Thoughts on “Establishing Benchmark for Global Innovation Ecosystem”

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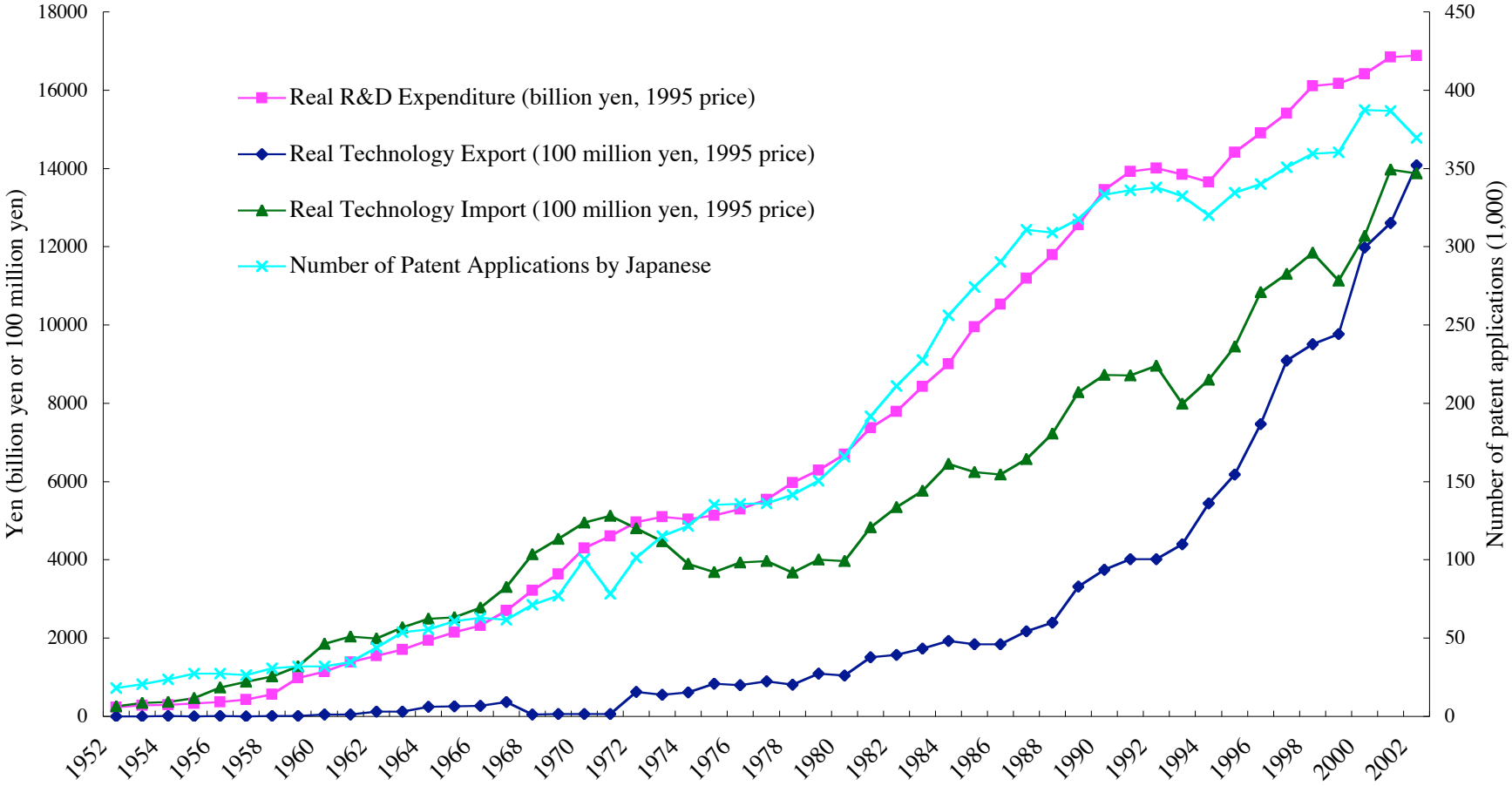
Japan's Post-war Technology Development: Three Periods

- Period 1: 1945-1972
  - Catch-up with technology importation
- Period 2: 1972-1990
  - Emphasis on own innovations
- Period 3: 1991 to the present
  - Increasing importance of science-based innovations

Period 1: Catch-Up

- Active technology importation
  - Regulations on imports and inward FDI forced foreign firms to license their technologies
- But, at the same time, Japanese firms increased R&D expenditures
  - To absorb imported technologies
  - To achieve own inventions
    - Remembering pre-war foreign dominance, particularly in some sectors (automobiles, electric equipment, etc.)
- Both technology import and R&D expenditure increased by 17% annually during 1952-1971.

Figure 1. Trend in Innovation Activity in Japan, 1952-2002



Period 2: Own Inventions

- Increasing R&D/GDP ratio

  1.8%(1970) => 2.9% (1990) => 3.4% (2004)

  Surpassing the USA in 1987
- Increasing patent applications
  - Annual rate of increase, 1971-1987: 9%
- Increasing technology export/import ratio
  - Partly because of royalty receipts from overseas subsidiaries, particularly in the automobile industry (about 90 % of receipts from subsidiaries)

Two Facts from International Comparison

- Active involvement of industries
  - Proportion of R&D exp. funded by industries
    Japan 73% (1991) -> 70% (2004)
    USA 57% (1991) -> 63% (2003)
  - Proportion of R&D exp. funded by government
    Japan 18% (1991) -> 20% (2004)
    USA 39% (1991) -> 31% (2003)
- Larger role played by big firms in science-based sectors
  - Proportion of industrial R&D by large firms (with 10,000+ employees)
    Japan 43% (2006), USA 55% (2003)
  - Proportion of biotechnology patents by large firms in 2000 (among the top 100 applicants)
    Japan 72%, USA 21%

The Environment Is Changing Rapidly …

- Economic environment
- Business System
- Science and technology

Economic Situations

- Completion of catch-up
- Depressed market demand and financial and monetary stinginess since 1990 until recently
- Declining rate of new business establishment
  - 5.9% (1975-78) to 3.5% (2001-04)
  - Now, lower than the exit rate (6.1%)

The Japanese Business System until the 1980s was characterized by

- Ownership
  - Dominance of friendly and stable shareholders, e.g., main banks and group firms
- Management
  - Internal promotion
- Labor
  - Long-term company-employee relationship
  - Internal training, both on and off the job

With the consequence of

- Orientation towards long-term growth
- Tight R&D-Production-Sales linkage
- Tight linkage with suppliers
- High skill levels and flexibility at factory levels

  => Effective for catch-up, incremental innovation, and *kaizen* (improvement)

Odagiri, *Growth through Competition, Competition through Growth*, OUP, 1992

It has been changing …

- Weakening presence of stable shareholders

Share ownership (%)	Banks	Trust banks	Trust & pension funds[a]	Industrial companies[b]	Foreigners
1986	14.9	7.3	2.9	30.1	5.3
2006	4.6	17.9	8.2	20.7	28.0

a) included in banks & trust banks, b) including holdings by parents

- Occurrence of hostile M&As
- Occurrence of bankruptcy and worker dismissal
- Shift of production bases to overseas

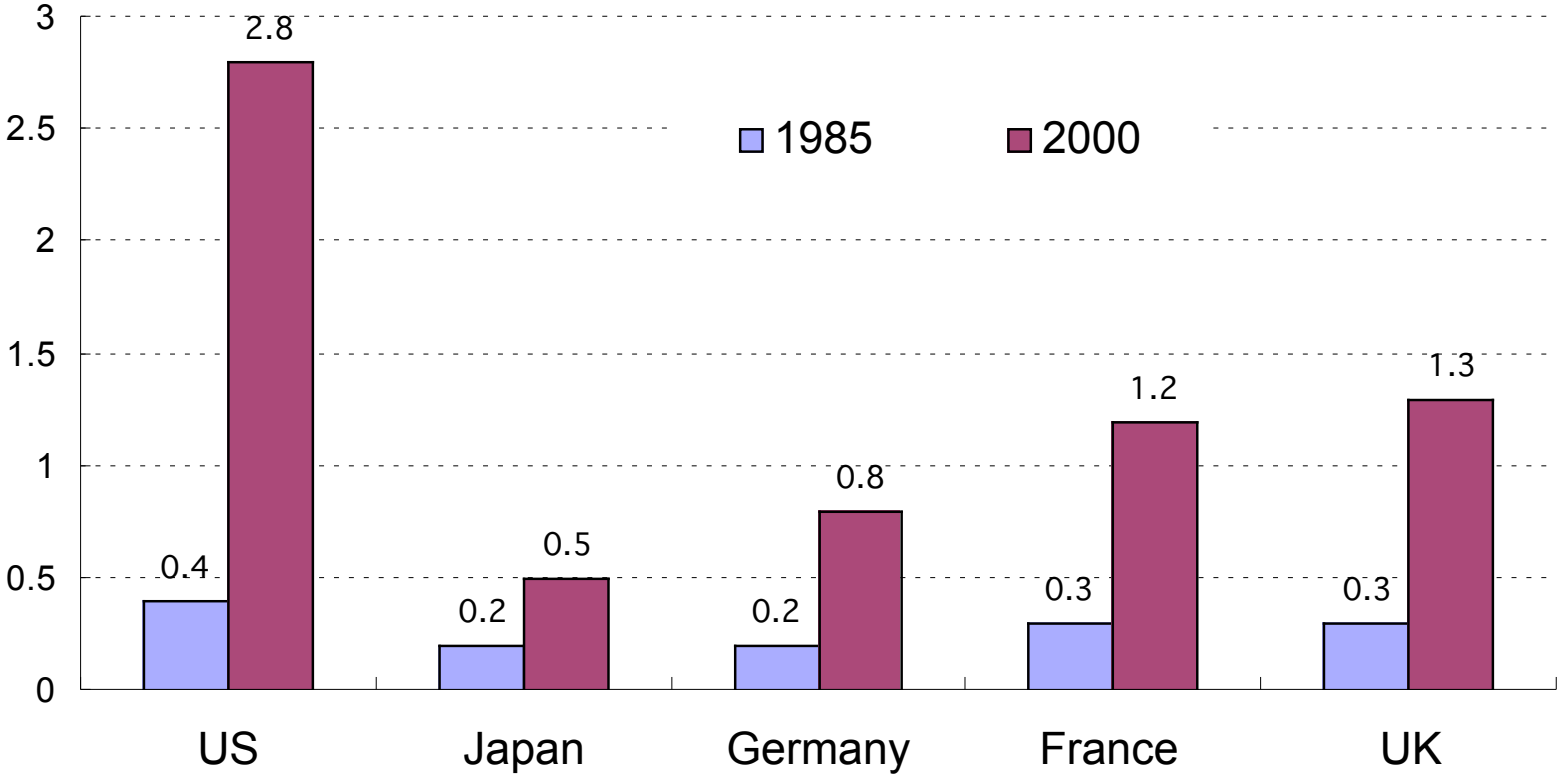
=> Making long-run growth orientation & internal skill accumulation more difficult.

Changing Science and Technology

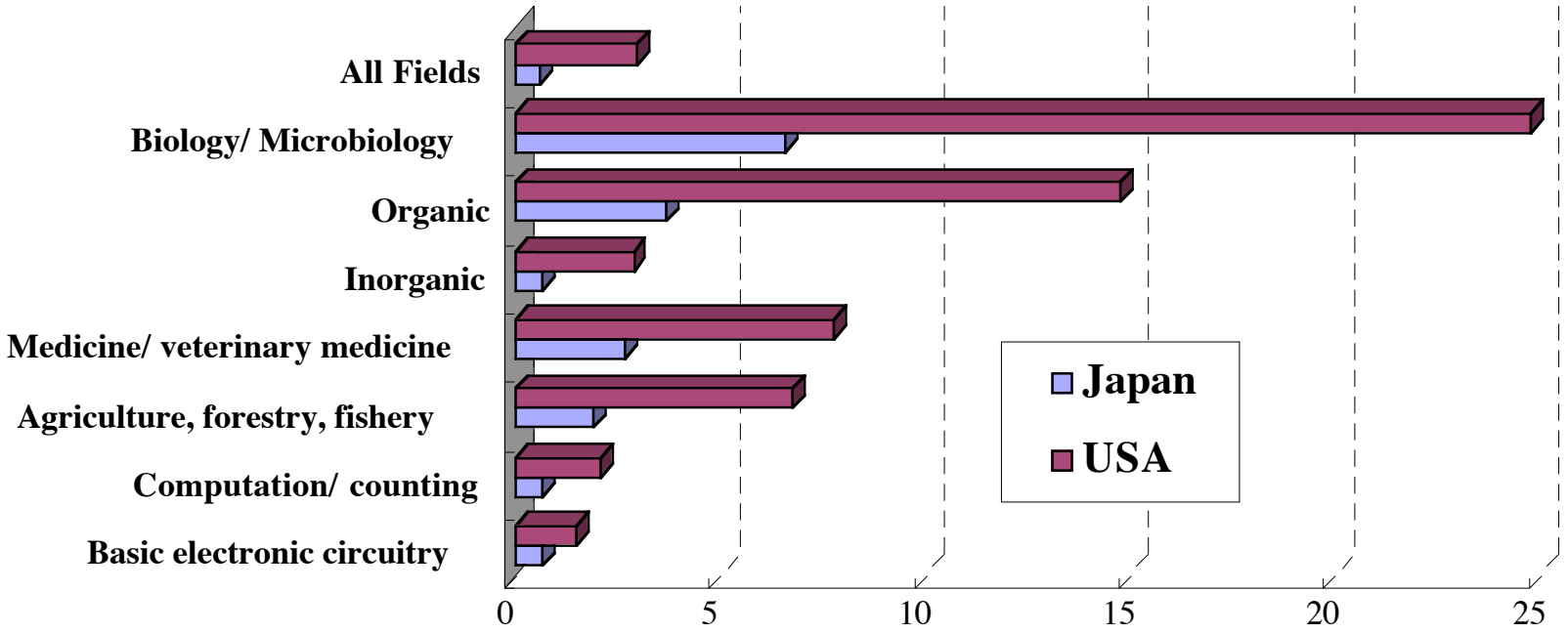
- Strict enforcement of intellectual property rights by foreign companies
  - Difficulty in acquiring overseas technologies
  - IPR disputes, particularly with US firms
- Increasing science linkages
  - Measured by the number of citations of scientific papers by US patents

Science Linkages

(No. of scientific paper quotation per U.S. patent)



Science Linkage in All Fields and Six Major Fields, 2001



Science-Based Industries

- Life science and biotechnology
- Information and communication technologies
- Environmental sciences
- Nano-technology and materials

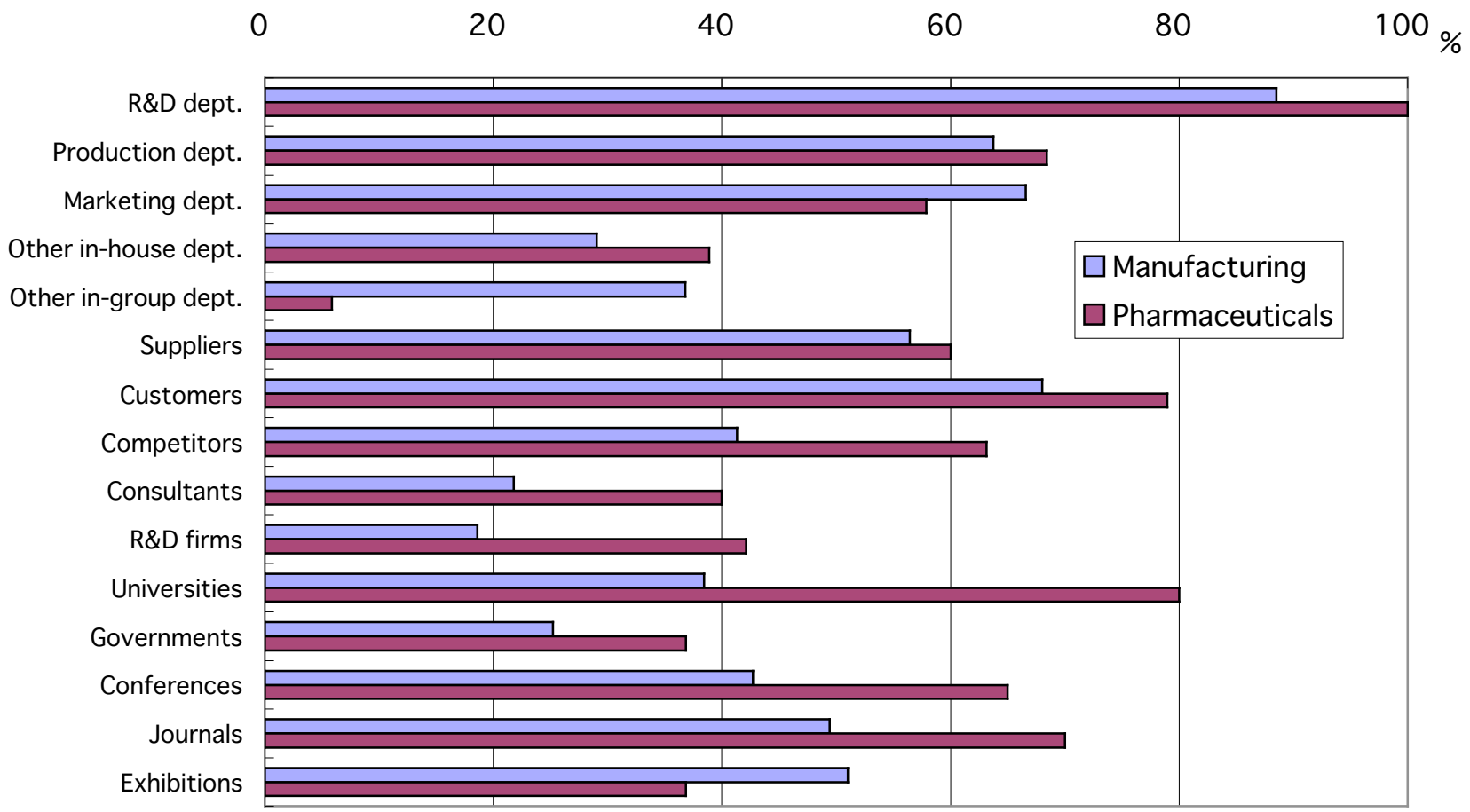
<< Four areas of priority in Japan's

Science and Technology Basic Plan, 2001>>

The importance of scientific knowledge is also shown in Japan's "National Innovation Survey"

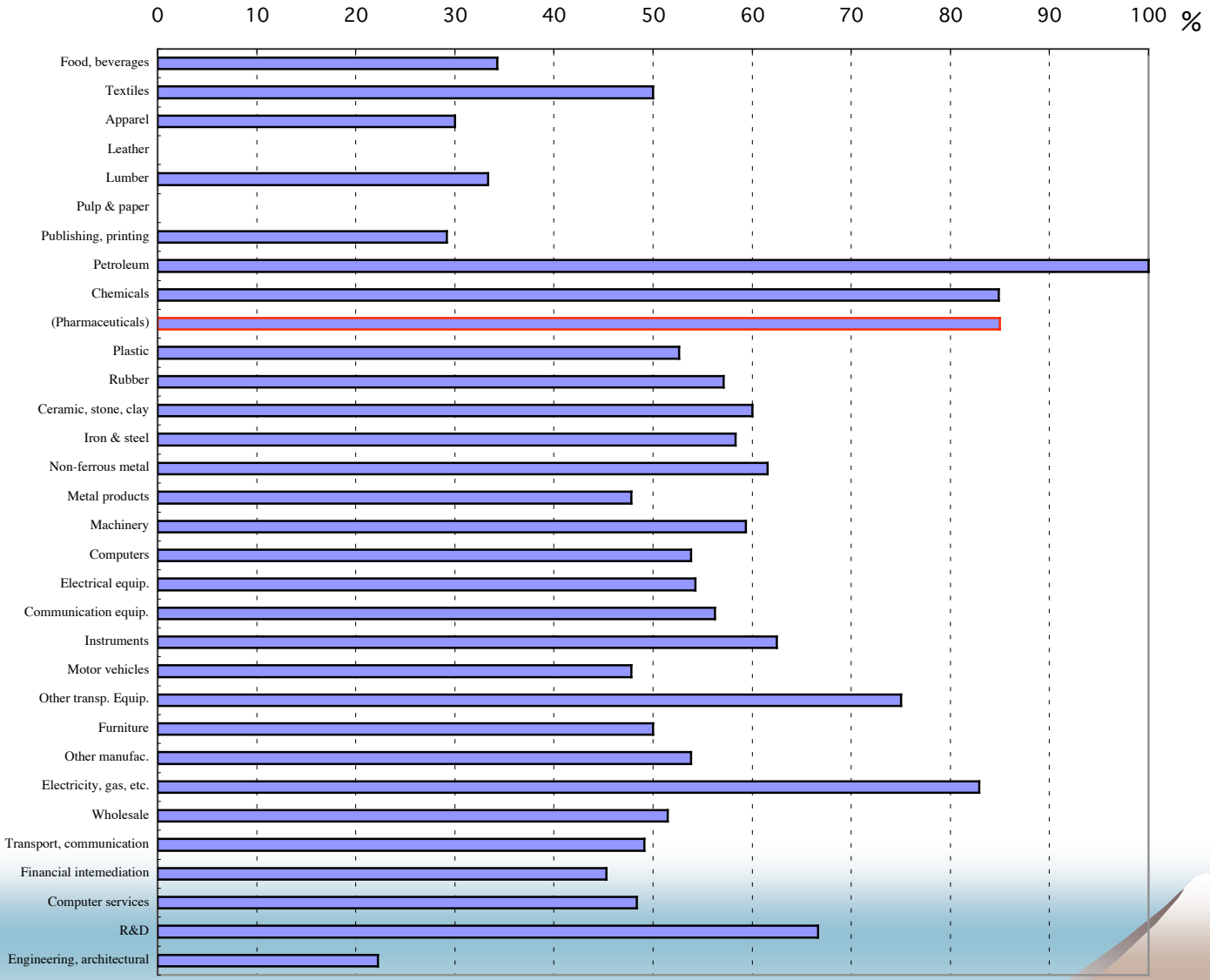
- National Innovation Survey (J-NIS)
  - Conducted by the National Institute of Science and Technology Policy (NISTEP), 2003
  - Sent questionnaires to about 43,000 firms
  - Response rate: 21.4%
- We cite the results for large firms (with 250 employees or more)

Information sources for innovations (suggestions for new innovation projects)
-Proportion to total innovation-active enterprises-

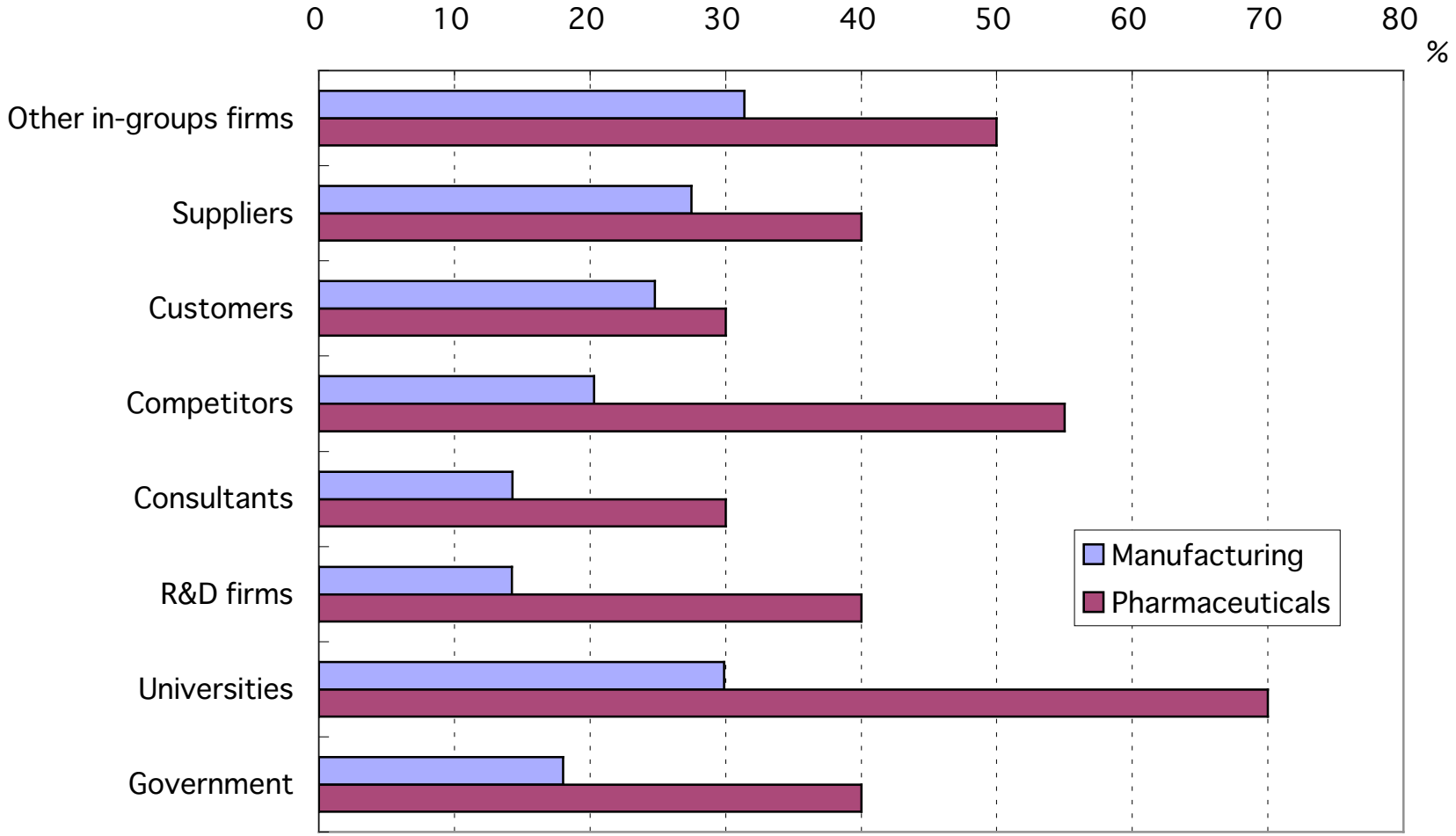


Cooperation Agreements for Innovations:

Proportions to Total Innovation Active Firms



Partners in cooperation for innovations: Proportion to total innovation-active enterprieses with cooperation agreements for innovations



So, what should be the issues?

- National innovation system and the national economic/business system *do* and *have to* co-evolve.
  - Who are the better performers of science-based innovations -- diversifying large firms or startups?
  - What allocation mechanism for finances?
  - What allocation mechanism for human resources?

- National innovation system and the national education/science system *do* and *have to* co-evolve.
  - How to promote university-industry collaborations?
  - How *not* to neglect basic scientific inquiries?
  - Should universities patent their inventions?

The Measurement Issue

- Many studies have been made to measure the impact of commercial R&D
  - Production function approach
    - By estimating a production function with R&D stock or patents as one of the factors
    - By regressing productivity increase on R&D
  - Market value approach
    - By regressing Tobin's *q* on R&D or patents

- We still do not know how to measure the contributions of scientific research
  - Incorporating academic R&D expenses in the production function approach or the market value approach cannot capture the full impact of scientific contributions
  - Long lags and big uncertainties
  - Science linkage indexes can capture the contribution of scientific research only in a limited manner

The contributions of scientific research is bound to be undervalued

- There is no question that we have benefited greatly from scientific advance
  - E.g., improved health and longer life,
    social impact of internets
- Scientific advance, no doubt, has also contributed to the economy
  - E.g., improved productivity,
    increased product variety
- However, such economic returns are likely to be only a fraction of the contribution of scientific advances to the welfare of mankind