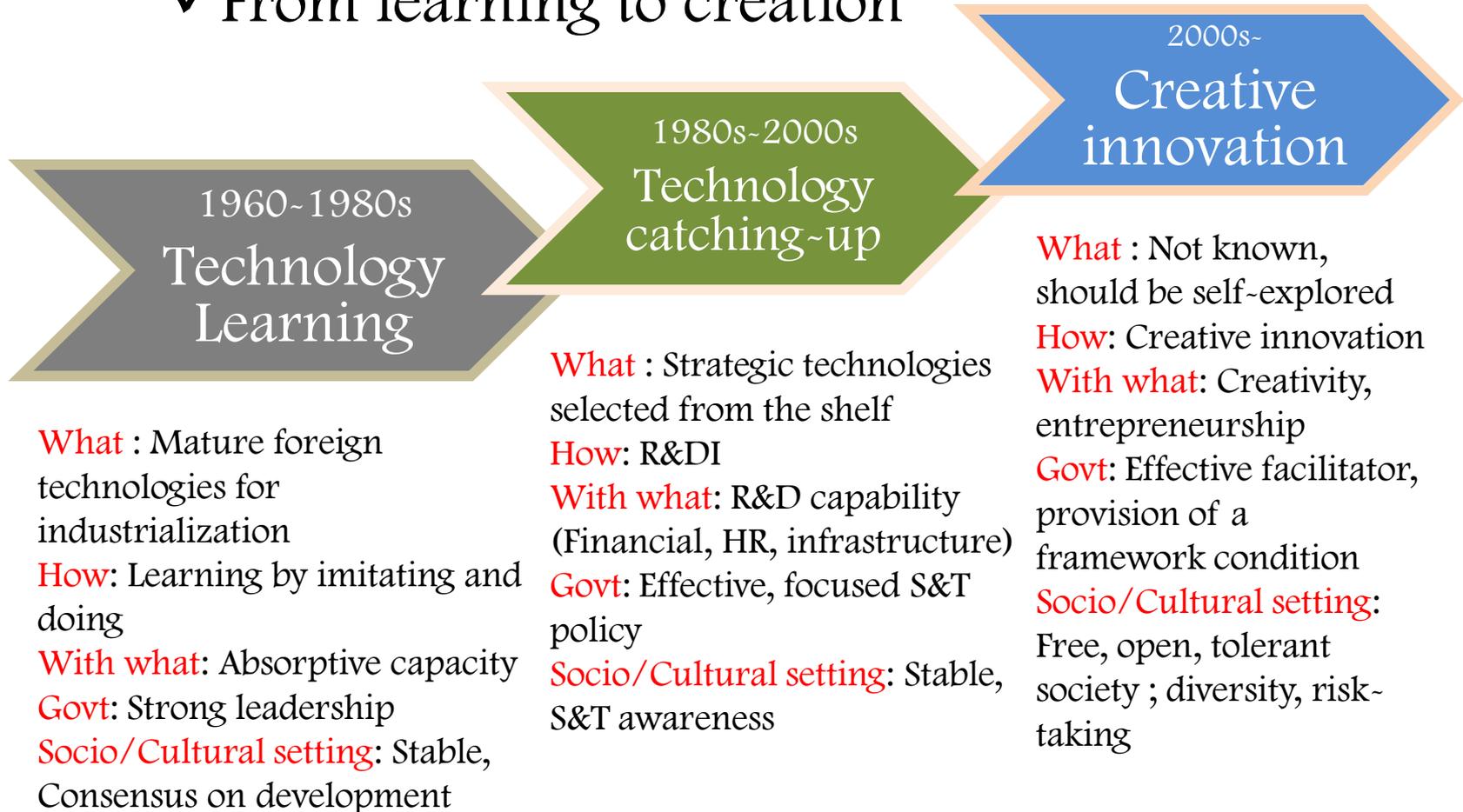
- ◆ GNI PC: \$ 87('61) → \$20,000('10)
- ◆ Exports: \$55 M('61) → \$400 B ('10)
- ◆ Unemployment: 22.3%('61) → 3% ('10)

Korea has transformed itself from one of the poorest countries in the world into one of the most dynamic industrial economies...



◆ Evolution of STI Policy in Korea

✓ From learning to creation



Technology Learning

1960s~1980s

*“In the beginning, R&D was not the major element of STI policy...
Lacking in technological capability, Korea had no option
but looking outward for technologies required for
industrialization -- an “outward-looking development
strategy.”*

Where Korea was in the 60s.....

- ◆ Socio-political situation: Unstable, recovering from the Korean War
- ◆ Economic situation: Traditional agrarian society, relying on agriculture for more than 60% of GDP
- One of the poorest economies then in the world suffering from all the problems that poor countries in those days were facing.....*So, the most urgent challenge for Korea as a nation was how to liberate its people from the chronic poverty*
- ◆ But Korea had neither capital nor technology required for industrialization. The only resource it had was human resources – “well-educated but under-exploited” workforce.

Institutional setting

- ❖ Strong government, autocratic but determined to develop the nation
 - ✓ The Five-year Economic Development Plans
 - ✓ The New Community Movement (Sae-ma-eul Undong)
- ❖ Incentive system based on export performance
 - ✓ Financial incentives
 - ✓ New opportunities for business
- ❖ Industry-targeting strategy
 - ✓ Technology transfer and development for strategic industries
 - ✓ Technological independence of strategic industries
- ❖ S&T capacity building for long-term growth
 - ✓ Government R&D Institutes
 - ✓ Legal framework

→ **Government-initiated institutions to promote and facilitate learning by doing foreign technologies for industrialization**

Korean STI strategy in the early stage

◆ “outward-looking technology strategy”

- ✓ As Korea lacked both technology and capital in the beginning of the industrialization, it had no option but resorting to foreign sources for technology and capital required for industrialization. But Korea was faced with additional constraints that further limited its strategic options for technology acquisition, such as **shortage of foreign exchanges and people's desire for economic independence**. So, Korea could not rely so much on direct foreign investment and foreign licensing for the acquisition of capital and technology as other developing economies did and do....

✓ Technology acquisition via informal channels

“Gov’t brought in large-scale foreign loans and allocated them for investments in selected industries, which led to massive importation of foreign capital goods and turn-key plants. Industries later reverse-engineered the imported capital goods for the purpose of acquiring the necessary technologies, while, at the same time, building a base for scientific and technological development...”

. Channels for technology acquisition: 1962-81 (M US\$)

	FDI	FL	Capital Goods
1962-66	45.4	0.8	316.0
1967-71	218.6	16.3	2,541.0
1972-76	879.4	96.6	8,841.0
1977-81	720.6	451.4	27,978.0

Innovation actors' response

- ❖ The emergence of the Chaebol system
 - ✓ Group of diversified business corporations formed to better respond to the new business opportunities offered by the national development plans
 - ✓ Export-oriented business group
 - ✓ Leading actors in the government-initiated industrial development projects
- ❖ Public sector research
 - ✓ Created the government R&D institutes to help private sectors identify, acquire, and assimilate foreign technologies
 - ✓ Strengthen university research capacity
 - ✓ S&T capacity-building: Base for future S&T development
- ❖ Private industries' technology strategies
 - ✓ Technology learning: Turn-key plants, OEM, technical training, FL ...
 - ✓ R&D labs: Created to adopt and assimilate technologies borrowed from foreign sources

→ Institutions born in response to government development strategy: Focused on acquiring and learning foreign technologies

How industries acquired technologies ?

Light industries, such as shoes, apparels, etc. learned technology mainly through OEM production arrangements, as OEM buyers provided everything from raw materials to design, to production knowhow, and to quality control.

Chemical industries relied very much on turn-key base importation, which provided technical training programs as part of the package. They later internalized the technology by implementing and operating the imported factories and attained technical capability to maintain and further improve upon the imported technologies....

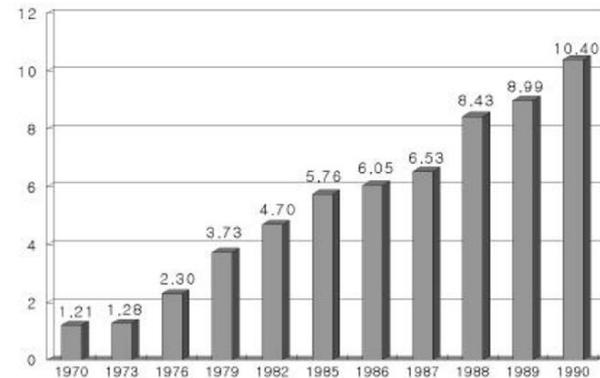
Machineries and, to a lesser extent, electronic industries resorted more to formal licensing for technology acquisition than other industries...

 learning by imitating and implementing foreign technologies

Shoes industry: Technology learning through OEM production arrangements

	Technological Transition	Market Transition
<u>1960s/1970s</u> OEM <i>Original Equipment Manufacture</i>	Local Firm learns assembly process for standard, simple goods	Foreign TNC/buyer designs, brands and distributes/gains non manufacturing value added
<u>1980s</u> ODM <i>Own Design and Manufacture</i>	Local firm learns process engineering and detailed product design skills	As with OEM, TNC buys, brands and distributes. TNC gains non-manufacturing value added
<u>1990s</u> OBM <i>Own Brand Manufacture</i>	Local firm conducts manufacturing, product designs and conducts R&D for new products	Local firm has own brand, organises distribution and captures all value added

As learning proceeded, the unit export price of Korean shoes increased rapidly...



POSCO: Learning through technical training

- ◆ In the late 1960s, POSCO acquired technologies required to build and operate steelworks from Nippon Steel Corp and Nippon Steel Pipe Corp
 - ✓ The Japanese companies provided POSCO with not only technologies but also technical training
 - ✓ POSCO engineers also developed personal relationship with Japanese engineers who later provided tacit knowledge that could not be acquired through on-the-job training
- ◆ POSCO also hired retired Japanese technicians as technical consultants to acquire knowhow to operate the steel mill.
- ◆ POSCO then accumulated technical knowhow and developed capability to improve the imported technologies,
 - ✓ Two decades later, POSCO built a new steel mill on its own technologies and knowhow..

LG: Technology learning through FL

- ◆ LG licensed TV technology from Hitachi in 1965 as a package that included not only assembly processes but also product specifications, production knowhow, parts, components, training and technical experts.
 - ✓ LG also sent 7 engineers to Hitachi for intensive training
 - ✓ In addition, LG invited Hitachi engineers to supervise the installation and start-up of the production system to minimize trial and error time
 - ✓ But the utility of the Japanese engineers diminished within a year

- ◆ LG was able to internalize the TV technology and apply the technologies to the assembly of other consumer electronics, such as cassette recorders, and simple audio systems without foreign assistance.

- ◆ LG's case shows how Korean electronics companies absorbed and internalized technologies acquired from foreign sources...

◆ Benefits and costs of the Korean strategy

In a nutshell, Korean industries depended more on informal channels for technology acquisition than formal channels.

✓ *Less costly, but require higher capability of technology recipients in not just identifying and selecting technologies but also absorbing, assimilating and improving upon the transferred technologies.*

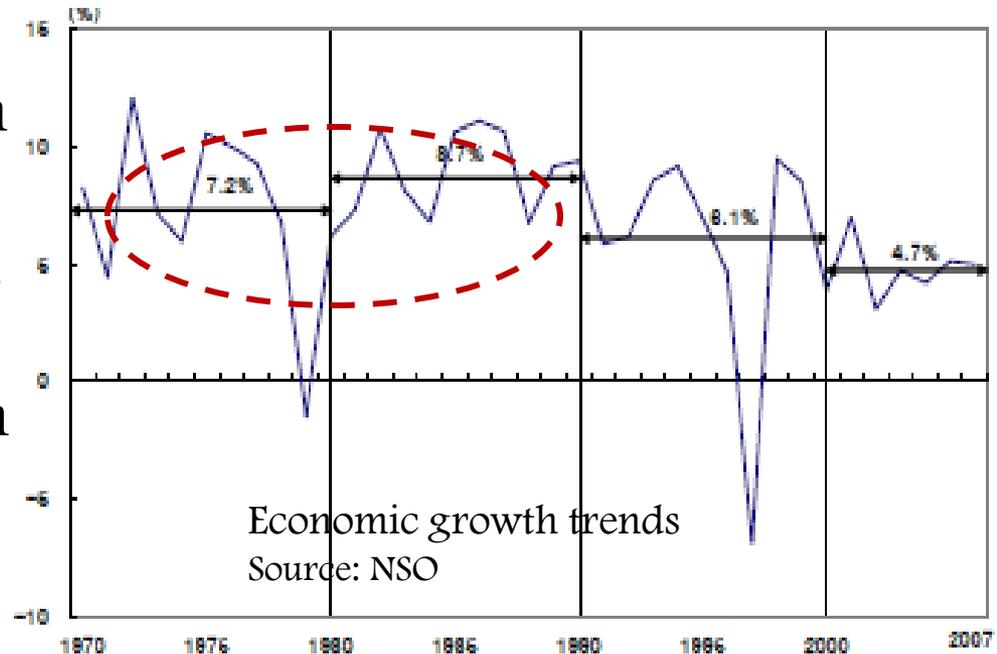
✓ *Independence from the technological predominance of MNCs, but Korea had to forego the opportunities that direct foreign investment offers..*

✓ *This means that Korea has been able to succeed in acquiring technologies for industrialization through this strategy largely owing to the rich pool of well-educated human resources....*

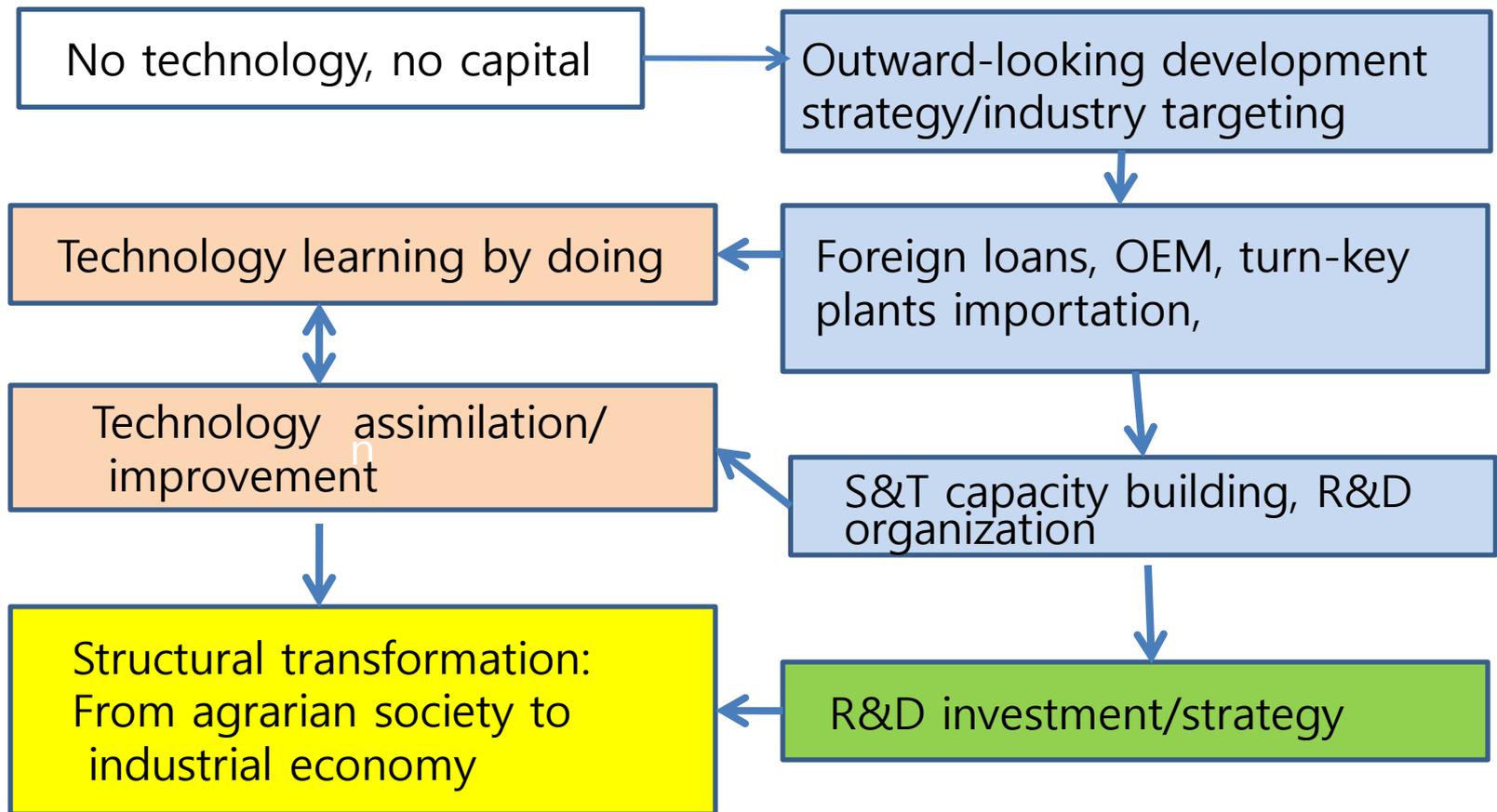
- ◆ Along with the effort for industrialization, the Korean government took various policy measures to build S&T capacity, such as:
 - ✓ Establishment of the Korea Institute of Science and Technology (KIST, 1966): Korea's first R&D institute in modern sense
 - ✓ Creation of the Ministry of Science and Technology (MOST, 1967): Responsible for S&T policy formulation and implementation
 - ✓ S&T Promotion Act (1967)
 - ✓ Establishment of GRIs in the strategic areas (1970s)
 - ✓ Creation of the Korea Advanced Institute of Sciences (KAIS, 1971): S&T graduate school (US system)
 - ✓ Construction of the Daeduk Science Town (Ground-braking 1974)

◆ Achievement: Industrialization with high growth

- ✓ 1960s~'80s: Average annual growth rate: over 9%
- ✓ Source of growth: **Effective technological absorption** (owing to abundant human resources, high investment rate, plus latecomer advantage)
- ✓ Transformation from an agrarian society to an industrial economy, which was based on low- and medium-tech industries.



Korean strategy in a nutshell



◆ Key factors behind the growth

1. Political leadership: vision and strategy
 - Consistent linkage of S&T to socio-economic development
2. Promotion of demand for innovation
 - Outward-looking development strategy
 - Challenge-led approach: Heavy and chemical development strategy
3. Human resources
 - Investment in education
 - HRD linked to socio-economic development

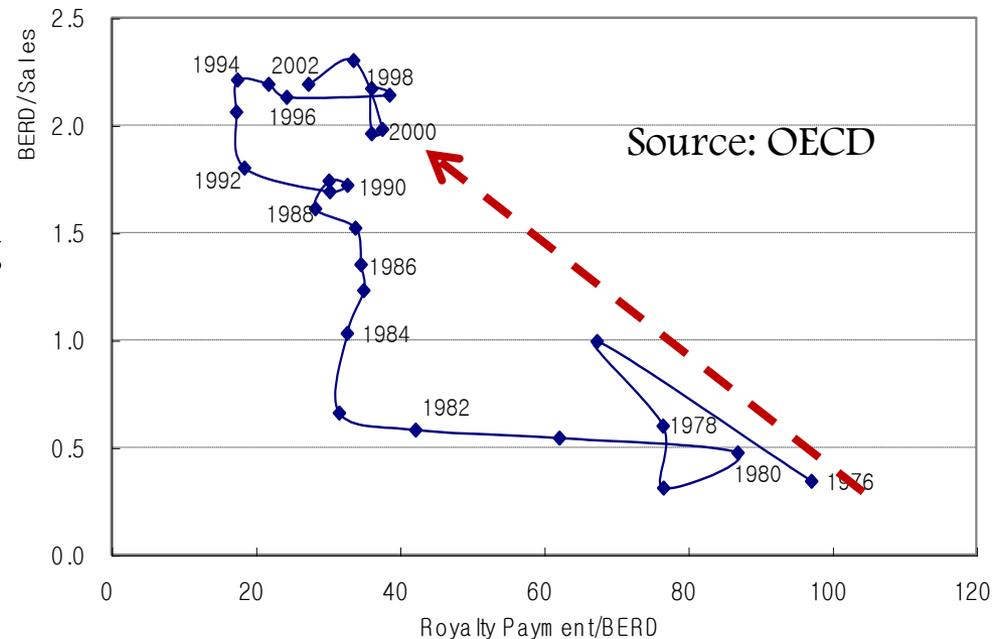
Technology catching-up

1980s-2000s

In the early 1980s, the government shifted its policy from promoting technological learning to technology development, as the technological requirements for further development could no longer be met through learning by implementing and imitating.

◆ Policy shift to indigenous R&D

- ✓ Launching of the national R&D program (1982)
- ✓ Promoting private firm's research: financial, tax and other incentives to stimulate R&D investments in the private sectors
- ✓ In response, private industries changed their technology acquisition strategies from learning to developing, increasing investments in indigenous R&D



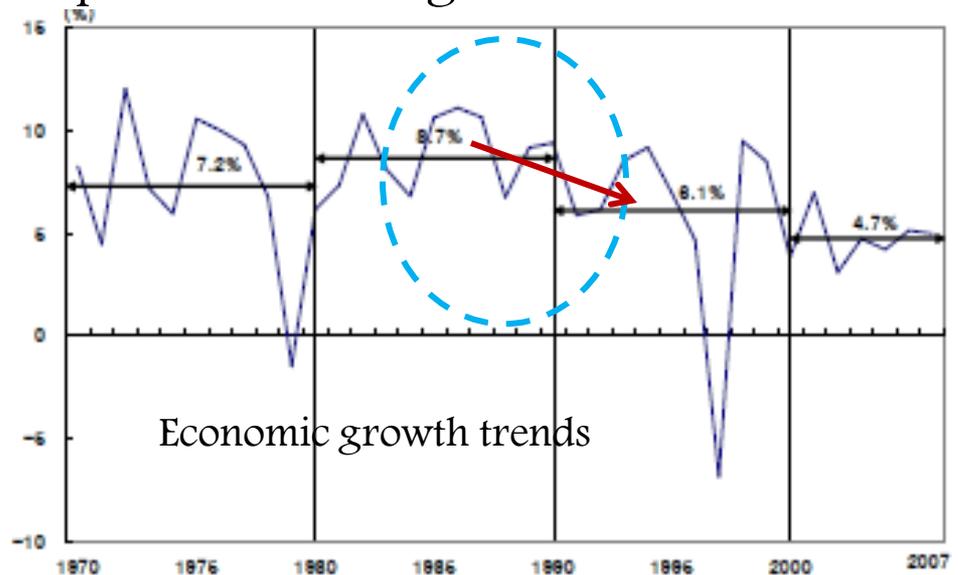
◆ Transition toward a low-growth phase

✓ The high growth phase was coming to an end around the end of the 1980s

- Exhaustion of latecomer advantage in growth
- Changing socio-economic environments: Change in trade regime(WTO), democratization, union movements, increasing wages – decline in growth potential and urgent need for alternative sources of growth

✓ Need for structural transformation toward high-tech, high value-added industries

➔ **A new challenge
for Korean
development**



◆ Policy responses: Key components of the STI policy for industrial transformation

(1) Expansion of R&D and launching of mission-oriented national R&D programs:

- ✓ HAN Project launched in 1992
- ✓ Aiming at developing strategic technologies to fuel the growth in the next decade
 - A. Product-oriented: Semiconductor, HDTV, ISDN, New drugs/agro-chemicals, Advanced production system, Electric cars
 - B. Core technologies: New materials, Next generation nuclear reactor, New energy, Environmental technology, New functional bio-materials
- ✓ Formulation process: Technology foresight > PP joint committee > Inter-ministerial agreement > Implementation
- ✓ Format: Large, long-term industry-government collaboration

- ✓ The HAN project was followed by other similar programs involving private companies
 - Private companies' participation in the major projects during the 1990s :

Projects	Exporting* companies surveyed	Participants in the projects	%
Semiconductors	39	20	51.3
Display	29	19	65.5
Mobile phone	15	9	60.0
Telecom parts	49	30	61.2
Ships	14	11	78.6
Automobiles, parts	81	47	58.0
Computer	21	12	57.1

•Number of firms surveyed.

•Source: KISTEP

- Target technologies were identified through foresight activities: Of the promising technologies identified, what Korea could do better...

(2) Promotion of ICT development

- ✓ Creation of the Ministry of Information and Communication ('95)
- ✓ ICT Promotion Fund (Government budget + telecom companies' contributions , '96)
 - App 1~1.5 Billion US dollars for ICT R&D per year
 - Funding PP collaborative R&D
- ✓ Informatization Promotion Act ('96)
- ✓ Korea Information Infrastructure Initiative (KII, '95)
 - 10 year 3 stage Plan for the construction of Info highway)
- ✓ The Informatization Promotion Committee ('96)
 - Chaired by the Prime Minister

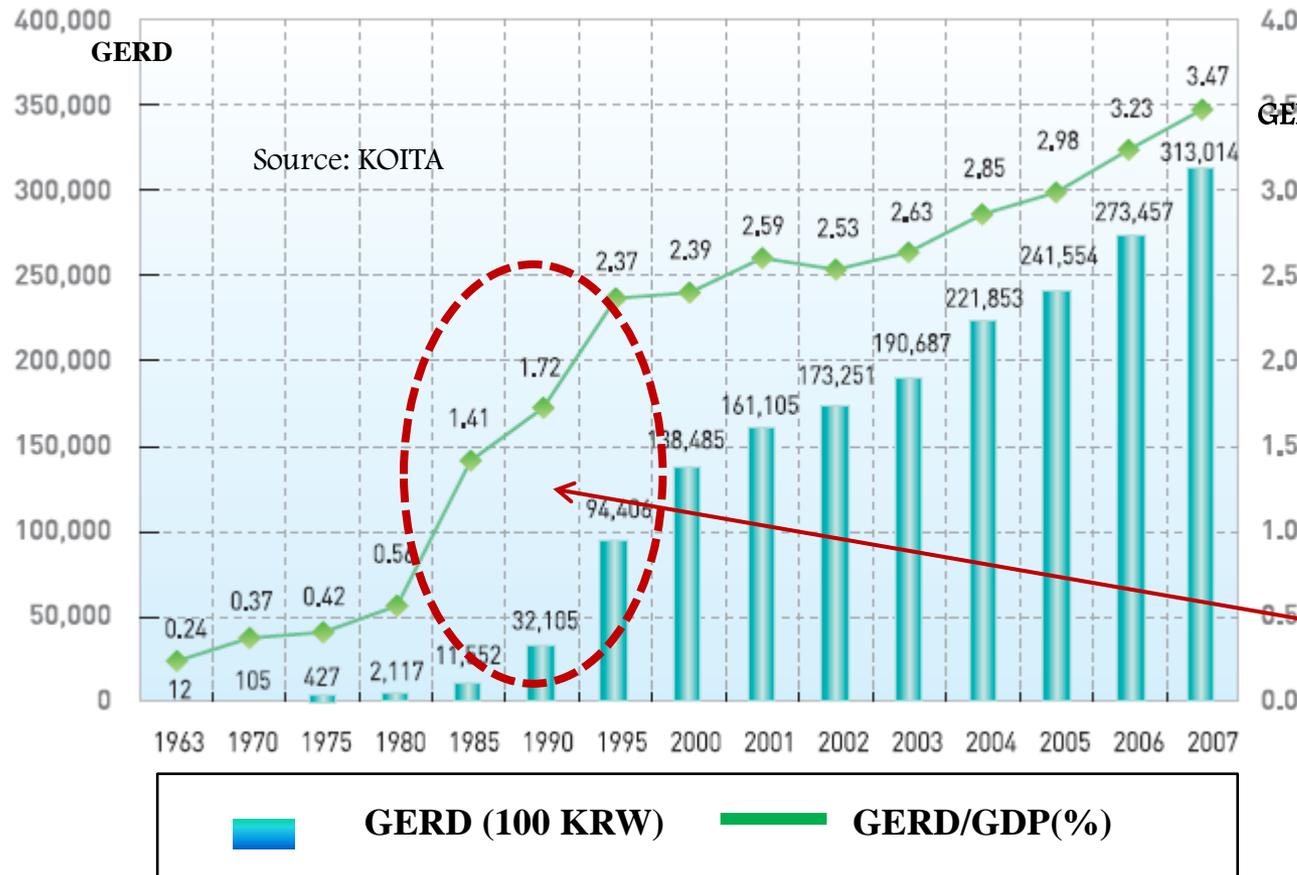
(3) Strengthening policy incentives to promote and facilitate RDI in the private industrial sectors

- ✓ Promoting private firm's research: strengthening financial, tax and other incentives to stimulate R&D investments in the private sectors
- ✓ Opening of a stock market for new technology-based firms: KOSDAQ (Korea Securities Dealers Automated Quotations) as a division of KRX (1996)
- ✓ Promotion of venture capitals
- ✓ Strengthening advanced education in science and technology
- ✓ Information infrastructure

(4) Reforms in economic institutions

- ✓ In the early 1990s, in response to the changing economic environments:
 - Liberalization and deregulation (foreign trade and investment)
 - IPR regime (in compliance with the TRIPS)
 - Competition policy (in particular, in the communication industry)
- ✓ Around the end of the 1990s, in response to the Asian Financial Crisis:
 - Public sector reform: **Down~sizing, stream~lining**
 - Labor market reform: **Enhancing flexibility**
 - Financial sector reform: **Liberalization**
 - Corporate sector reform: **Tuning to international business practices**

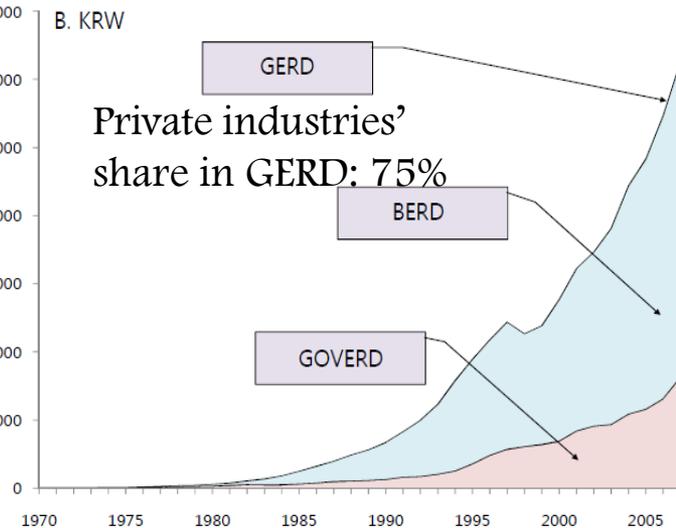
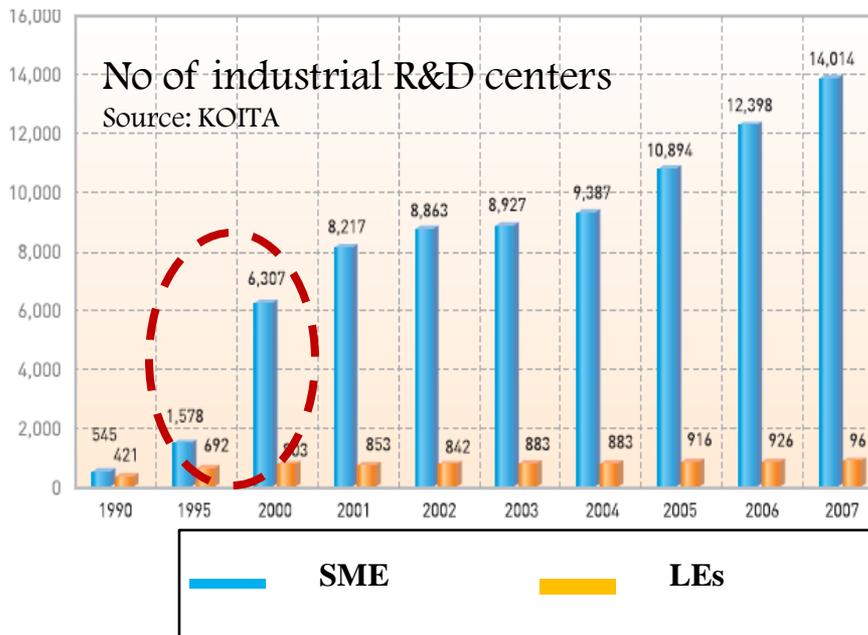
◆ Policy results (1): Rapid increase in R&D expenditures



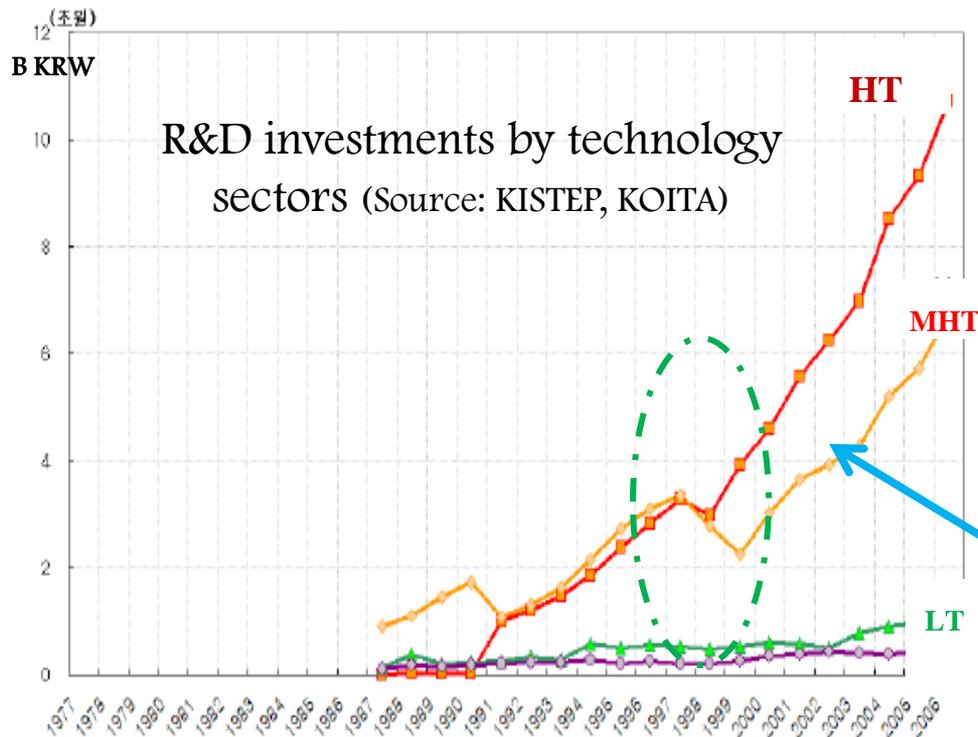
✓ The policy contributed to the drastic increases in GERD in the early 1990s,

◆ Policy results (2): Remarkable growth of private industrial R&D and innovation activities

- ✓ Rapid increases in private R&D centers, in particular, SME R&D labs.
- ✓ Increased share of industrial R&D expenditures in the gross national R&D expenditures to 80% (around the end of 1990s)
- ✓ Massive investment in high-tech fields by large Chaebol companies



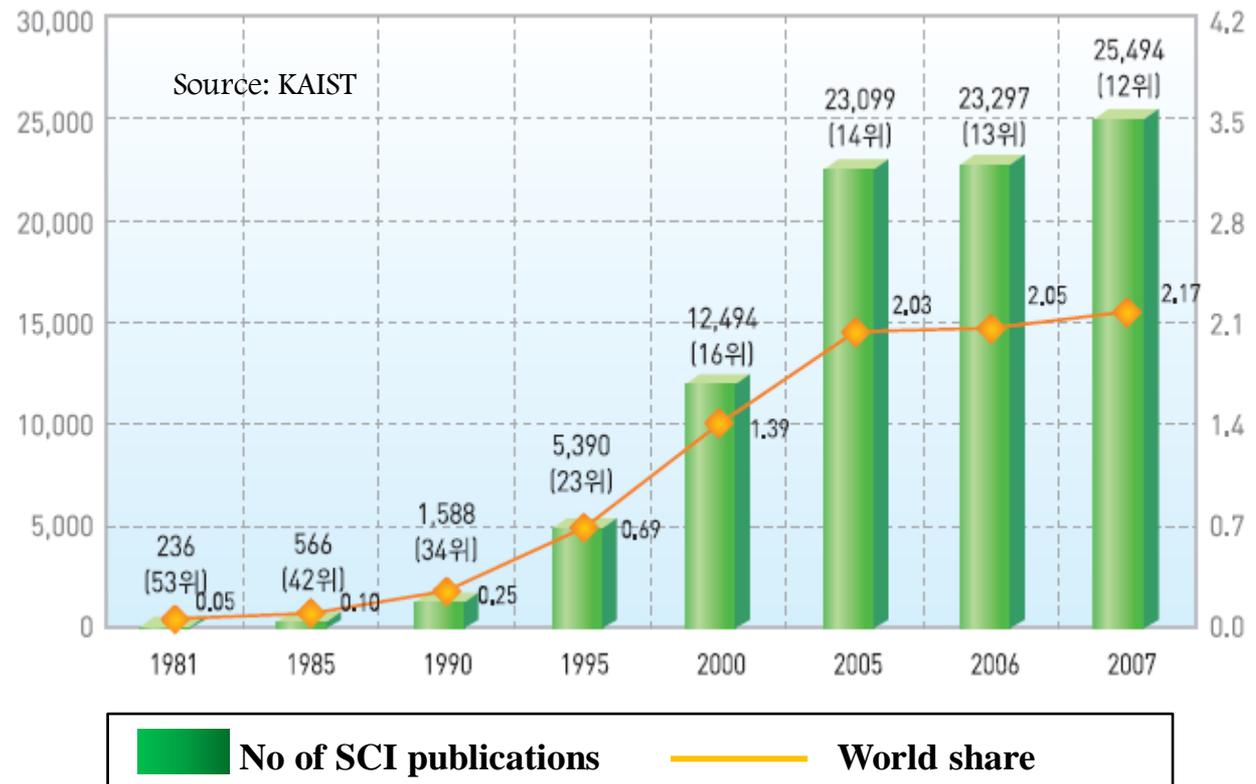
◆ Policy results (3): R&D investments focused on high-tech sectors, such as machineries, office equipments, electronic parts, medical equipments, automobiles, etc



Industry	R&D (billion won)	R&D intensity (%)
Total	21,339	2.97
Food	331	0.76
Textile	146	0.86
Pulp, paper	40	0.71
Chemicals	2,399	1.49
Non-metal minerals	142	1.20
Basic metals	171	0.63
Fabricated metals	75	1.92
Machinery	1,617	3.56
Office equipment	343	4.29
Electro components	7,624	6.33
Comm. equipment	2,886	6.71
Med/precision equip	205	7.50
Automobiles	3,831	3.42
Others	56	1.39

◆ Outputs from the investments(1): massive increases in scientific publications (SCI), making Korea visible in the international science and technology community

✓ Starting from nowhere, Korea now is 12th producer of SCI publications...

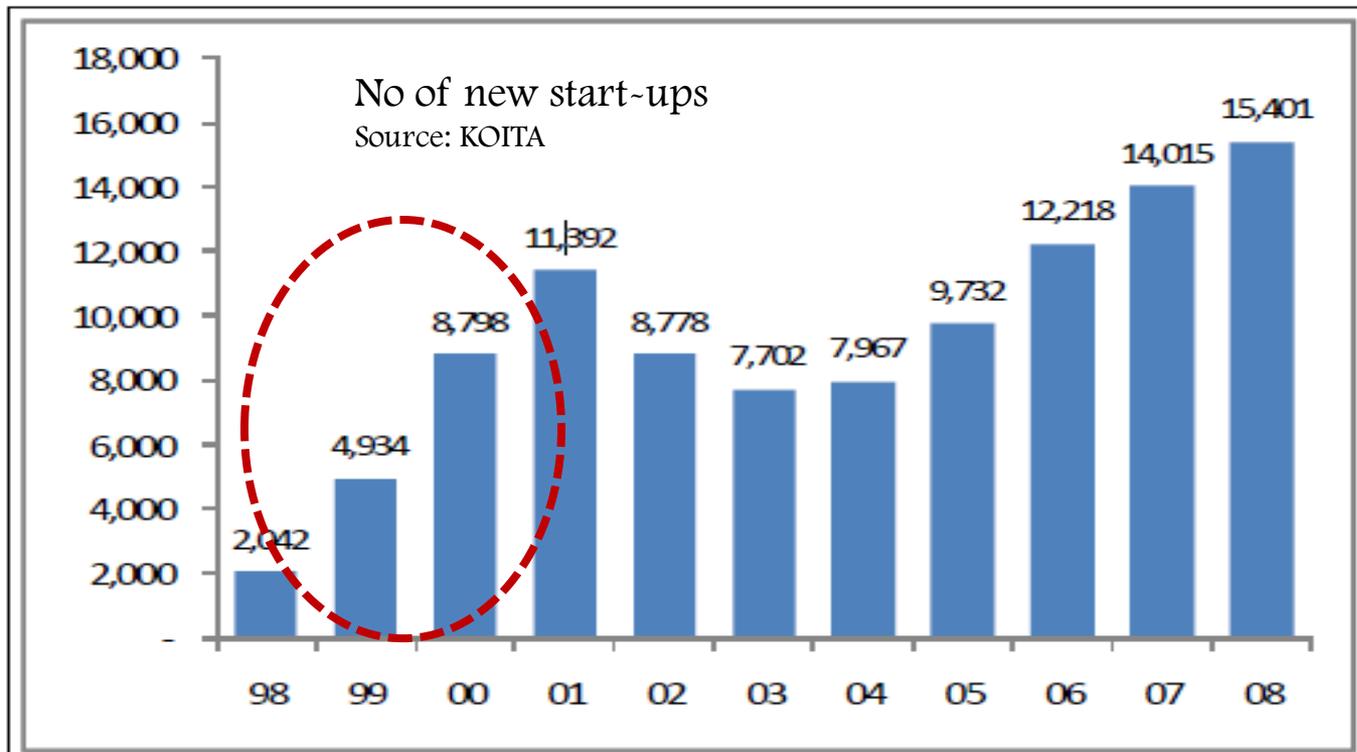


- ◆ Outputs from the investments(2): increased patents, both international and domestic, opening new technological opportunities for industries..

	PCT applications			US patents		
	No	Share	Rank	No	Share	Rank
1993	128	0.4	19	779	0.8	11
1995	196	0.6	18	943	0.9	10
2000	1,580	1.7	10	3,314	2.1	8
2002	2,520	2.3	9	3,786	2.3	7
2004	3,558	2.9	7	4,428	2.7	5
2006	5,948	4.0	5	5,908	3.4	5
2007	7,080	4.5	4	6,296	4.0	4

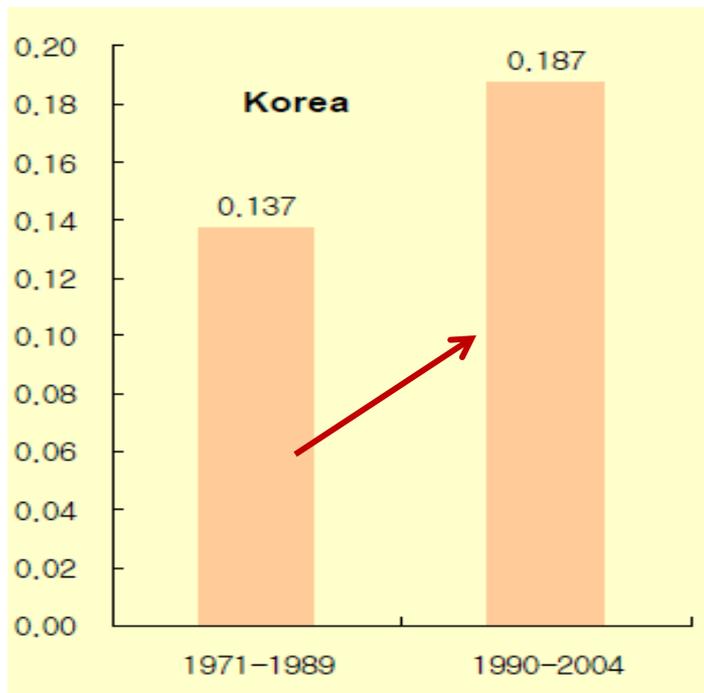
Source:
KOITA

- ◆ Economic impacts (1): Young entrepreneurs took the increased technological opportunities to start new businesses.
 - ✓ Major factors: New ideas + improved business environments + KOSDAQ



◆ Economic impacts (2): Contribution to TFP growth
 Measured as R&D elasticity of TFP

$$Y_t = A_t K_t^\alpha L_t^{1-\alpha} \quad \frac{\Delta A_t}{A_t} = \beta_0 + \beta_1 \log RD_t + \varepsilon_t$$



Source: STEPI, OECD

✓ Productivity growth in high-tech industries

R&D elasticity of TFP by industries:

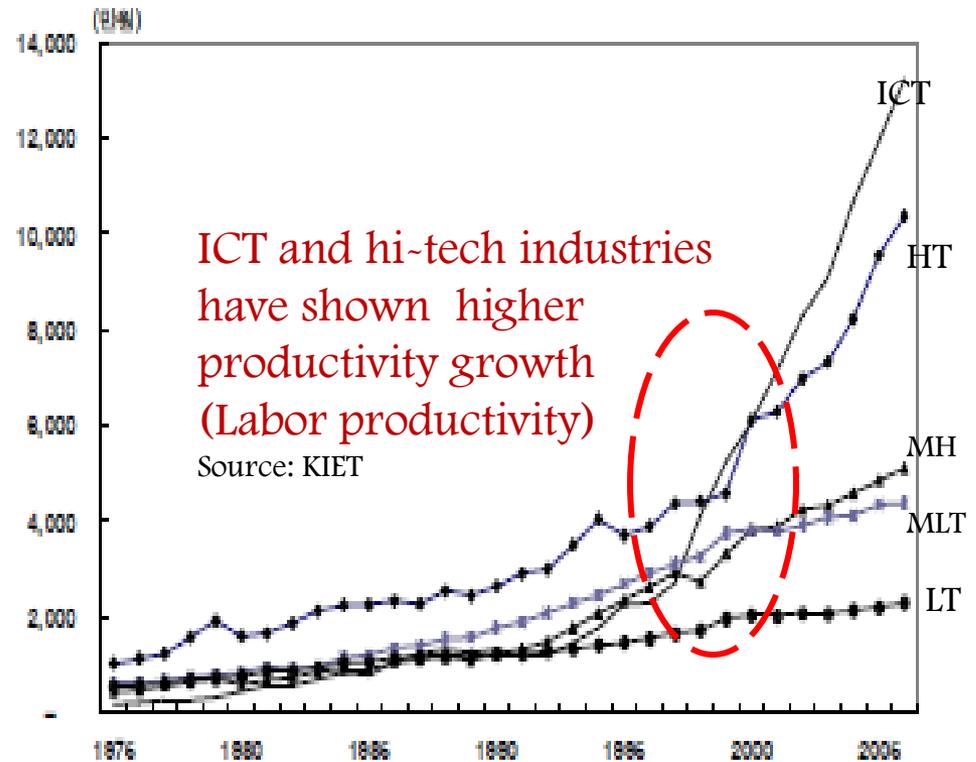
Hi-tech ind: 0.175

M hi-tech ind: 0.089

M low-tech ind: 0.076

Low-tech ind: 0.109

R&D investments have resulted in higher productivity growth in high-tech industries (Estimation: STEPI 2007)



◆ Economic impacts (3): Growth of ICT and financial sector innovation

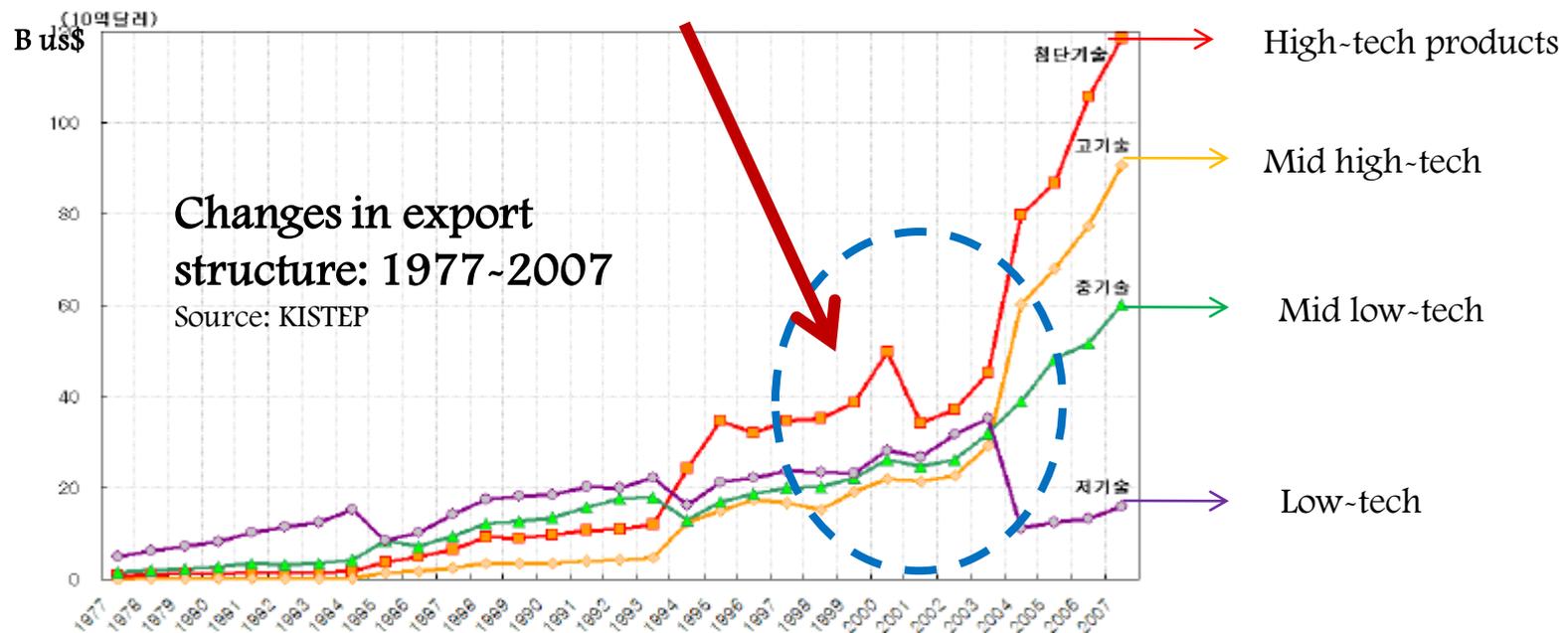
✓ Share of ICT in manufacturing industries (%)

Country	2006	1995
Korea	21.1	16.0
Finland	20.1	8.7
Japan	12.8	12.6
Hungary	12.6	4.8
Ireland	11.5	14.2
USA	7.7	10.3
UK	6.0	8.3
OECD average	7.2	6.9

✓ Financial sector innovation: Internet banking subscriber (30 mil, 32% of the total transactions, '05), On-line stock trading: 65% of the total ('05)

◆ Economic impacts (4): Structural changes in exports

- ✓ Structural change in exports took place gradually and continuously over time, but very clearly and rapidly in the late 1990s and early 2000s



Structural transformation

Top 10 exports 1980s
Apparels
Ships
Knit wear
Shoes
Semiconductors
Automobiles
Polyester
Leather
Textiles
Radio sets

National R&D projects for GRI-
Industry collaboration

D-RAM memory chip: '86-97, 92-97

CDMA technology: '89-'96

Flat display: '95-'01

Auto engine: '92-01

Ship design system: '01-05

Mobile internet(Wibro): '03-05

Next generation display: '95-'01

■
■
ICT promotion,
Plus improvement in business
environments

Top 10 exports 2000s
Semiconductor
Automobiles
Ships
Mobile handsets
Synthetic resin
Auto parts
Monitor
Com. Equip. parts
Flat display
Computer parts

◆ Economic impacts (5): Establishing world prominence in several high-tech areas

- ✓ Semi-conductors: 3rd (2006)
- ✓ Electronic products: 4th (2006)
- ✓ Mobile handsets: 2nd (2008)
- ✓ Display (TFT LCD): 1st (2008)
- ✓ Automobile: 5th (2006)
- ✓ Steel: 5th (2006)
- ✓ Shipbuilding: 1st (2006)

◆ Key factors behind the structural transformation

- ✓ Human resources
- ✓ Private sectors' RDI capability: financial and technological
- ✓ Focused strategy: Combination of technology policy and institutional reforms
- ✓ PPP
- ✓ National consensus: sense of crisis

Creative Innovation

2000~

From learning to creating

◆ Moving toward a creative innovation-based economy

✓ Increased focus on creative basic research

- Increase funding for basic research to 50% of the government R&D budgets (2008, 26%)
- Increase investment in big sciences (space, high energy physics, etc)
- Increase investment in research on the issues of global concern
- Increase the proportion of doctorate level researchers to 30% (currently, 23%)

✓ Contribution to socio-economic development

- Enhance industrial competitiveness: enhance productivity of the existing industries – Automobile, ship-building, machineries, semiconductors, telecom, display, etc.
- Creation of new industries; Bio-med, next generation system s/w, et.

- ✓ Along with the increase in basic research, the following policy programs are being implemented:
 - Nurturing scientific talents:
 - Expansion of the schools for scientific talents
 - Fostering world-level research universities
 - Stable funding for GRIs
 - Promotion of new technology-based SMEs: Innovation Support for SMEs (977 B KRW/year), Technology Funds for SMEs (target 7.7 Trillion KRW by 2012)
 - Applying ICT to various sectors of the economy
 - Combining ICT with new business ideas
 - Internationalization of ST activities
 - Strengthening ST infrastructure: large facilities, bio-resource banks, etc.

DISCUSSIONS

- ◆ Korea has been successful to a certain extent in making structural transformations from an agrarian society to high-tech, high value-added industrial economy
- ◆ Factors behind the success:
 - ✓ Early stage (1960s-80s): Political leadership, HR, outward-looking development strategy, sense of crisis, social cohesion
 - ✓ Later stage (1980s-): HR, private industries' RDI capability, focused strategy(proactive government), PPP, and national consensus (sense of crisis)
- ❖ The reform measures taken in response to the Asian financial crisis also made an important contribution to the structural transformation by improving the regulatory frameworks and business environments (public sector, labor market, financial system, corporate sector).

- ◆ But to complete the transformation, Korea has to make another transition toward a creative innovation-based economy, which will be much harder to achieve
 - ✓ To achieve the goal, Korea has to solve the following problems, among many others:
 - Combining the Confucian tradition with ‘culture of innovation’: Diversity, tolerance, openness, accommodating failures, etc.
 - Education for creativity
 - Setting up an institutional environment conducive to creativity and innovation
 - Internationalization of the STI system

Thank you