KBE Chapter 7

Harnessing the Potential of Science and Technology

June, 2006

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Structure of the presentation

1. **Objectives**
2. **Industrialization and S&T development**
3. **Government and Public Sector R&D**
4. **Industrial Technology Policy**
5. **Recovery from the Economic Crisis**
6. **Key Characteristics of KIS**
7. **Lessons for late-comes**

I. Objectives of the chapter

- To overview the process of building technological capability within the framework of economic development
- To assess the Korean innovation system
- To derive lessons for late-comers

II. Industrialization and S&T development

1. Where Korea was in the 1960s

- Geo-political and geo-economic conditions
  - A small divided country relying on foreign countries for security
  - A resource-pour, densely populated country with small domestic market and weak technological base : Human resource was the only asset for economic development
  - ⇨ Outward-looking development strategy based on human resources and technology

- Economic situation (1961)
  - GNP : $ 2.3 billion (1980 prices), GNP P/C : $87
  - Exports : $55 million, Imports : $ 390 million
  - Share of manufacturing in GNP : 15%
  - Unemployment rate : 22.3%
  - ⇨ One of the poorest counties in the world

- S&T situation
  - R&D manpower (1969) : 5,337
  - R&D investment (1963) : $ 9.5 million (Gov't: $ 9.2 million)
  - R&D organization : National Defence R&D Institute (1953)
    Korea Atomic Energy Research Institute (1959)

⇨ A barren land as far as S&T is concerned

2. How Korea acquired technology for industrialization

- Acquisition of technologies for development : ’60s and ’70s
  - ❖ Development of light industries and heavy chemical industries for import substitution and export-expansion
  - ⇨ Generated enormous demand for technologies that were not available from domestic sources
  - ❖ Policy responses
  - ⇨ Promotion of inward transfer of technologies
  - ⇨ Developing domestic absorptive capacity to digest, assimilate and improve upon the transferred technologies

- Promotion of technology transfer
  - Policy constraints : shortage of foreign exchanges, strong desire for economic independence
  - ⇨ Restrictive stance toward DFI and FL
  - ⇨ Policy relying on long-term foreign loans to finance industrial investment : “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 plant. Industries later reverse-engineered the imported capital goods for the purpose of acquiring the necessary technologies.”

- Private industries' responses
  - ❖ Light industries (shoes, clothing, textile…)
  - ⇨ Rely on OEM production arrangements
  - ❖ Chemical industries
  - ⇨ Resort to turn key-plant importation with technical training
  - ❖ Electric and machineries
  - ⇨ Relatively more reliant on FL

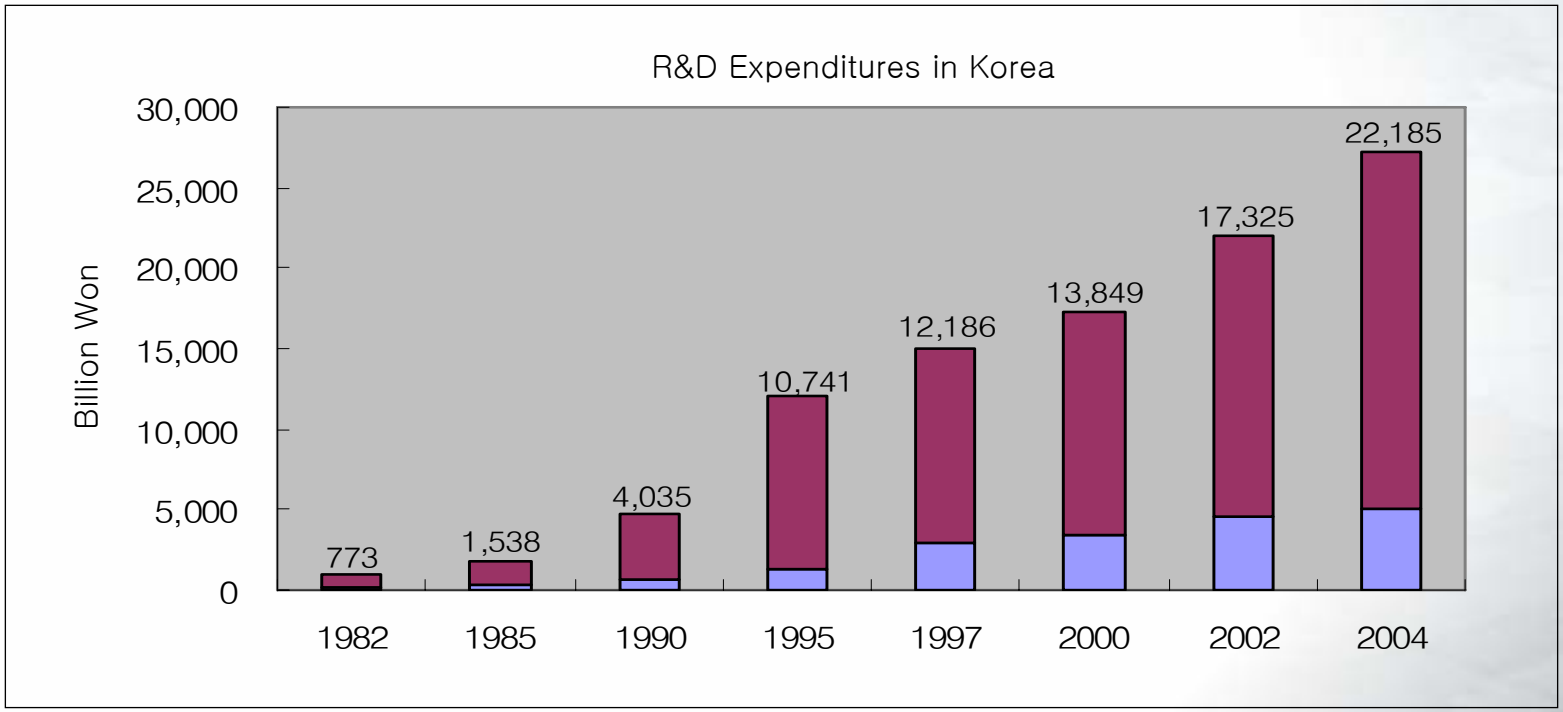
> ➢ DFI and FL played relatively less important role in TT in the process of industrialization of Korea.
> Korea relied on its HR for learning from foreign technologies transferred through informal channels.

3. How Korea built up an indigenous R&D system

- Korean economic growth
  - ⇨Increased demand for complex and sophisticated technologies
  - ⇨Increasing reluctance of foreign countries to transfer technologies to Korea

- Policy response : Launching the NRDP and promoting private industrial R&D
  - ⇨NRDP in 1982
  - ⇨Policy incentives for industrial R&D : financial, fiscal, tax, etc.

❑ Growth of R&D investment



Note: Upper portion of the bar refers to industry contribution, and the lower parts that of the government.

⇨ 6th largest R&D investor among OECD countries

- Factors behind the growth
  - Demand side : Outward looking development → export-orientation of industries → pressure from international market for technological competitiveness → increased demand for R&D investment
  - Supply side
    - Financial resources : Large-firm-oriented industrial development → chaebol system → increased abilities of private industries to finance long-term, risky R&D projects
    - Human resource : Korea prepared itself well for R&D by investing heavily in education and HRD

❑ R&D Outputs

❖ Number of KPO patents granted

	1981	1985	1990	1995	2000	2004
Number	1,808	2,687	7,620	12,512	34,579	45,298
Korean share	12.8	13.0	33.5	52.5	65.6	66.7

- ❖ Number of US patents granted to Koreans : 7th in the world
- ❖ Number SCI publications : 15th in the world (Highest growth)
- ❖ Established world prominence in such areas as : LCD, semi-conductors, PDP, cellular phones, etc.

❑ R&D structure

	1980	1985	1990	1996	2000	2002	2004
R&D Expenditures (billion won)	282.5	1,237.1	3,349.9	10,878	13,849	17,325	22,185
Government	180.0	306.8	651.0	2,398	3,435	4,557	5,190
Private	102.5	930.3	2,698.9	8,467	10,387	12,699	16,630
Gov : private	64:36	25:75	19:81	22:78	25:75	26.3:73.3	25:75
R&D/GNP(%)	0.77	1.58	1.95	2.79	2.65	2.91	2.85
R&D Performers(%)							
Industry	28.8	65.4	74.9	73.2	74.0	74.9	76.7
Universities	9.2	10.3	7.6	9.4	11.3	10.4	9.9
GRIs*	62.0	24.3	18.5	17.4	14.7	14.7	13.4
Industrial R&D Intensity(%)	0.47	1.23	1.72	2.13	1.98	2.19	2.71

Note : * including national labs.
Source : MOST(1997a, 1998b), KITA(1998)

III. Government and Public Sector R&D

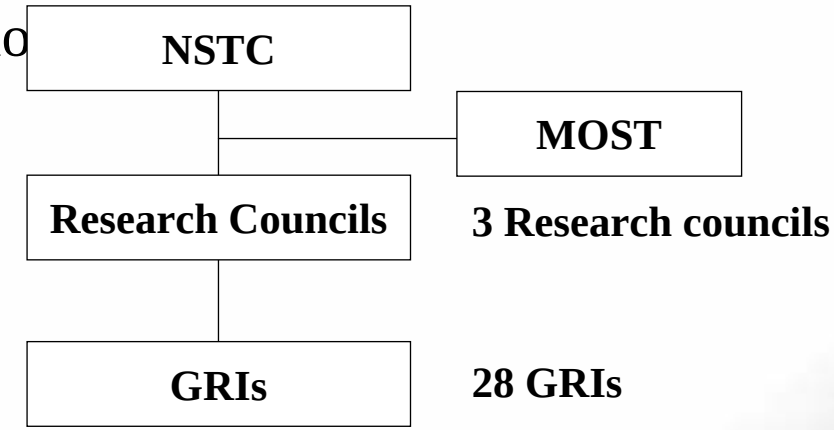
- Evolution of Public Sector R&D

	Formation stage (1982–1985)	Take-off stage (1986–1990)	Maturing stage (1991–)
NRDP objective	**Internalization of foreign technologies**	**Development of core technologies**	**Creative research, future-oriented research**
Planning	**No planning: bottom-up**	**Based on loose long-term plan**	**R&D planning, technology foresight**
Main actors	**Government research institutes (GRIs)**	**Main: GRI Minor: Universities and industries**	**Main: GRI, with increased role of universities and industries**

❑ Government R&D Programs

Ministry	Year initiated	Major program	Management agencies
Ministry of Science and Technology	1982	Specific R&D Program	Korea Institute of Science & Technology Evaluation & Planning (KISTEP) Korea Science & Engineering Foundation (KOSEF)
Ministry of Commerce, Industry and Energy	1987 1988	Industrial Base Technology Development ProgramAlternative Energy Development Program	Korea Institute of Industrial Technology Evaluation & Planning (ITEP)
Ministry of Information and Communications	1989	IC Technology Development Program	Institute of Information Technology Assessment (IITA)
Ministry of Environment	1992 1996	Environmental Engineering Technology Development Program Environmental Basic Technology Development Program	National Institute of Environmental Research (NIER)
Ministry of Construction and Transportation	1994	Construction Technology Development Program	Korea Institute of Construction Technology (KICT)
Ministry of Agriculture and Forestry	1994	Agricultural Technology Development Program	Agricultural R&D Promotion Center (ARPC)
Ministry of Health and Welfare	1995	Health and Medical Technology Development Program	Korea Health Industry Development Institute (KHIDI)
Ministry of Education	1983	Basic Scientific Research Support Program	Korea Research Foundation (KRF)

- Government Research Institutes
  - Legal basis : Law for the creation and promotion of GRIs (1999)
  - Legal status : Non-government special corporate
  - Organizatio



  - Accounting for about 14% of the GERD

- Universities
  - Universities harbor 72.7% Ph.Ds
  - Universities account for about 10% of GERD
    - ➔Relatively less important as R&D actors than in other countries
  - Research structure

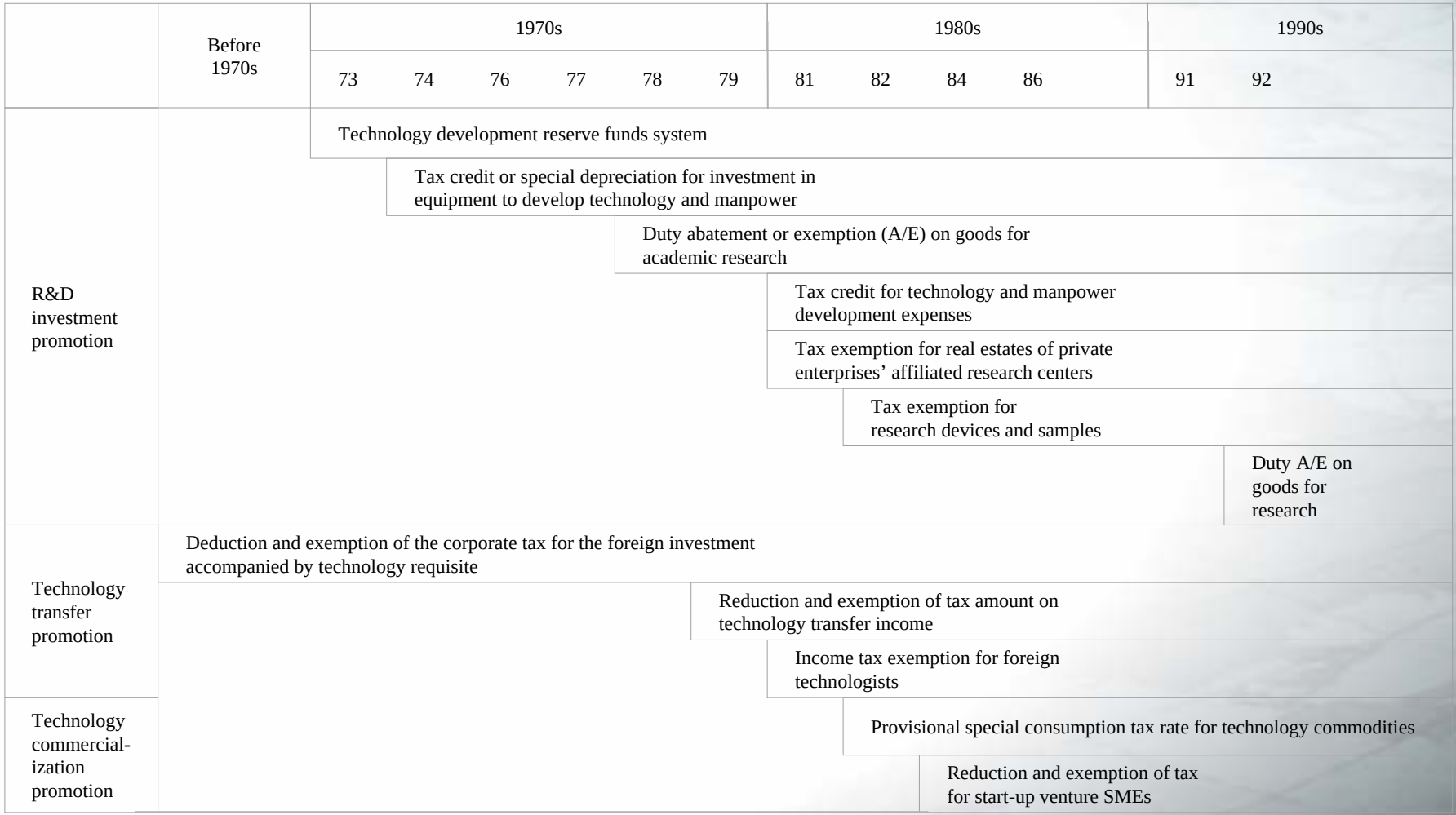
		1998	2000	2003
R&D expenditure (billion won)		12,650 (11.2 of gross national R&D)	15,619 (11.3)	19,327 (10.1)
Source of fund (%)	Government	52.1	60.4	75.1
	Industries	47.7	39.4	24.5
	Foreign	0.2	0.2	0.4
Type (%)	Basic research	40.1	42.4	36.0
	Applied research	33.8	30.5	32.8
	Development	26.1	27.2	31.2
Areas (%)	Sciences	18.5	20.0	18.9
	Engineering	49.1	50.3	50.2
	Agriculture	7.0	6.5	5.9
	Medicine	17.6	11.4	16.3

IV. Industrial Technology Policy

❑ Industrial Technology Policy

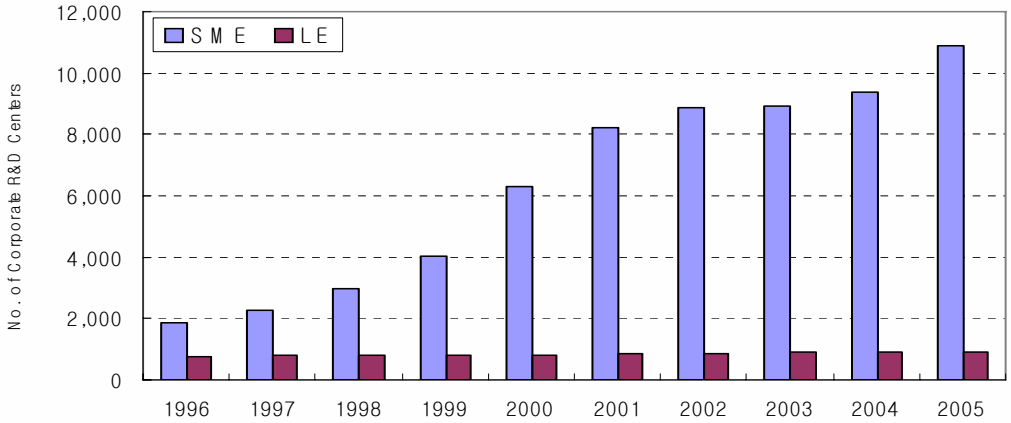
	National R&D programs	Infrastructure and diffusion	Institutional support	Incentives
Objectives	To develop core industrial technologies	To enhance intermediary functions and to fill the gaps among innovation actors	To nurture GRI and to strengthen GRIs' research capabilities	To induce or assist private enterprises' technology development activities
Tools	Ministries' R&D programs	Research personnel, technical information, cooperative R&D facilities, regional R&D centers, spin-offs, etc.	Funding for GRIs' operational expenses and basic research	Tax-exemptions, financial support, subsidy for technology development
Effects on industry	To expand knowledge and the technology pool for industrial use	To facilitate diffusion and to make better industry use of technologies	To bring up helper or partner for industry's technology development	To strengthen industry's own technological capabilities

❑ Evolution of Major Technology Policies



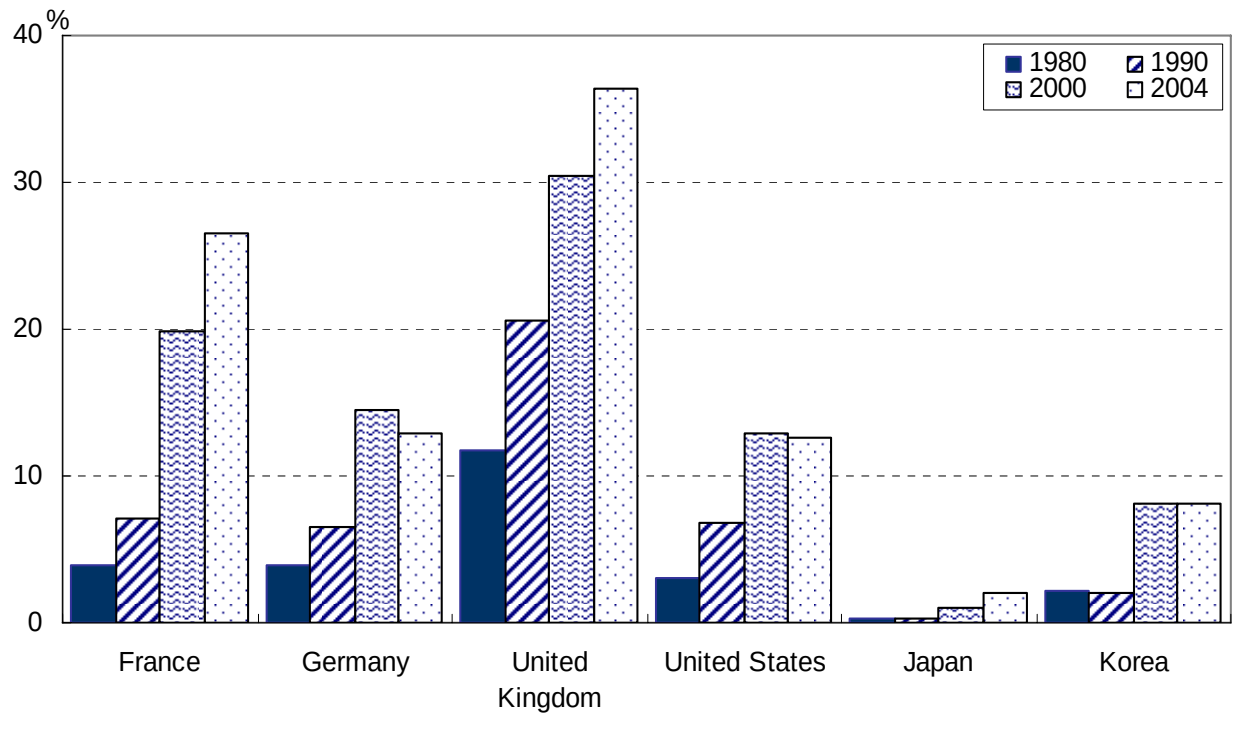
V. Recovery from the Economic Crisis

- The impacts of the economic crisis
  - Cut in R&D expenditures by LEs : 14%
  - Cut in R&D personnel : 10%
- Recovery
  - Growth of small-scale, specialized R&D centers and/or technology-based firms : SME's growth in R&D

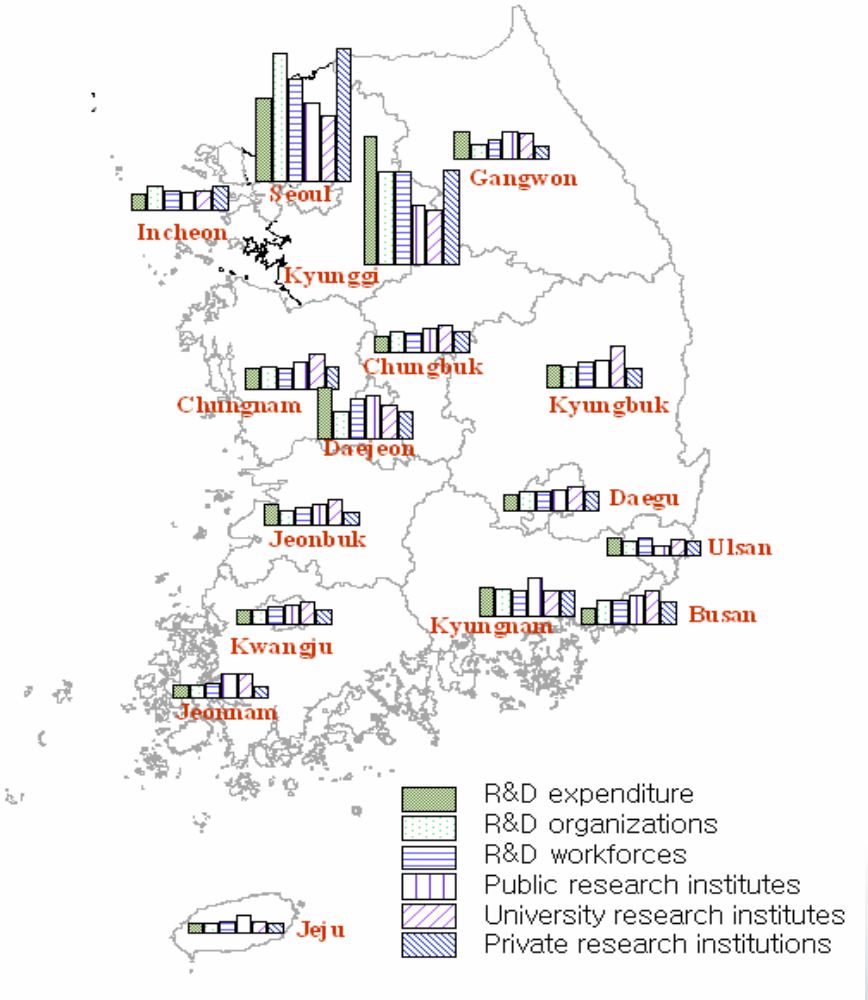


	R&D expenditure, in billion won (and as percentage of sales)			Researchers (doctoral level)		
	1997	2000	2003	1997	2000	2003
SMEs	1,090.2 (2.82)	2,106.4 (3.14)	3,425.4 (3.57)	17,703 (474)	36,494 (1,543)	52,332 (2,291)
Large enterprises	7,755.1 (2.07)	8,148.2 (1.81)	11,084.2 (2.05)	56,990 (3,613)	57,839 (3,878)	71,698 (5,562)

❖ Role of FDI Companies



❖ Regional Innovation System



VI. Key characteristics of KIS

- Key characteristics of KIS
  - Export-oriented economy: Strong pressure for R&D
  - Dynamism: Highly- motivated private industries with strong supports from gov't
  - High absorptive capacity: Rich pool of HRST
  - Imbalances
    - Industrial technology vs. basic sciences
    - Large firm vs. SMEs
    - Regional imbalance: High concentration in Seoul area
    - Industrial imbalance: High concentration in IT, etc.

- Key factors that influenced the KIS
  - Outward-looking development strategy ⇨Pressure for R&D investment
  - Government policy toward FDI and TT ⇨Focus on indigenous R&D
  - Government-led industrial development
    - Industry-targeting ⇨Inter-industry R&D imbalance
    - Favoring large enterprises ⇨R&D system biased for large firms/Financial capability to invest in R&D
    - S&T for industrialization ⇨R&D system biased toward technology development
  - Rich pool of well educate HRST ⇨ High absorptive capacity
  - Government-led development of S&T infrastructure ⇨ Relative importance of GRIs

- Strength and weakness
  - Strength
    - Dynamism fuelled by the strong commitment of the government and private industries' efforts for competitiveness
    - Domestic firms' exposure to international markets:pressure for R&D
    - Chaebol system:ability to invest in long-term risky projects
    - Human resources
  - Growing scientific achievements:publications, IPR, etc
  - Attained technological leadership in selected areas

❖ Weakness

⇨ Disadvantage of being small

⇨ Imbalances in innovation system

1. Basic scientific research vs technological development

2. Large firms vs SMEs

3. Regional concentration

⇨ Excessive reliance on private investment: vulnerable to changes in markets

⇨ Weak industry-science relationship

⇨ Insufficient internationalization: insufficient R&D DFI, international co-invention, etc.

VII. Lessons for late-comes

- Lessons for late-comers
  - Market competition is the very source of motivation for innovation
    - ⇨ Pressure for technological competitiveness
    - ⇨ Effectiveness of the outward-looking development strategy for small economies
  - Human resource is the key to learning
  - Government can play effectively the role of facilitator and promoter at the early stage of development
  - The efficiency of an NIS hinges very much upon ISR