Global Innovation EcoSystem

Session2

Capitalization of Science to Socioeconomic Values

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Questions

- Why do increased research inputs often fail to produce productivity increase and sustainable growth in a society?
- What are the important factors that determine efficiency of research and development investment?
- What are the role of players, especially government, in activating S&T based innovation that can create the socioeconomic value?

Motivation

Can Korea switch itself to an innovation-driven economy?

- South Korea has rapidly been catching up the world frontier over the past three decades.
  - But, the swift catch-up in output per worker is for the most part attributed to physical and human capital accumulation.
  - Productivity (TFP) growth has been low.
- The speed of catching-up the world technology frontier has been slowed down in recent years.
  - Technology progress was mostly achieved by technology adoption (imitation) rather than technology creation innovation).
- Growth rates of potential GDP has been declining

Figure 1. Change in the Gap of Output per Worker and its Components between Korea and the U.S., 1970-2000

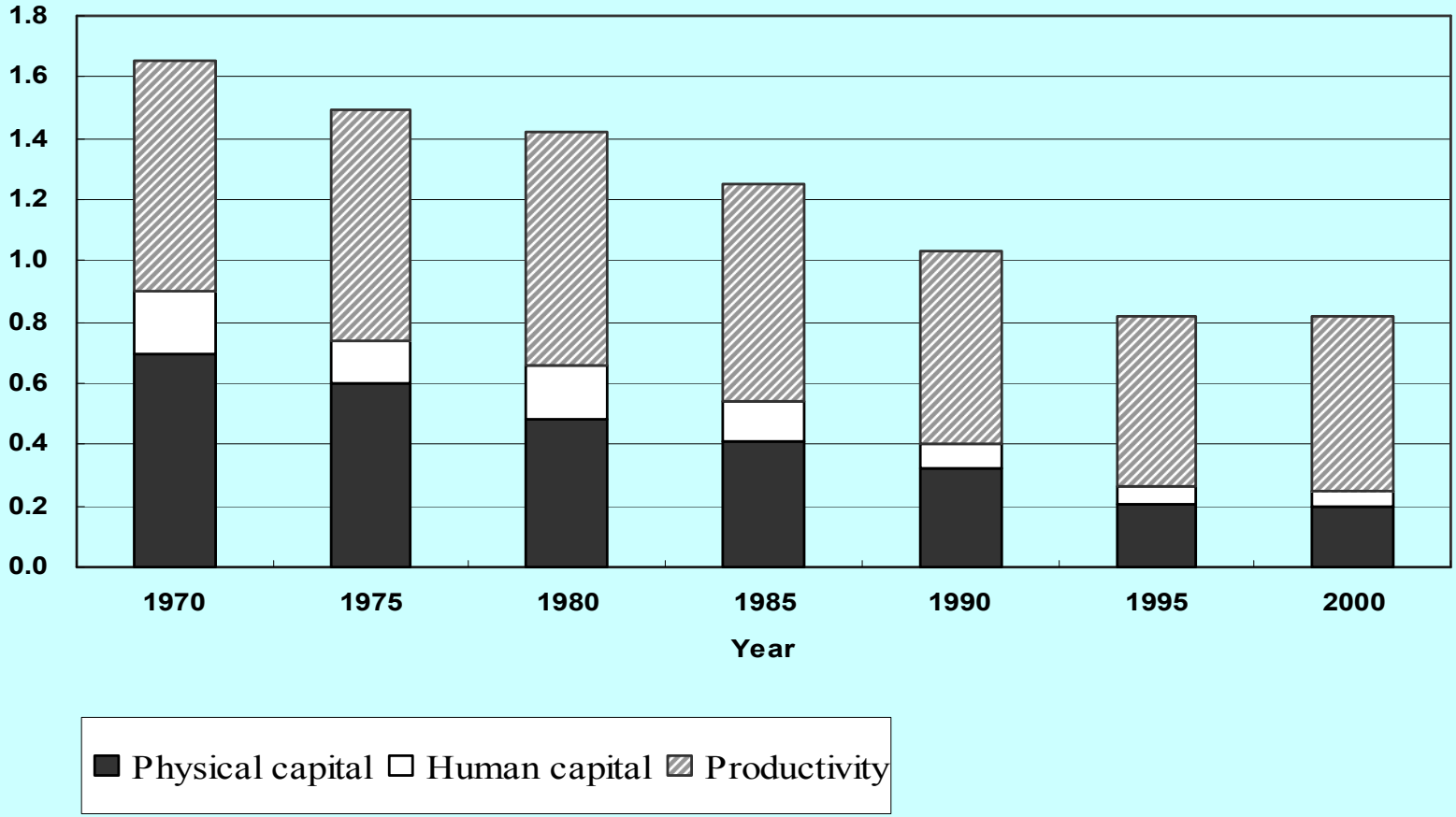


Figure 2. Growth Rate of GDP in Korea, 1990-2005

Motivation, *continued*

Why is the productivity of R&D investment in Korea relatively low?

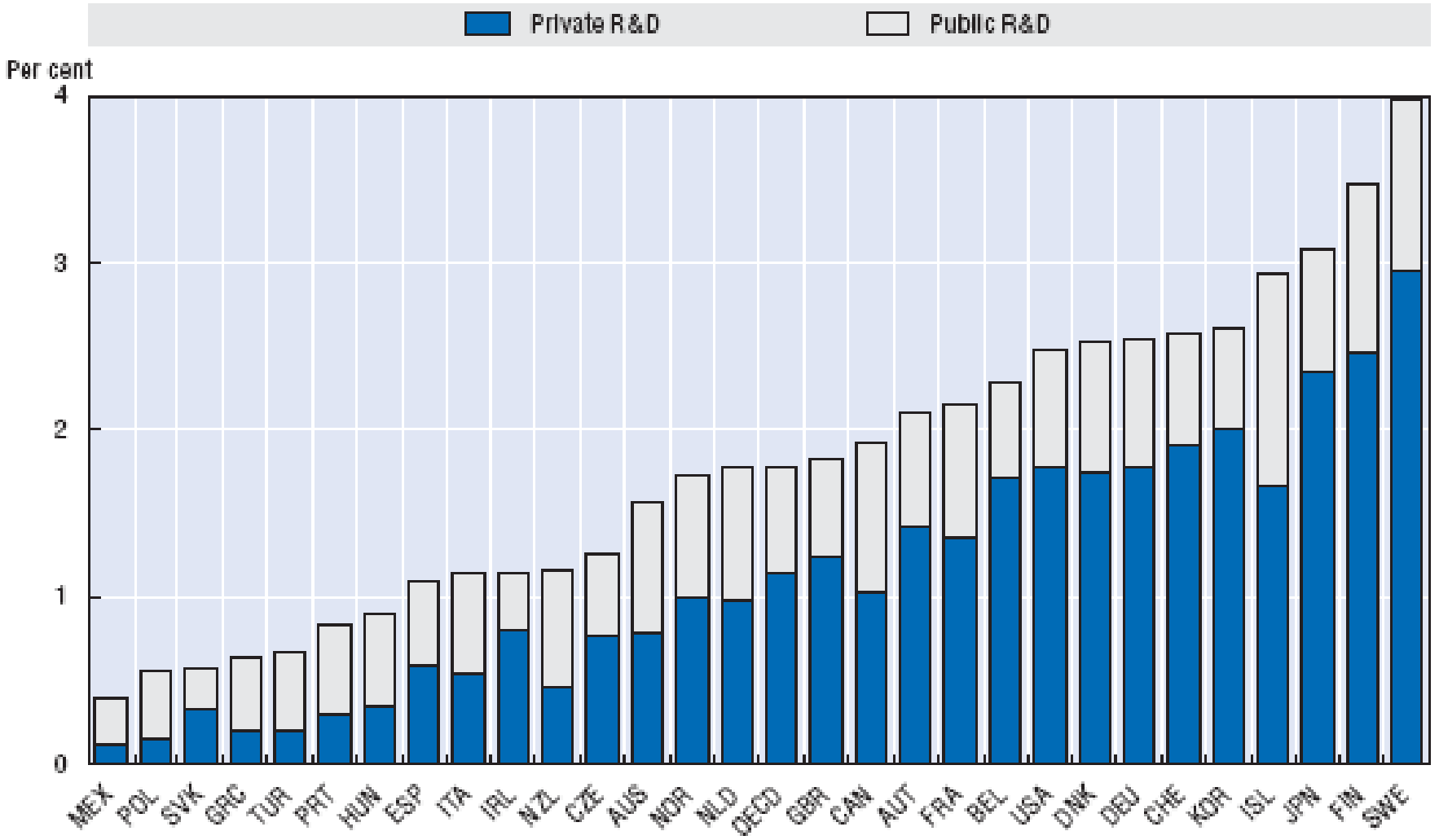
- Korea's total R&D expenditures remain high.

  - R&D intensity is the fifth highest in the OECD.
  - Venture capital investment is the fourth highest in OECD.

- But, the innovation performance is not very satisfactory.

  - TFP growth has been low..
  - The number of triadic patents per population is low.

Figure 3.1. **Expenditures on R&D performed in the public and business sectors as a percentage of GDP, 2003**[1]

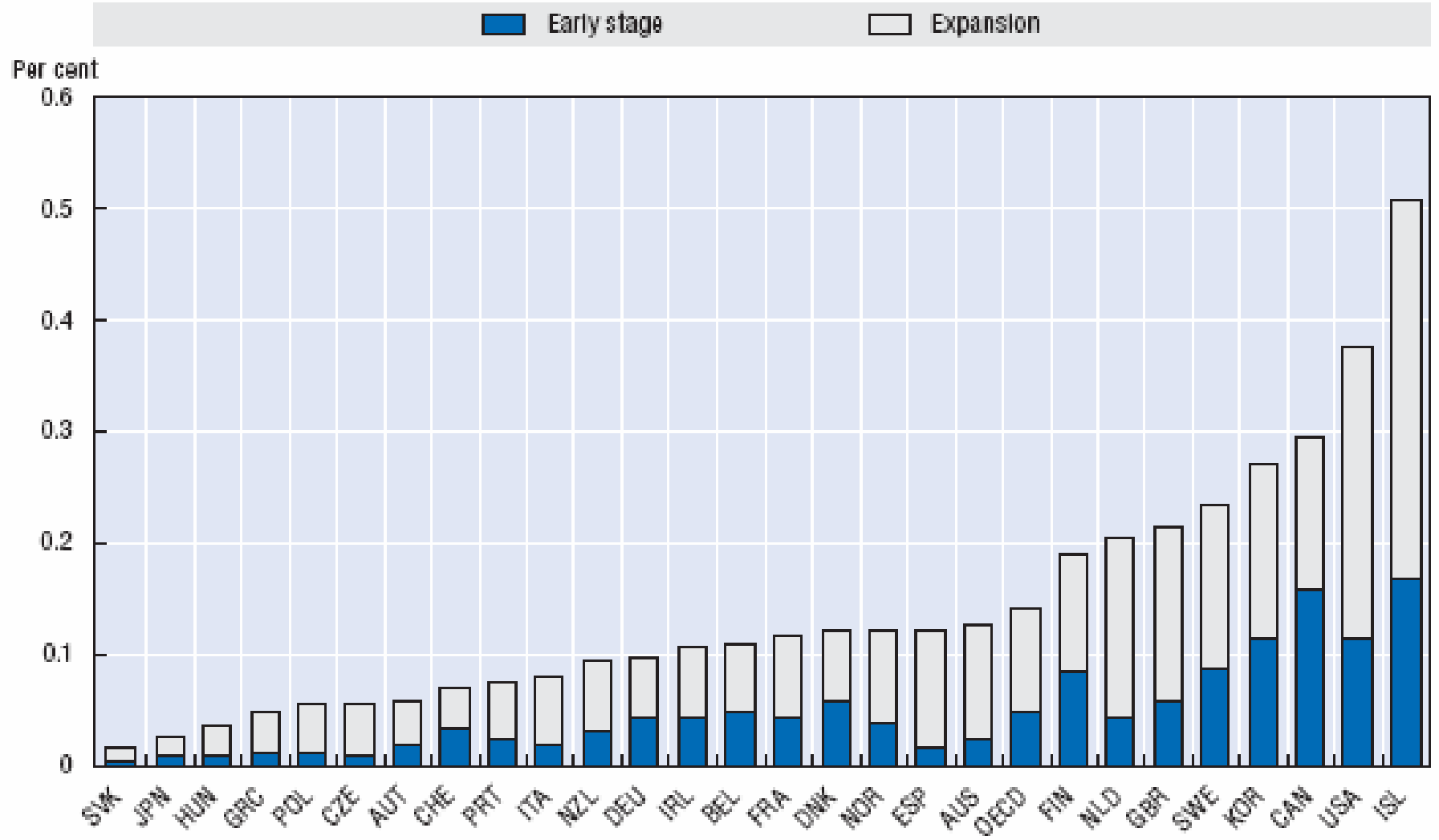


1. 2002 for Australia, Austria, Portugal, Switzerland and Turkey; 2001 for Greece and Mexico.

Source: OECD, Main Science and Technology Indicators database.

StatLink: http://dx.doi.org/10.1787/462688616478

Figure 3.7. **Venture capital investment flows as a percentage of GDP, 2000-03**[1]

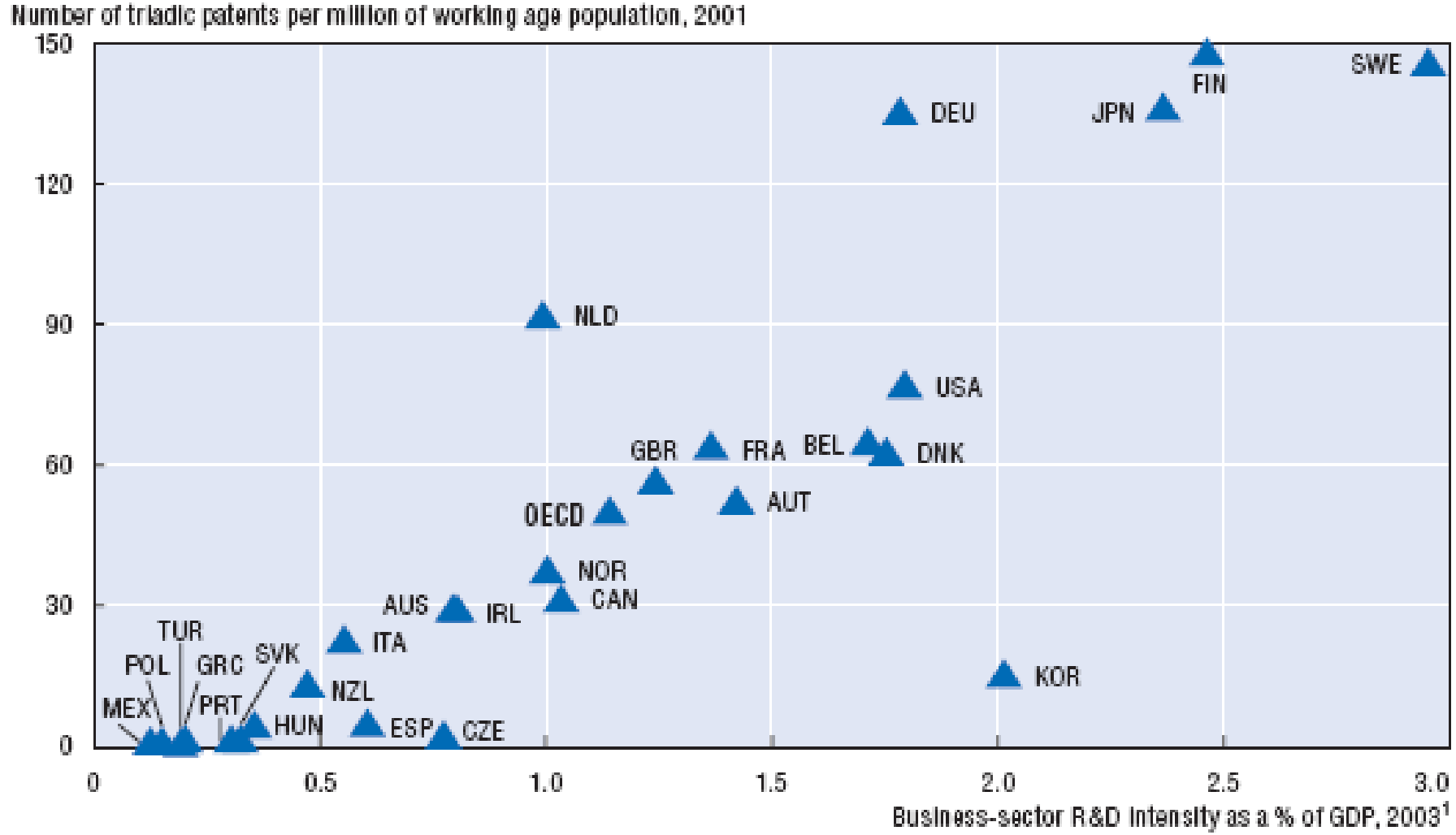


1. 2000-02 for Iceland; 1998-2001 for Australia, Japan, Korea and New Zealand.

Source: OECD, Venture capital database.

StatLink: http://dx.doi.org/10.1787/462688616478

Figure 3.4. Number of triadic patents per million of working age population and business-sector R&D intensity



1. 2002 for Australia, Austria, Portugal, Switzerland and Turkey; 2001 for Greece and Mexico.

Source: OECD, Main Science and Technology Indicators database.

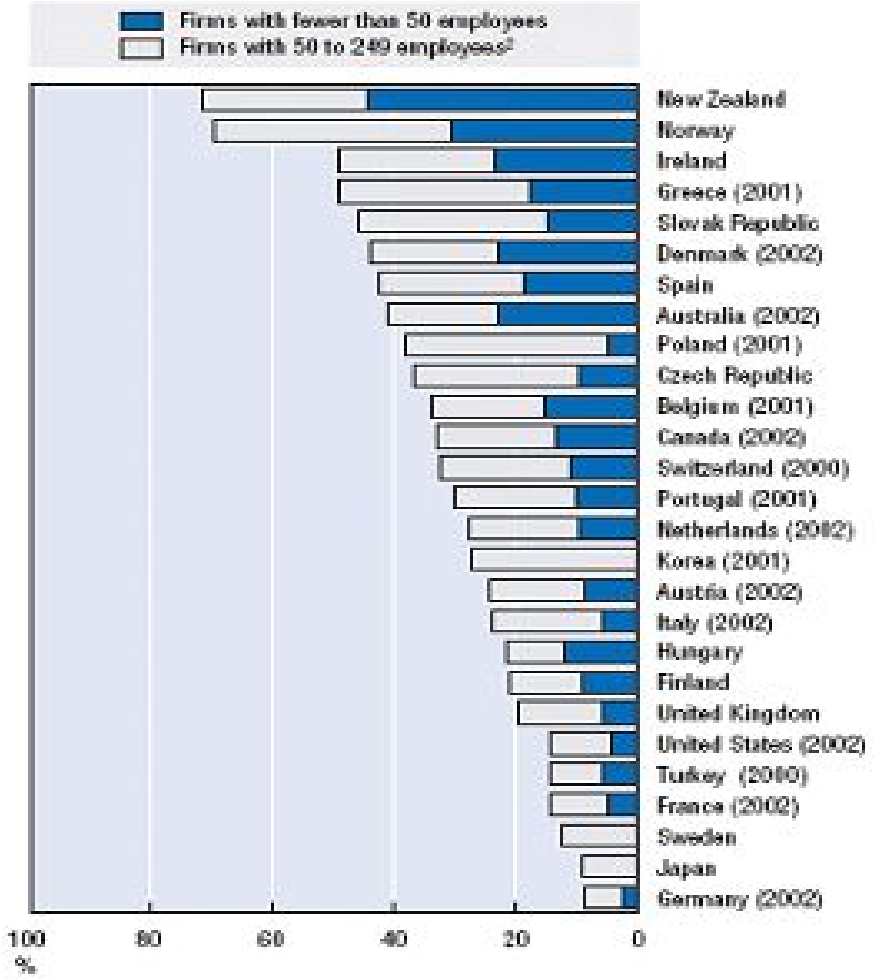
StatLink: http://dx.doi.org/10.1787/462688616478

Factors for Improving Productivity of R&D Investment (Challenges for Korea)

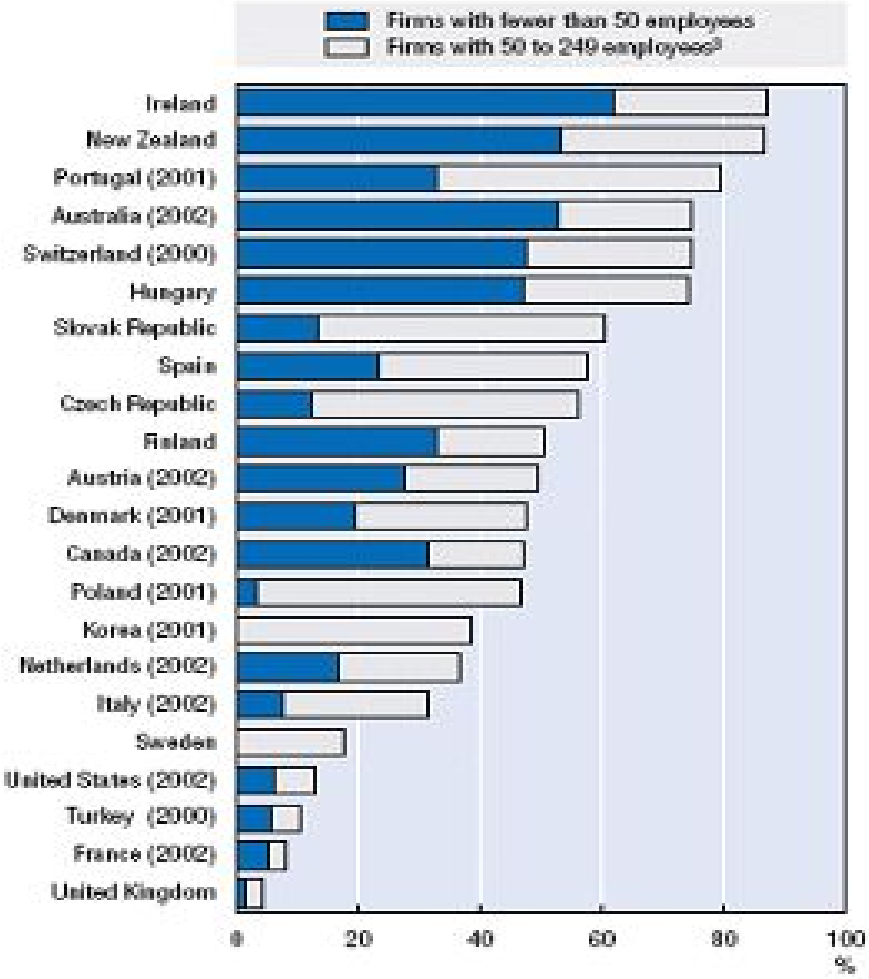
- The structure of research investments, not just the volume of research inputs, is important.
  - Korea needs to increase basic research investments as a country approaches to the world technology frontier.
- It is important to nurture long-term, risky investments for innovation and allocate them efficiently.
  - Korea needs improve the efficiency of financial to encourage innovative activities of SMEs and start-ups, and promote more innovation in service sectors.
  - Reduce political instability and policy uncertainty to encourage entrepreneurship.
- Upgrading the quality of education at the tertiary level is crucial for technology innovation..
  - Korea needs to improve the efficiency of educational system and promote competition among schools .

A.6. Business R&D by size classes of firms

Share of business R&D by size class of firms,[1] 2003



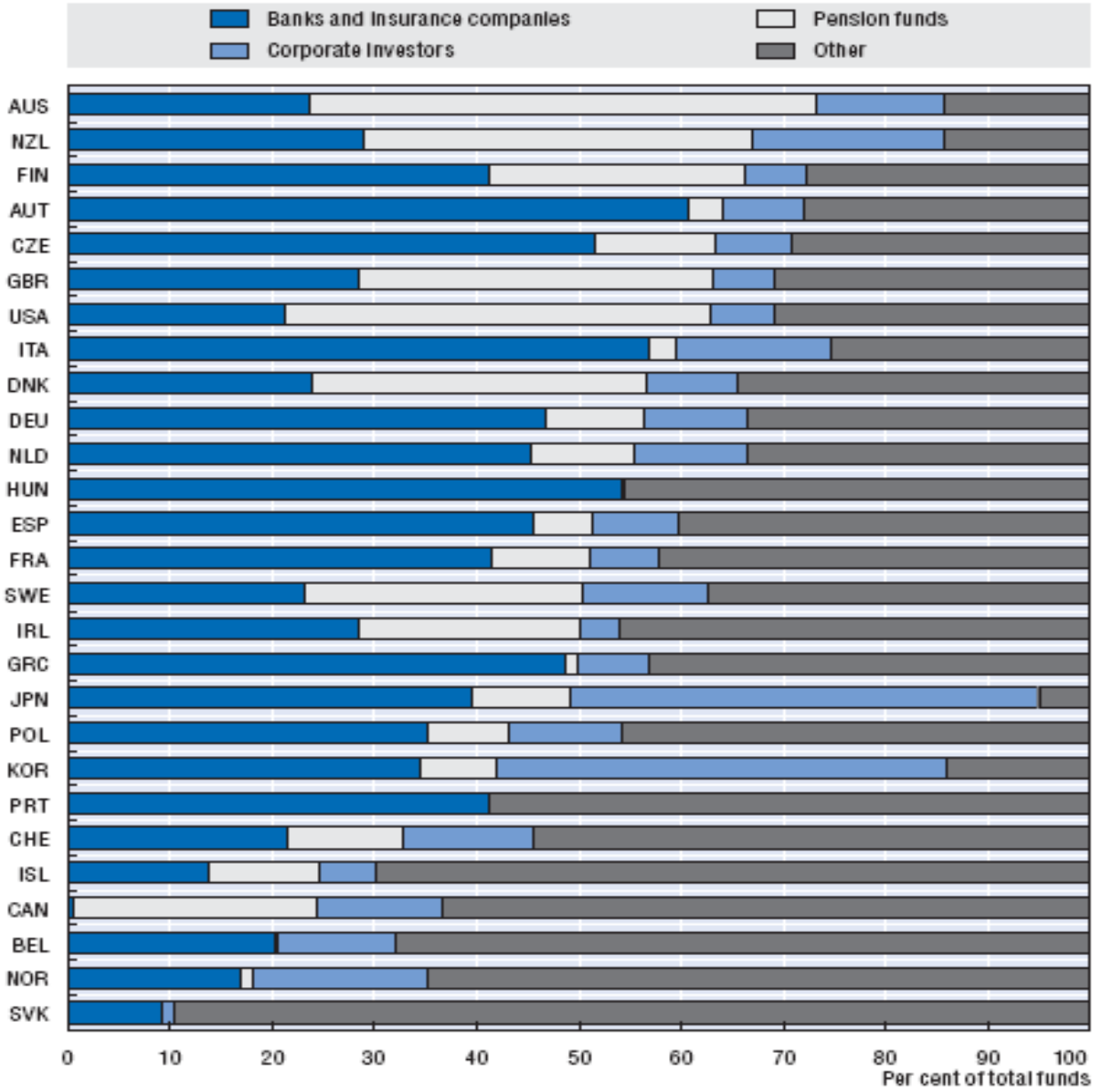
Share of government-financed business R&D by size class of firms, 2003



1. For the United States, federally funded research and development centers (FFRDCs) are excluded. German data excludes co-operative research institutes.
2. For Japan and Korea, fewer than 299 employees.
3. For Korea, fewer than 299 employees.

StatLink: http://dx.doi.org/10.1787/430048678578

Figure 3.8. **Sources of venture capital funds, 1999-2002**[1]

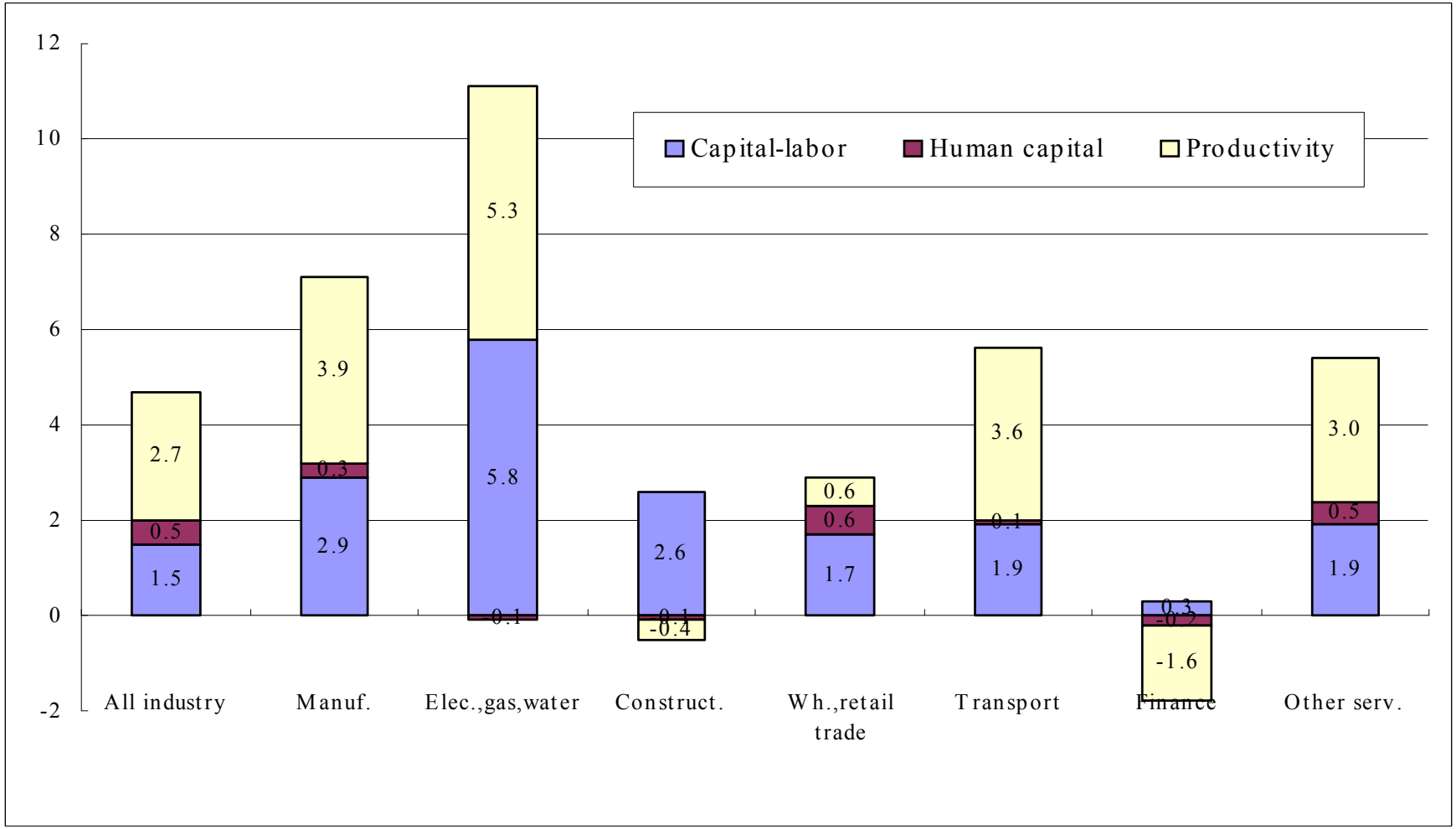


1. Countries are ranked according to the sum of bank, insurance and pension funds.

Source: OECD, Venture capital database.

StatLink: http://dx.doi.org/10.1787/462688616478

Figure 3. Sectoral Output per Worker and TFP Growth, Average of 1970-2001



The Optimal Structure of Basic and Applied R&D Investments (Kim, Ha, and Lee, 2006)

- The theoretical model shows that the optimal structure of R&D investments depends on an economy's stage of development.

- Economic growth is positively correlated with the level of basic research activities (and high-skilled human capital) in technology creation, if a country's technology gap to the world frontier is small.

- Empirical evidence show that the narrower is the technological distance to frontier, the higher is the growth effect of basic R&D, indicating that the share of basic R&D matters for economic growth. The quality of tertiary education has also a significantly positive effect on the productivity of R&D.

Empirical Analysis: Composition of R&D Investment and Economic Growth

- *The Model*:

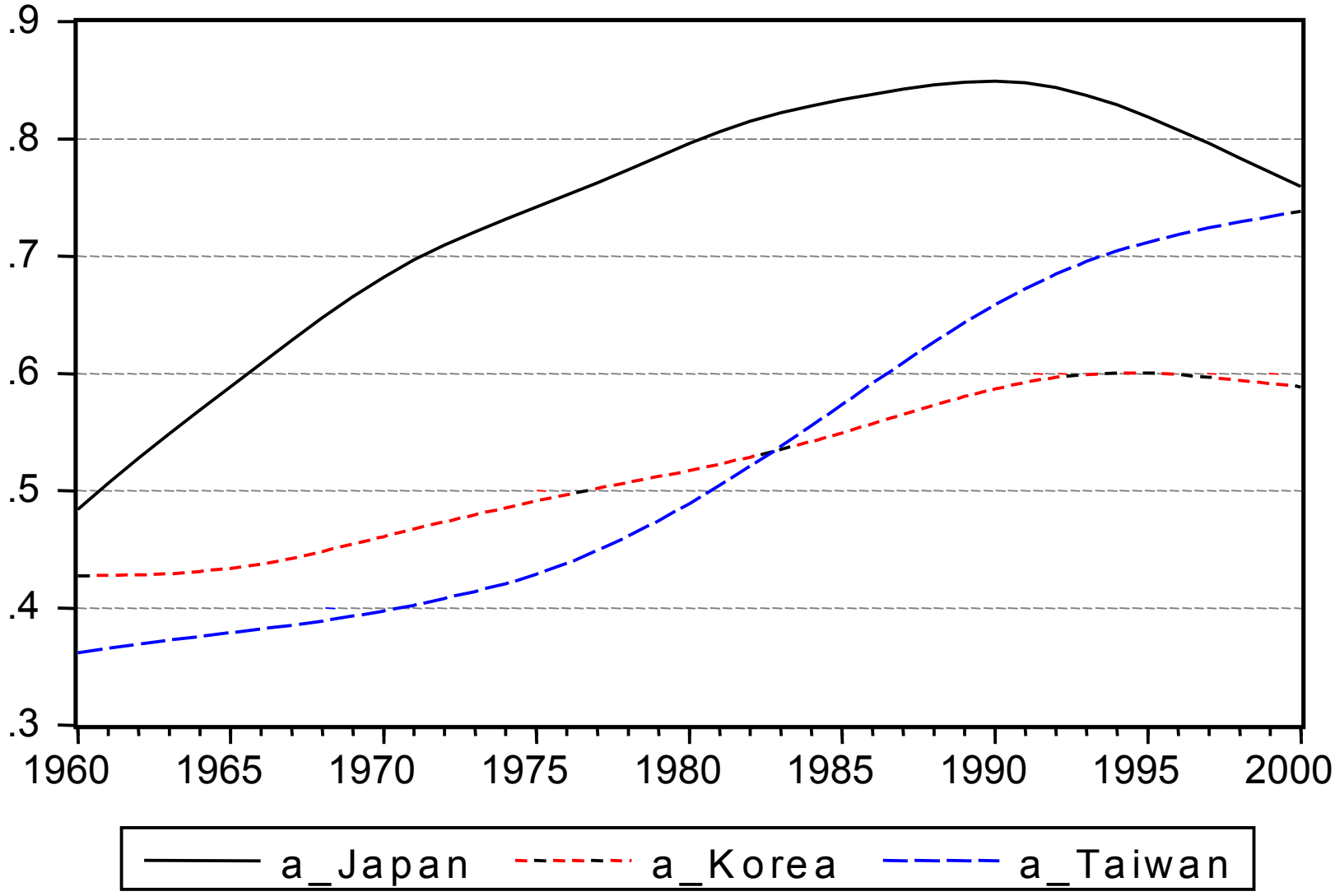
$$g_{jt} = \beta_{0.j} + \beta_1 x_{jt} + \beta_2 a_{jt} + \beta_3 x_{B,jt} a_{jt} + \beta_4 year_t + \varepsilon_{jt}$$

- g: TFP growth rate of country j and year t
- x: total R&D expenditure share in GDP,
- $x_{B:}$ the ratio of basic research to total R&D.
- a: the ratio of TFP level to the US TFP level

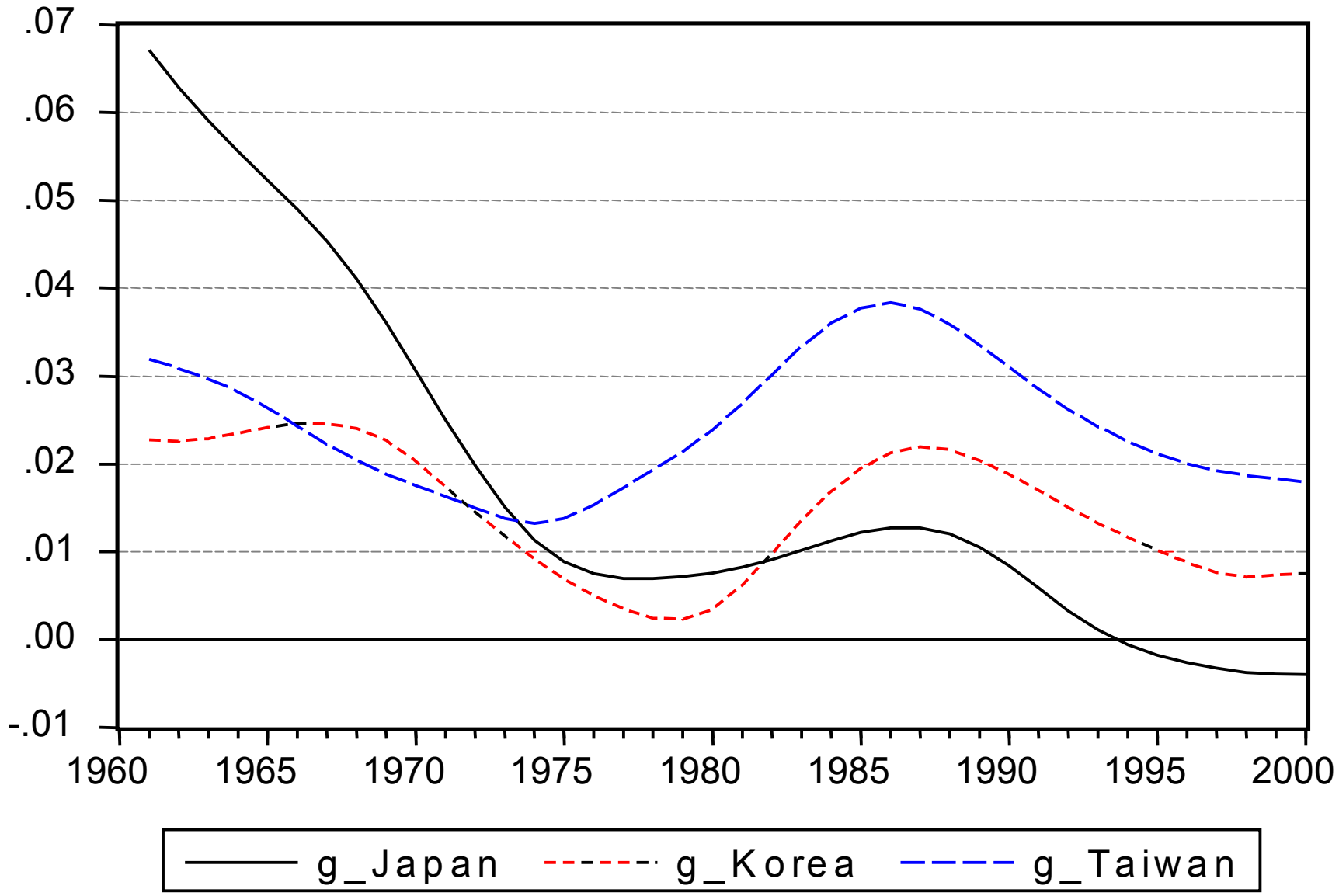
- *Data*: a panel of Korea, Japan, and Taiwan from 1979 to 2000.

Figure 4. TFP Levels and TFP Growth Rates of Japan, Korea, and Taiwan

(a) TFP level (ratio to US TFP level)



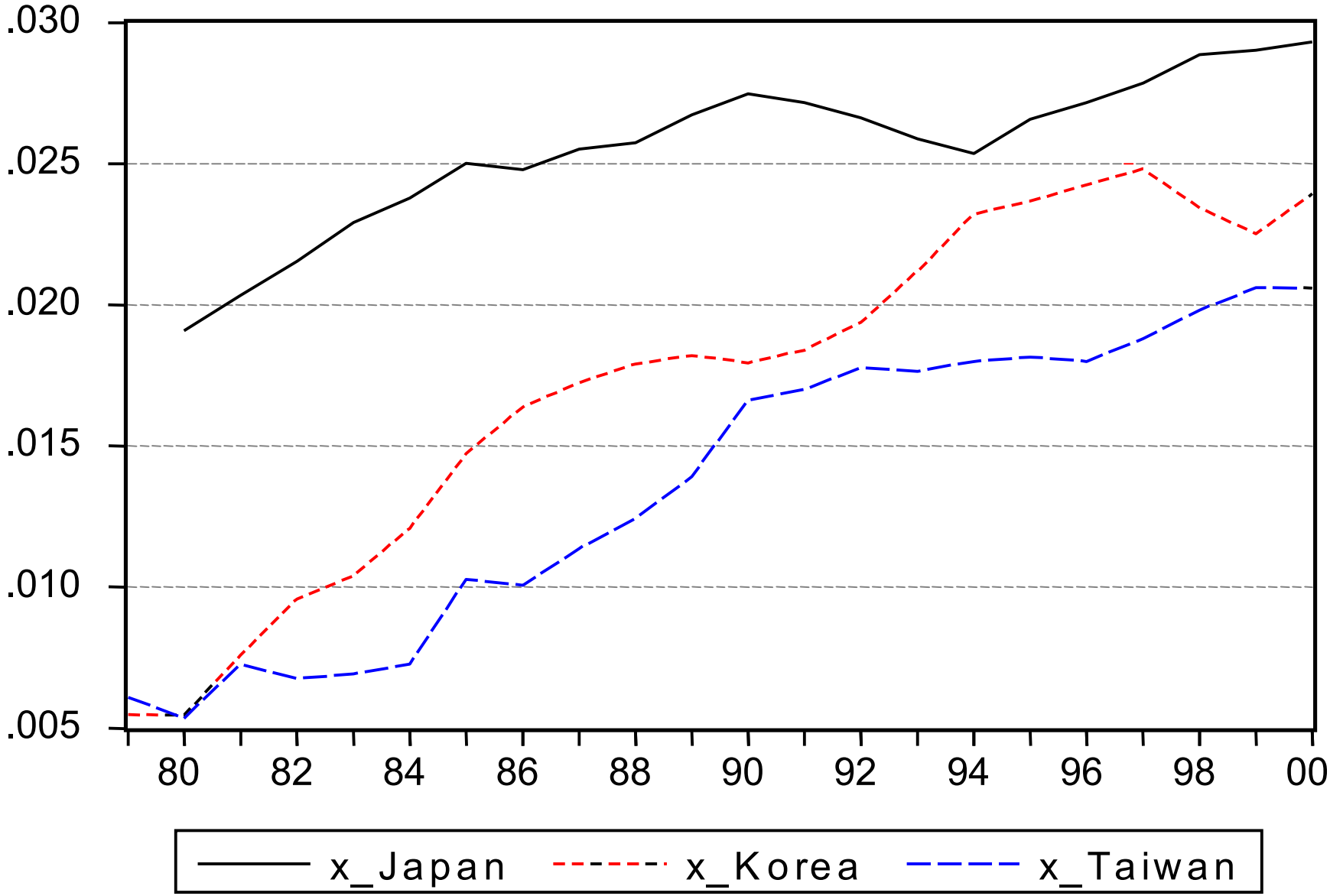
(b) TFP growth rate



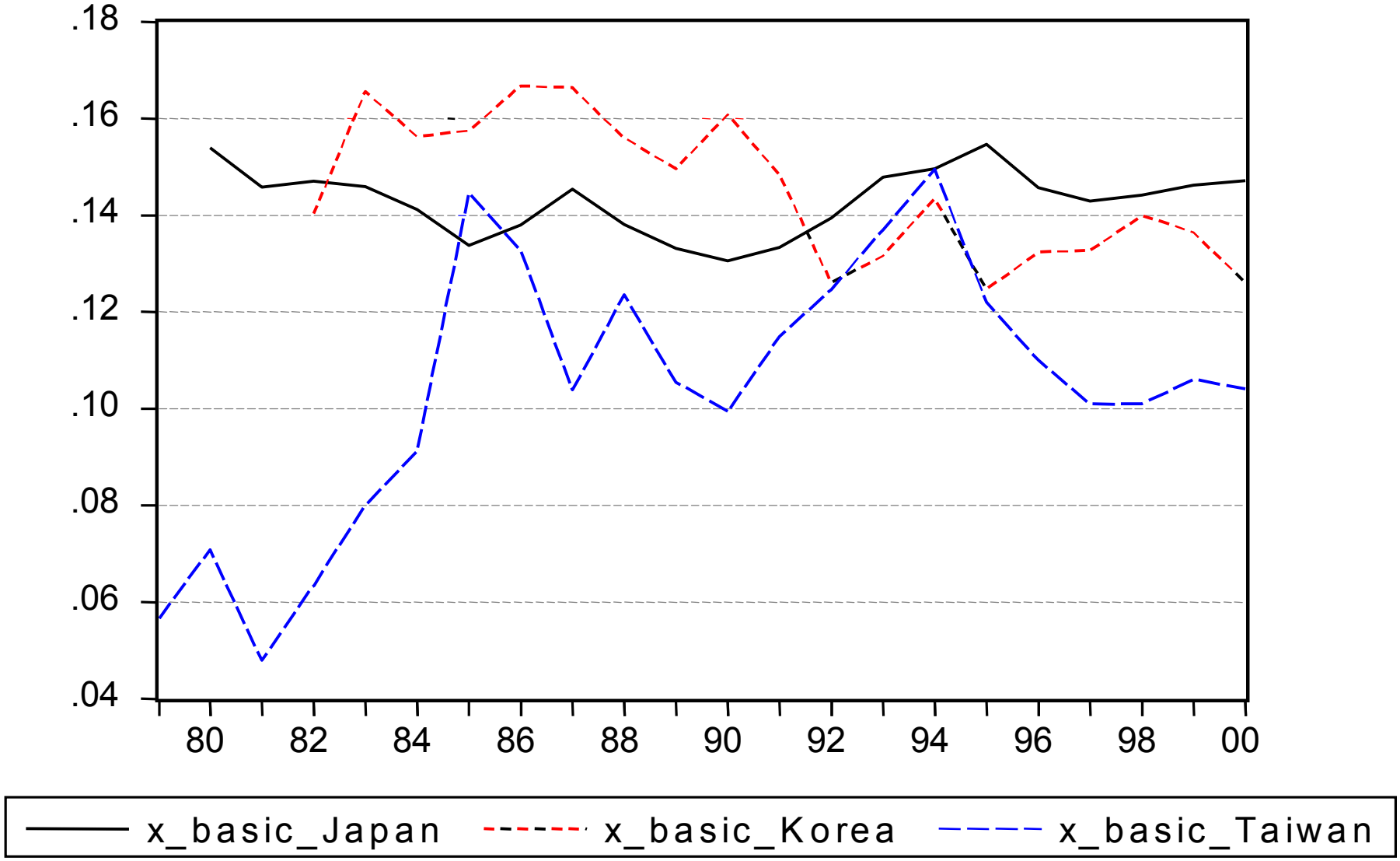
Sources: Authors' calculation, Smoothed using HP-filter

Figure 3. R&D Intensity and Basic Research Expenditures

(a) R&D intensity



(b) Basic research expenditure (as a ratio to total R&D)



Source: National Statistics Office (Korea) database; National Institute of Science and Technology Policy (NISTEP, Japan) 「Science and Technology Indicators, 2004」; Directorate General of Budget, Accounting, and Statistics, Taiwan, 「Statistical Yearbook of the Republic of China, 2004」 and its database for updated data

<Table 1> Regressions for TFP Growth

Dependent variable :*g*	(1)	(2)	(3)	(4)
x	1.015 (2.37)**	0.763 (2.38)**		
a	-0.020 (-0.89)			
ax_B	0.136 (2.38)**	0.103 (2.39)**		
ax_Bx			7.643 (2.14)**	8.992 (3.41)***
$a(1-x_B)x$			0.305 (0.57)	
Year	-0.001 (-5.81)***	-0.001 (-5.95)***	-0.001 (-6.46)***	-0.001 (-6.92)***
R^2	0.61	0.61	0.58	0.58
No. of obs.	62	62	62	62

Note: Estimation is based on country fixed effects. * indicates a 10% significance level, ** 5%, and *** 1%, respectively.

Implications of the Empirical Analysis

- The estimation result shows that as the TFP level of a country approaches that of the world frontier, basic research investment for new knowledge creation becomes relatively more important than applied and development investment.

- The estimate implies that in Korea (a=0.6) an increase in basic R&D by 0.1 percentage point of GDP would increase TFP growth rate by 0.13 percentage point..