Digest of Japanese Science and Technology

Indicators

- Data Updated in 2007 for 5th edition -

Jun 2008

NISTEP,MEXT

This material is the English translation of the main points extracted from the "Science and Technology Indicators - Data Updated in 2007 for 5th edition –" issued by NISTEP in July 2007. The original report in Japanese is a 422-page long report. Part of the composition of the report has been changed for summarizing purposes, but the data are the same as those in the original version.

Digest of Japanese Science and Technology Indicators

- Data Updated in 2007 for 5th edition -

Jun 2008

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Overview

Major global trends

- For various countries throughout the world, investment in science and technology has increasingly been given importance as a key driving force for economic growth. The amount of research and development (R&D) expenditure has been stable in advanced industrialized countries, including Japan. There are other countries, such as China and Korea that have been rapidly increasing their R&D expenditure over recent years to join the club of major R&D spending countries. China's R&D expenditure has already become the third largest in the world in terms of purchasing power parities and will surpass Japan's level of expenditure in one or two year's. Korea's spending on R&D is approaching the level of France and the U.K.
- Science and technology activities that span national boundaries are being conducted at an ever increasing rate. Indicators that measure this, including data on the number of internationally co-authored papers, cross-border patent applications, the technology trade, and foreign trade of high technology products, show that the rapid globalization of science and technology that became noticeable in the late 1990s continues.
- The mode of knowledge production has changed significantly during the past quarter of a century. The formation of groups and networks for scientific research activities have steadily progressed, as shown in the data on co-authored scientific papers.

The knowledge base and innovation system

- Japan's R&D expenditure was 17.8 trillion yen in 2005, showing an increase of 5.4% over the previous year and reaching the highest level of 3.53% of gross domestic product (GDP). This strong growth, which departs from the slow growth of R&D spending that was less than one percent in the run up to 2004, indicates that the importance of R&D for the business sector. has increased.
- As the foundation for a knowledge-based society, the importance of human resources for science and technology has increased significantly. Until now, the majority of graduates in science and engineering have sought employment in the manufacturing sector. However, since the 1990s the rate of employment in the service sector has increased, and has surpassed the rate in the manufacturing sector since 2002. This reflects a shift in the economy towards service and in-

formation-based industries and shows the necessity of scientific and technological knowledge to the service industry.

- From the viewpoint of building a foundation for the future of science and technology it is extremely important to develop human resources. According to the results of an international survey of math and science education, Japan’s elementary, secondary and high school students have generally obtained high scores but have a low willingness to study. This has raised concerns over the difficulty of securing human resources and a potential weakening of the knowledge base in the future.

- Industry-academia-government collaboration has been promoted in many countries for the promotion of innovation. In Japan, various indicators show considerable development of industry-academia-government collaboration over recent years. However, the amount of R&D funds that universities and other higher education institutions have received from companies was 90 billion yen in fiscal year 2005, which is only 2.6% of the total amount of R&D expenditure in tertiary education during the same fiscal year. Thus, Japan is still at an early stage in the promotion of industry-academia-government collaboration.

Japan’s competitiveness

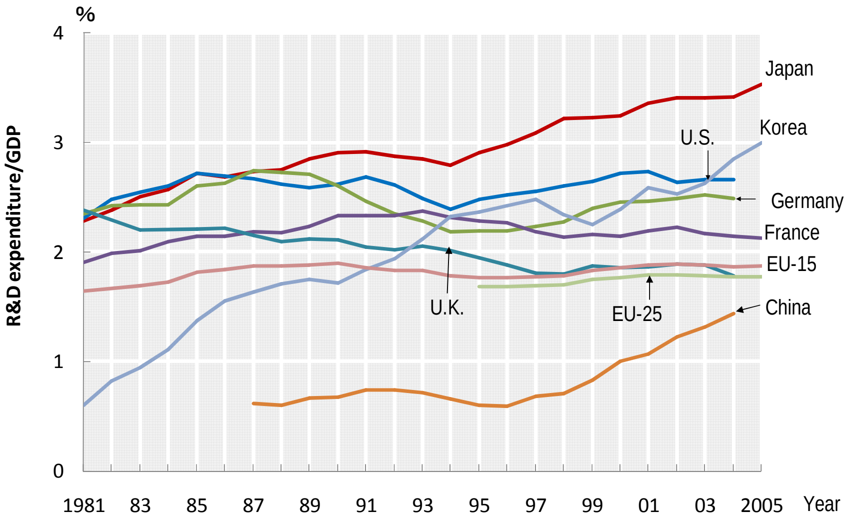
- Since the late 1990s Japan’s high-technology industries have increasingly faced difficulties in maintaining international competitiveness. Changes in the trade balance for high-technology industries show that an extremely strong reliance on the electronics-related industry contributed to economic prosperity in the 1980s, but on the other hand has been one of the causes of the economic slowdown in the 1990s and thereafter. This indicates the need for a more tenacious source of competitiveness.

- Observing the performance of scientific research based on the data for scientific papers, Japan’s share of papers was the second largest in the world following that of the United States, at 9.0% in 2005; but this share declined in 2004 and 2005. Maintaining an increase in the share, which Japan has achieved for more than 20 years, is becoming increasingly difficult due to the emergence of other major scientific countries, including China. In the future, Japan needs to improve the qualitative importance of papers produced.

1. International Trends in Science and Technology

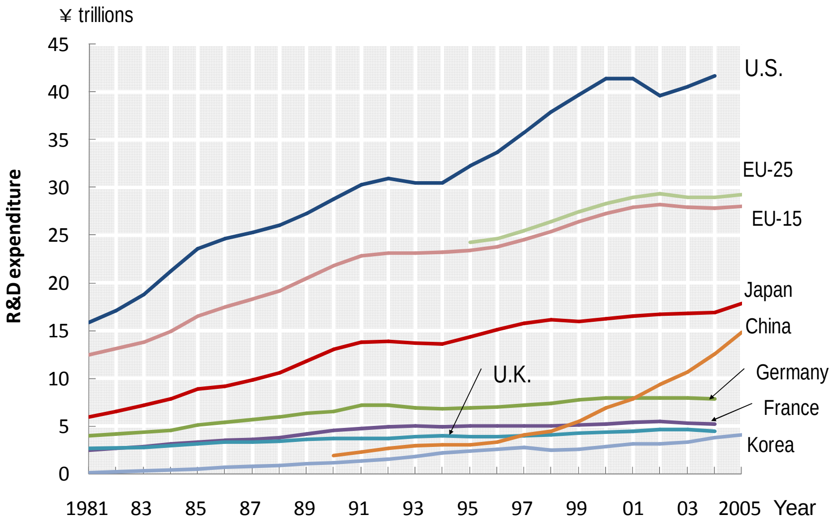
Japan is the only major country whose R&D expenditure exceeds three percent of its gross domestic product (GDP). Until 2004, growth in R&D expenditure had been one percent or less, but in 2005 increased by 5.4%.

Figure 1-1: Trends in R&D expenditure per GDP for selected countries



Notes and Sources: Please refer to the Notes at the end of this Digest Report.

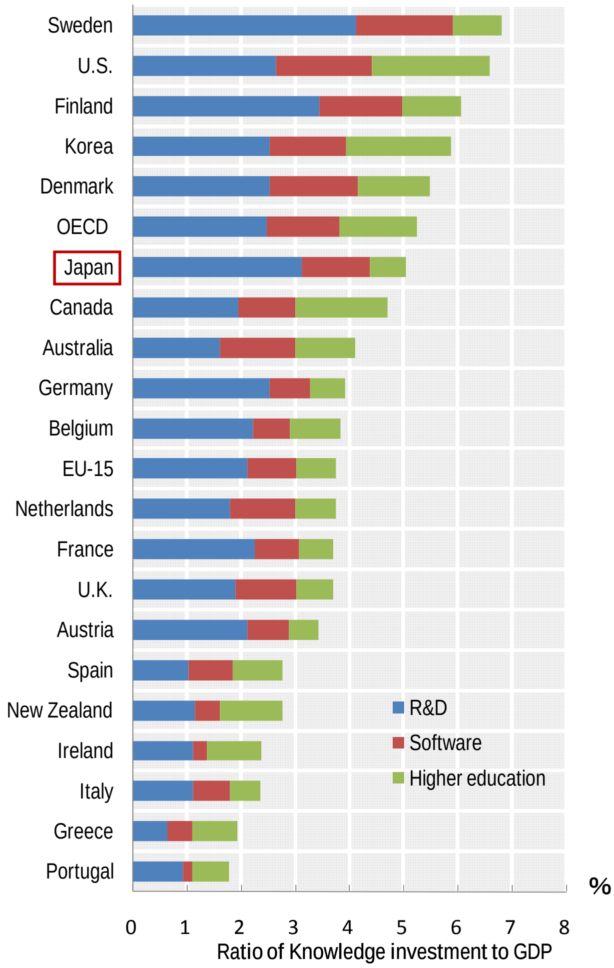
Figure 1-2: Trends in total R&D expenditure for selected countries Nominal figures (on OECD purchasing power parity basis)



Notes and Sources: Please refer to the Notes at the end of this Digest Report.

Japan's investment in knowledge is, however, amongst the middle rank of OECD member countries. Japan's investment in both higher education and software investment are lower than the OECD average; the level of investment in software is particularly low.

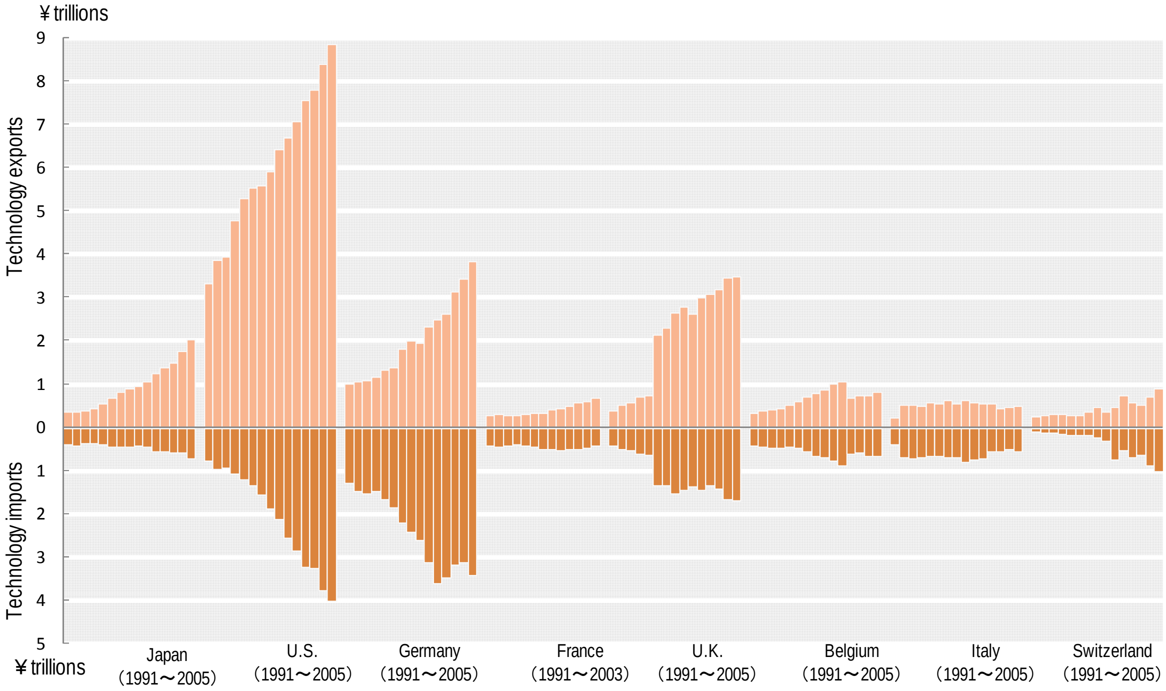
Figure 1-3 Investment in knowledge



Note: The data of EU-15 and OECD do not include those of Greece and Italy. The EU-15 does not have the relevant data for Luxembourg.
Source: OECD, "STI Scoreboard 2005"

Data covering the technology trade of eight countries indicates an increase in the international flow of technology rights. Since the mid-1990s Japan has witnessed a rapid growth in technology exports.

Figure 1-4: Trends in the total value of technology trade in selected countries



Note: Please refer to the Notes at the end of this Digest Report.

Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

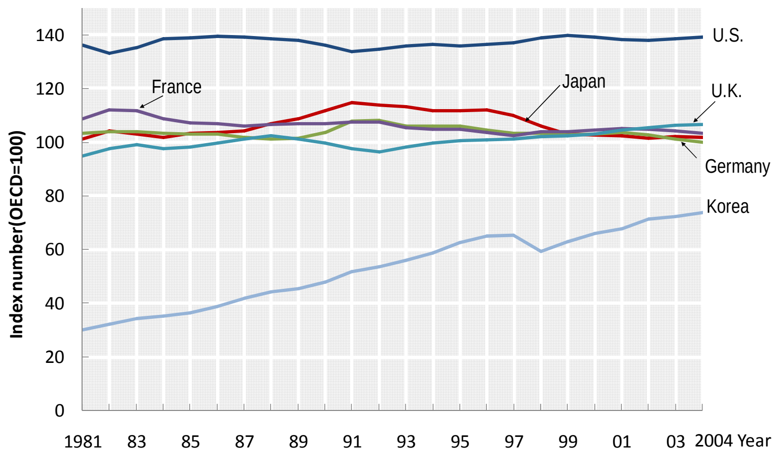
OECD, "Main Science and Technology Indicators 2006/2"

2. Performance of Japan's National Innovation System.

In comparison to other OECD member countries, Japan's GDP per capita reached its peak in 1991 and has declined since then.

Figure 2-1: Trends in per capita GDP in selected countries

Index number (OECD = 100)



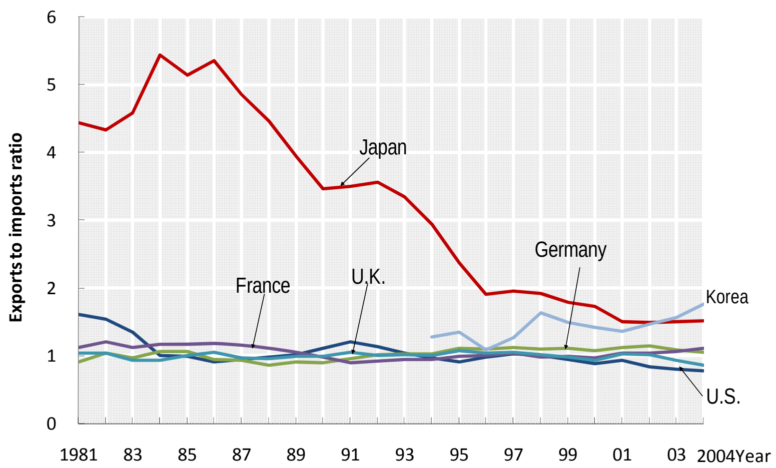
Note: 1) The data of OECD are for a total of 30 member countries excluding the Czech Republic, Hungary, Poland, and the Slovak Republic.

2) GDP figures are 2000-based real value compliant with 93SNA.

Source: OECD, "Annual National Accounts 2006/3"

When we observe the changes in the trade balance for high technology industries, it can be noted that Japan had a high trade balance. This peaked in 1984 and has since then been on a long-term decline. Korea surpassed Japan in 2003. Japan's high technology industries were clearly highly competitive until the first half of the 1990s, but since then their competitiveness has gradually deteriorated.

Figure 2-2: Trade balance in the high technology industry for selected countries

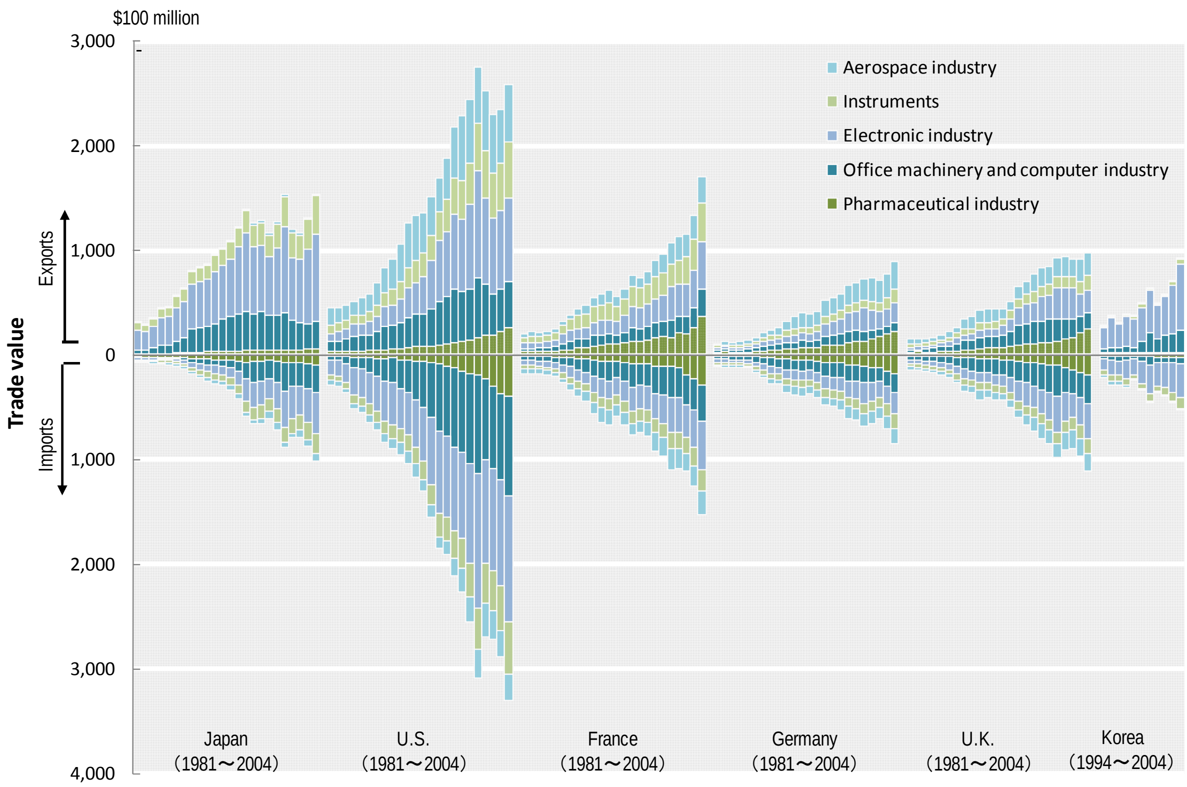


Source: OECD, "Main Science and Technology Indicators 2006/2"

A characteristic feature of Japan's high technology industries indicated by the value of trade is the strong reliance on electronics-related industries. Furthermore, Japan's aerospace and pharmaceuticals industries have an import surplus and are therefore considered to be less internationally competitive.

Unlike Japan, the competitiveness of the United States, Germany, France, and the United Kingdom does not derive specifically from electronics-related technologies, as shown by their favorable trade balance for the aerospace industry in 2004.

Figure 2-3: Trends in the trade value in the high technology industry for selected countries

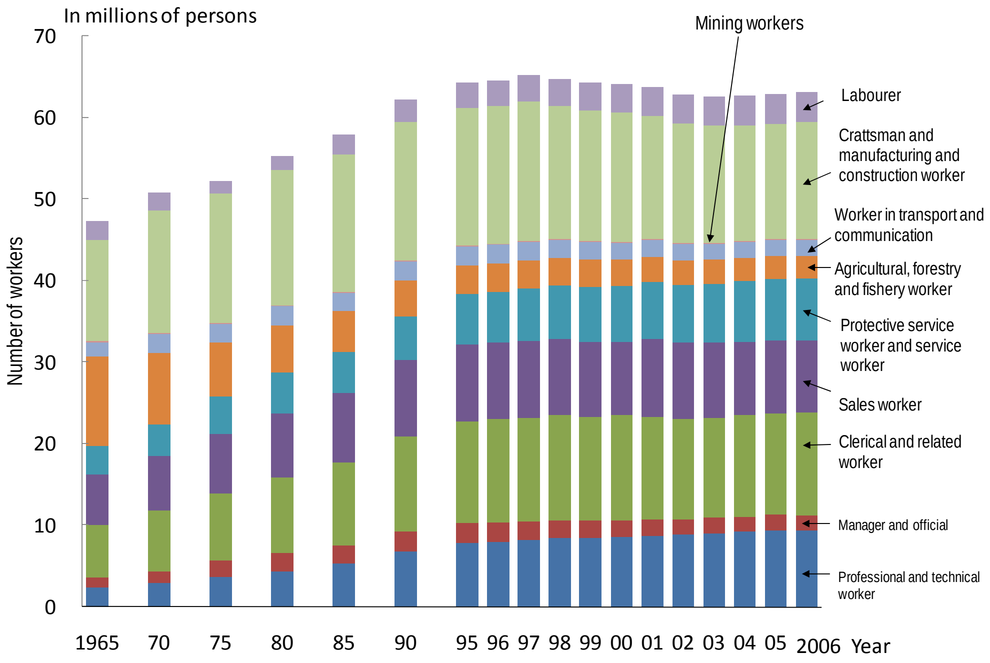


Source: OECD, "Main Science and Technology Indicators 2006/2"

3. Human Resources Devoted to Science and Technology in a Knowledge-based Society

Changes in the number of workers in Japan by profession show that the total number of workers has been on a gradual decline over recent years. The number of ‘professional and technical workers’ has grown significantly, increasing from 12% in 1995 to 15% in 2006. This indicates an increase in knowledge labor.

Figure 3-1: Trends in the breakdown of workers in Japan by profession

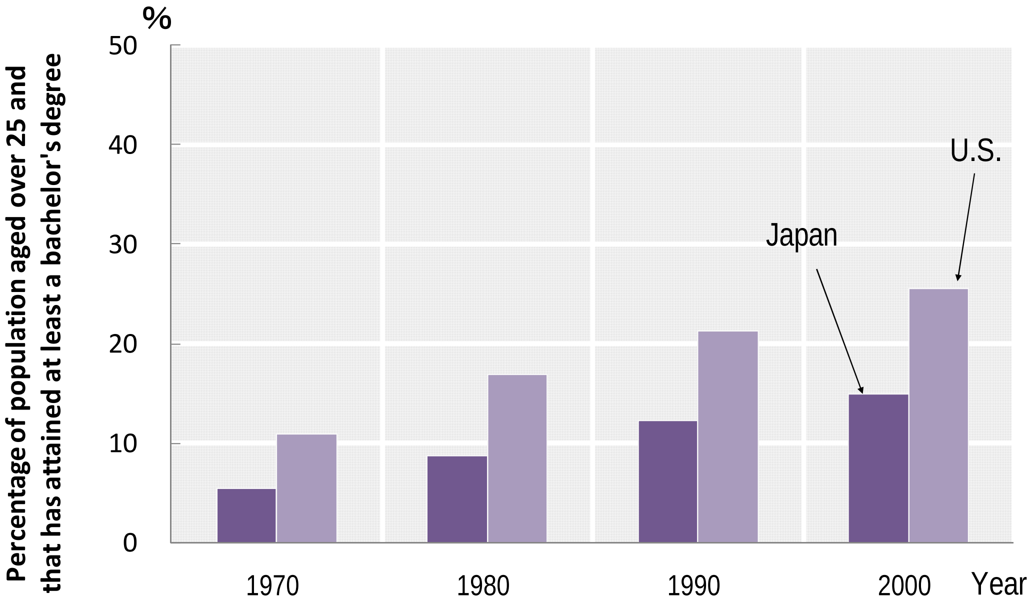


Note: Please refer to the Notes at the end of this Digest Report.

Source: Ministry of Internal Affairs and Communications, “Report on the Labor Force Survey”

The age structure of the Japanese population is rapidly changing. With society aging and the birthrate falling, the main working population aged between 15 and 64 has declined from 67.9% of the entire population in 2000 to 65.8% in 2005. It is expected that it will drop further to 58.5% by 2030. On the other hand, the popularization of higher education is advancing, and the percentage of population aged 25 years or older attaining at least a bachelor's degree has increased. The popularization of higher education, however, is progressing at a higher pace in the United States than in Japan.

Figure 3-2: Growth in the percentage of population in Japan and the United States aged 25 or over with educational attainment of bachelor's degree or higher



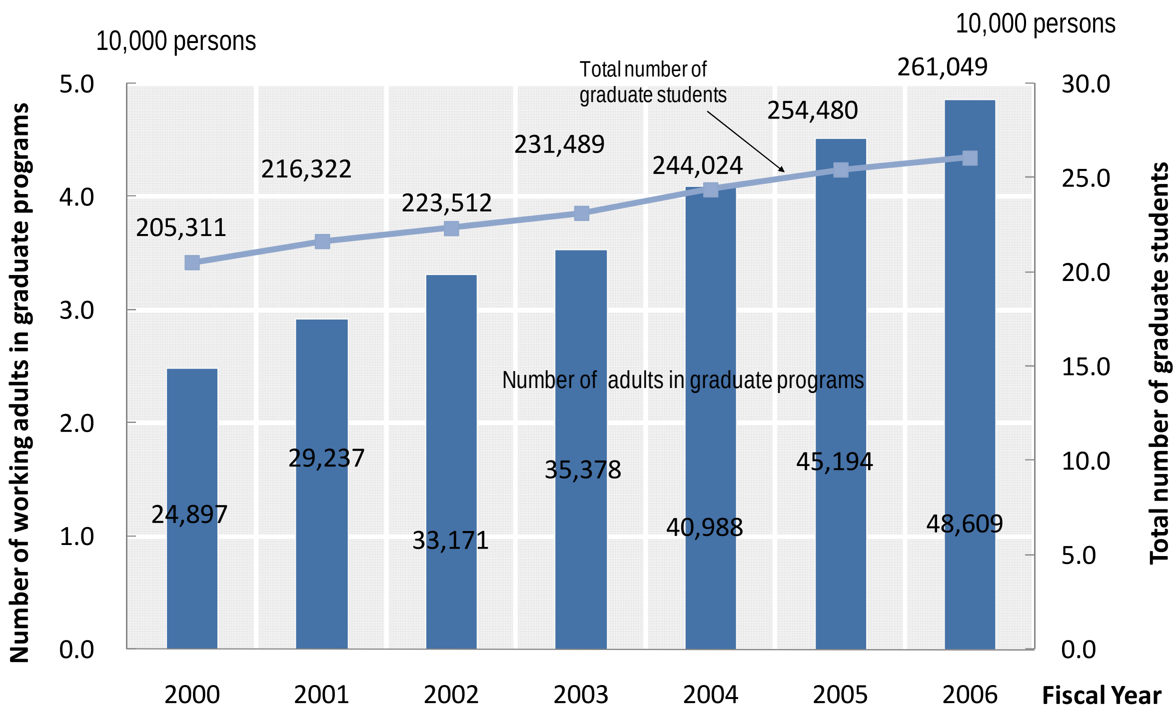
Note: Data on Japan does not include students currently enrolled in graduate schools.

Source: Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Japan 'Population Census,' 1970, 1980, 1990 & 2000

U.S. Dept. of Education, National Center for Education Statistics, "Educational Statistics"

Furthermore, the proportion of adults enrolled in graduate programs has also been increasing, rising from 12% in 2000 to 19% in 2006.

Figure 3-3: Growth in the number of adults in graduate programs in Japan



Note: 1) 'Adult' refers to a person who has a job as of May 1st each year, i.e., a person who has a job for the purpose of earning an income such as salary, wage, compensation, etc.. This also includes people retired from business organizations and housewives.

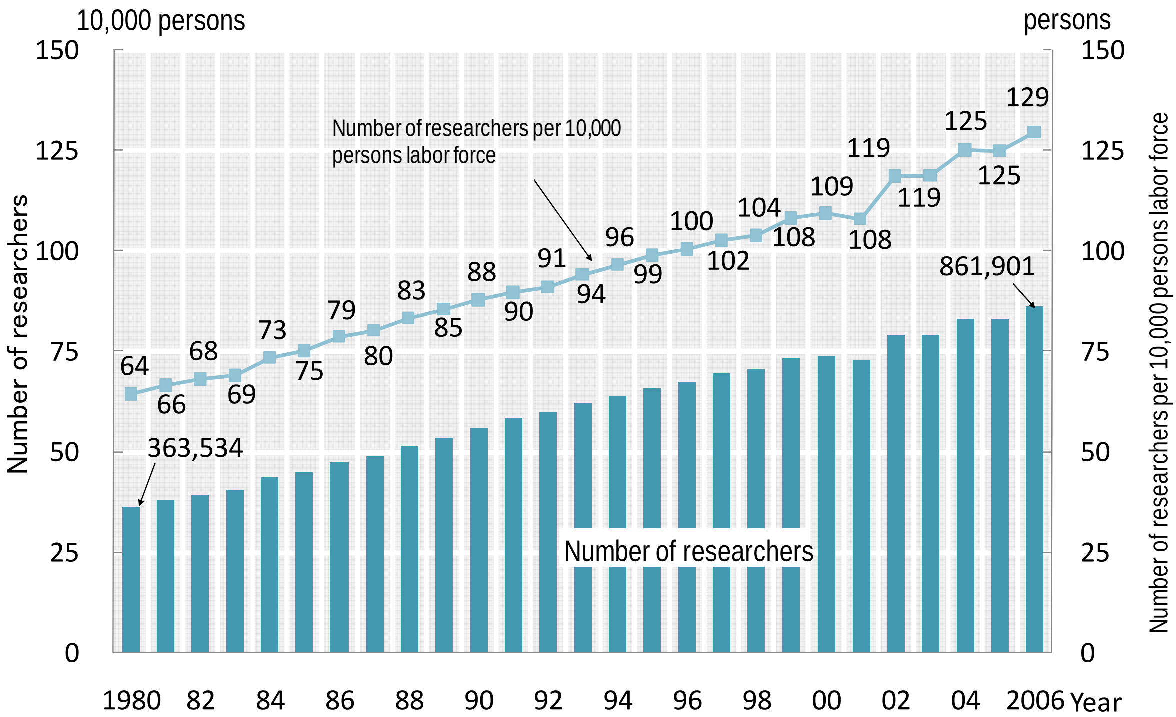
2) Here, a graduate student refers to a student who has enrolled in either a master's course or the first semester of a doctoral course, a doctoral course or the second semester of a doctoral course, or a professional graduate school.

Source: Ministry of Education, Culture, Sports, Science and Technology, "Basic Survey of Schools"

4. Researchers in a Knowledge-based Society

In Japan as of 2006 there are 129 researchers per 10,000 labor force. Over the past 25 years, the number of researchers has doubled from 64 in 1980 (Figure 4-1). This indicates that with the transition to a knowledge-based society the role of researchers engaged in knowledge production has become more important.

Figure 4-1: Trend in the number of researchers per 10,000 labor force



Note: 1) The labor force is the total of the number of employed and unemployed persons.

2) Number of researchers based on head count.

3) Includes natural science, social science and humanities.

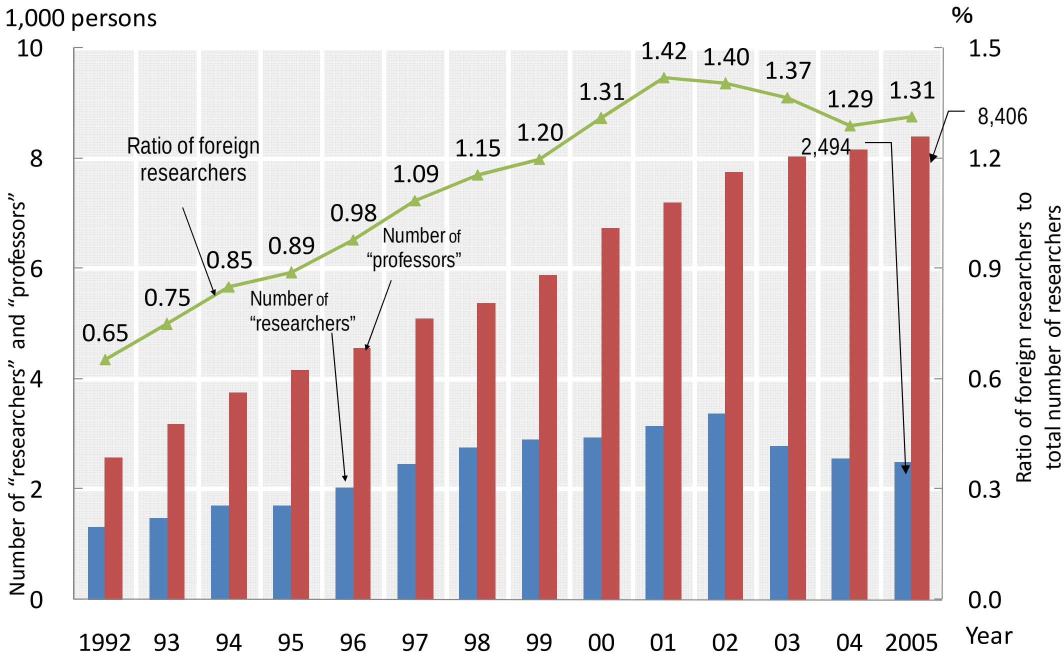
Please refer to other relevant notes at the end of this Digest Report.

Source: Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Report on the Survey of Research & Development"

Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Labor Force Survey"

At the end of 2005 the number of foreign researchers in Japan was 10,900. Looking at this figure over time, the ratio of foreign nationals to the total number of researchers in Japan has been decreasing over recent years. By breakdown of nationality as of the end of 2005, 32.3% of foreign researchers in Japan came from China, 12.3% from Korea, 11.9% from the United States, 4.9% from the United Kingdom, and 3.9% from India.

Figure 4-2: Trends in the number of foreign researchers and its ratio to the total number of researchers



Note: The number of foreign researchers is the total of foreign nationals whose visa status is "professor" (research, research guidance or education at a university or equivalent institution or a specialized institution of advanced learning) or "researcher" (involvement in research based on a contract with public or private institutions).

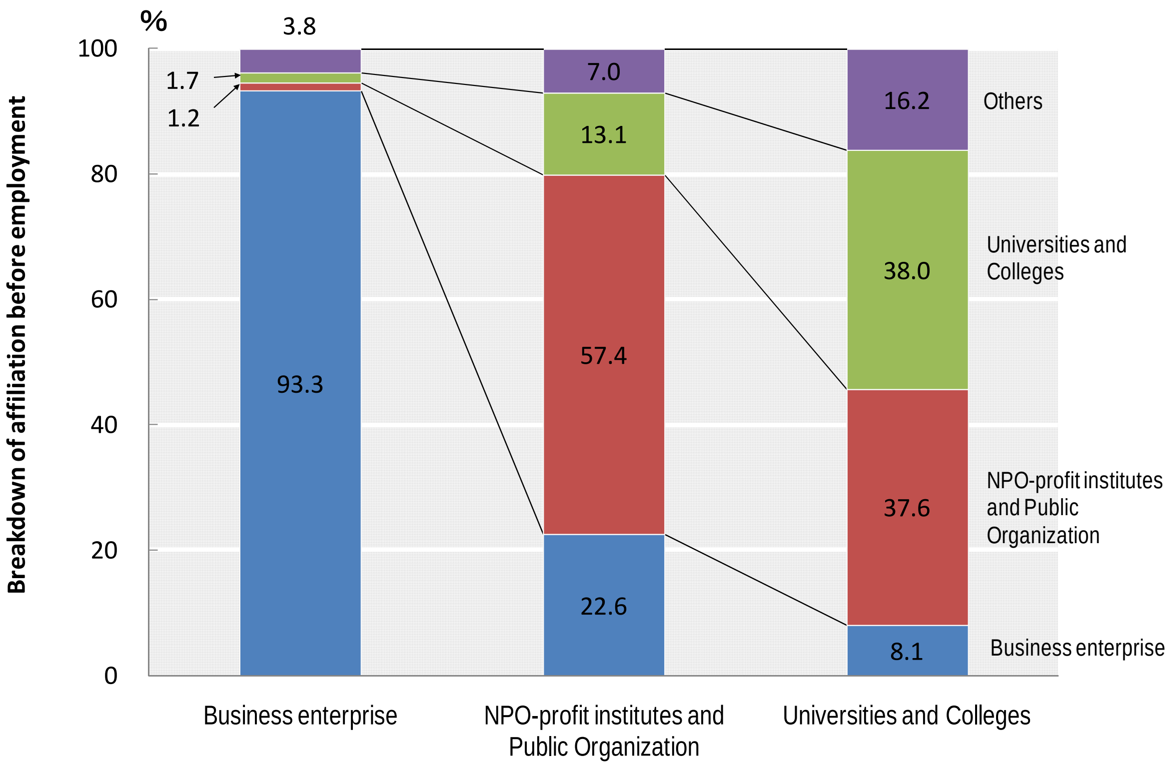
Source: Ministry of Justice, "Statistics for Foreign Residents in Japan"

Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

The mobility of researchers is a crucial aspect for maximizing research capabilities.

In 2006 the ratio of researchers recruited from another organization was 4.1%, which is larger than the 3.9% ratio of new graduate recruits. Of the researchers recruited by Universities and Colleges in 2006, 38.0% were from Universities and Colleges and 37.6% from NPO-profit institutes and Public Organization.

Figure 4-3 : Breakdown of original working place for researchers (2006)



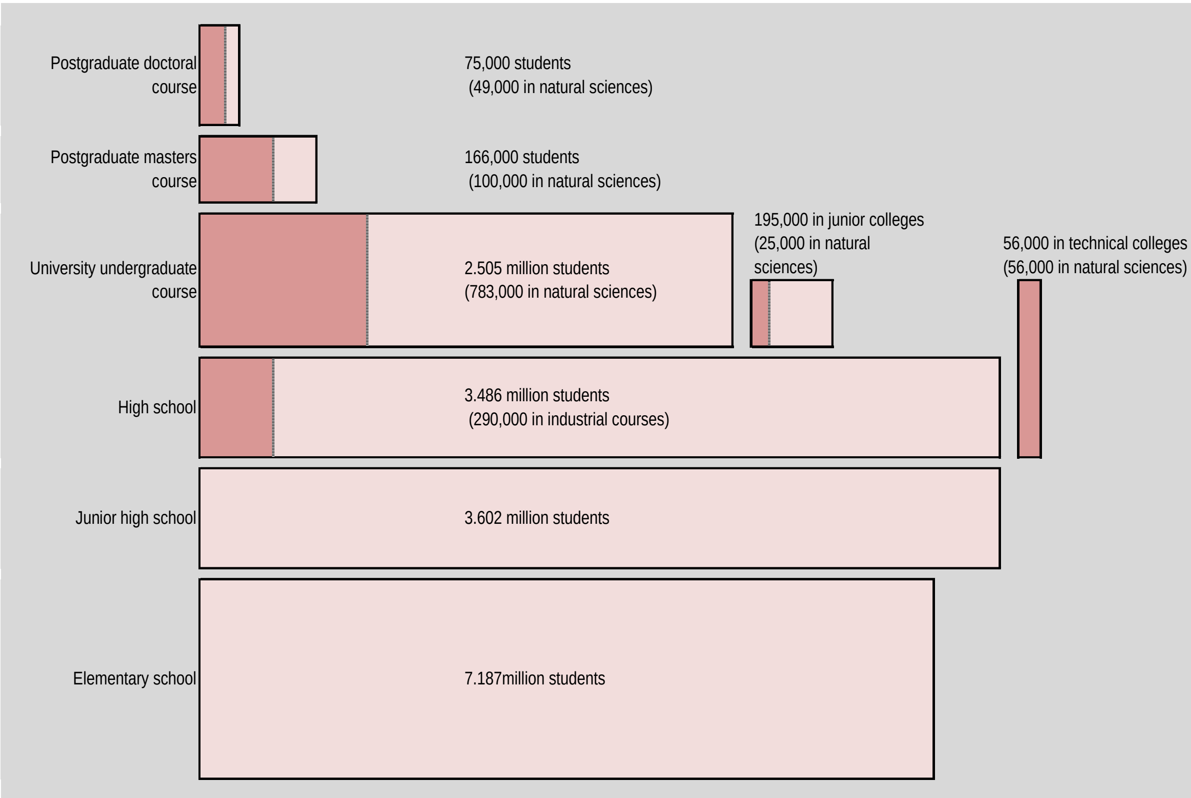
Note: The total is not consistent.

Source: Ministry of Public Management, Home Affairs, Posts and Telecommunications, "Report on the Survey of Research and Development"

5. Development of Human Resources Devoted to Science and Technology in School Education

In universities and colleges the ratio of undergraduate students studying natural science and related subjects was 31％(783,000 out of 2.505 million students), and 13% (25,000 out of 195,000) in junior colleges. The ratio in graduate school masters courses was 60％(100,000 out of 166,000) and doctoral courses 65% (49,000 out of 75,000 students) .

Figure 5-1: The current state of students in school education (FY2006; conceptual chart)



Note: 1) Conceptual chart breaking down the number of all full-time students in the various types of academic institutions and the ratio of those in science and engineering (shaded areas).

2) At undergraduate and postgraduate levels, 'natural sciences' represent the total of students in science, engineering, agricultural science and health sciences (including medicine, dentistry and pharmaceutical sciences).

3) Natural sciences in junior colleges represent the total students in industrial courses.

4) The width of the bar graph represents the number of years required for completion of study in the respective educational institutions. Bar area represents the number of students enrolled in such institutions.

5) The number of graduate students excludes those in specialized academic courses.

Source: Ministry of Education, Culture, Sports, Science and Technology, “School Basic Survey”

Statistics on the industrial sector of employment for graduates of bachelor, master and doctoral degrees in science and technology reveal that a larger number of bachelors and doctoral graduates obtain employment in the service industry rather than the manufacturing industry. A larger number of master's graduates obtain employment in the manufacturing industry.

Figure 5-2: Trends in the employment rate of university graduates in science and technology by industry

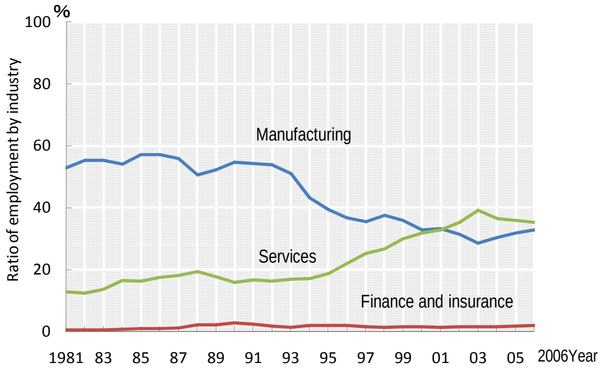


Figure 5-3: Trends in the employment rate of graduates in master's courses in science and technology by industry

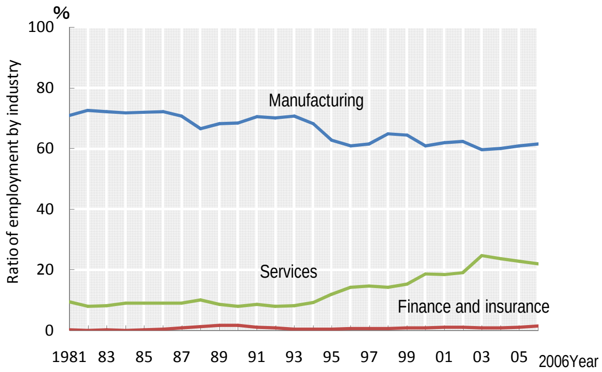
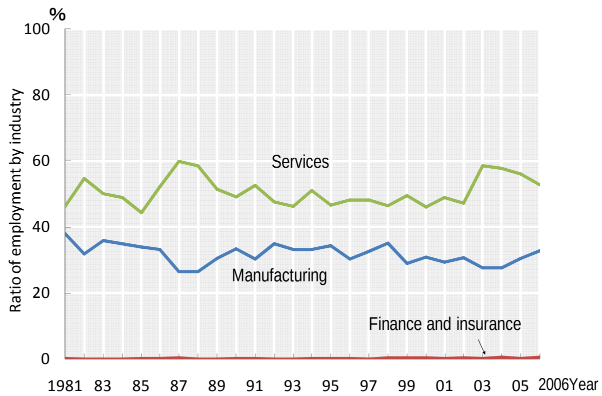


Figure 5-4: Trends in the employment rate of graduates in doctoral courses in science and technology by industry



Note: Please refer to the Notes at the end of this digest report.

Source: Ministry of Education, Culture, Sports, Science and Technology, "School Basic Survey"

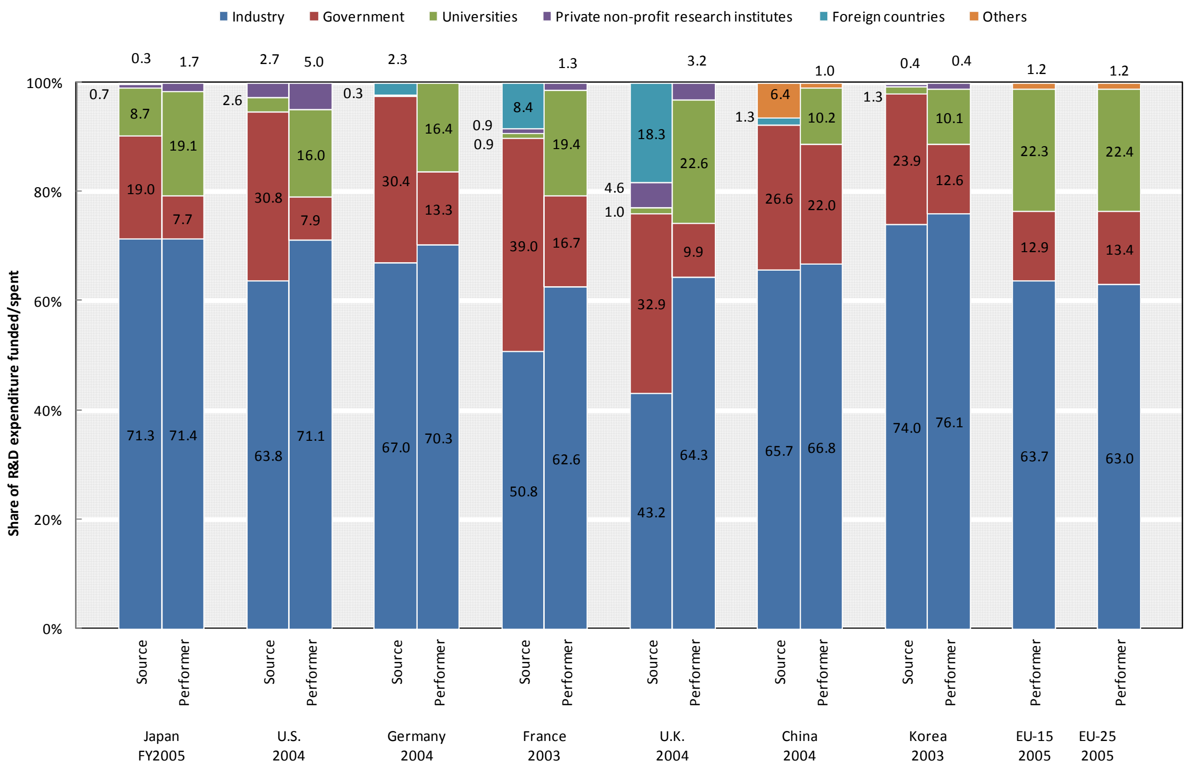
6. International Comparison of R&D Systems

Across countries there are large variations in the share of the government sector as an R&D performer and as a funding source. In Japan, the share of R&D expenditure funded by the government sector is the smallest amongst the seven largest countries; spending by the government sector is also small, similar to the U.S..

From the perspective of the performer of R&D, the higher education sector in Japan plays a major role, spending 19.1% of total R&D expenditure, comparable to levels found in France and the U.K.. France and the U.K. are, however, dissimilar to Japan in that higher education institutes make little contribution to R&D funding. In Japan, the private universities are the source for most R&D expenditure funded by the higher education sector.

A noteworthy point is that in the U.K., the share of R&D expenditure funded by "foreign countries" and private nonprofit research institutes is relatively large.

Figure 6-1: R&D expenditure by performing sector and source of funding for selected countries



Note: Please refer to the Notes at the end of this Digest Report.

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

<U.S.>NSF, "National Patterns of R&D Resources 2004 Data Update"

<Germany>Bundesministerium für Bildung und Forschung, "Research and Innovation in Germany 2005, 6"

<France; Korea>OECD, "Research & Development Statistics 2004/2"

<U.K.>National Statistics website: www.statistics.gov.uk Crown copyright material is reproduced with the permission of the Controller of HMSO

<China> Ministry of Science and Technology of the People's Republic of China, "S&T Statistics Data Book 2005 (website)"

<EU>OECD, "Main Science and Technology Indicators 2006/2"

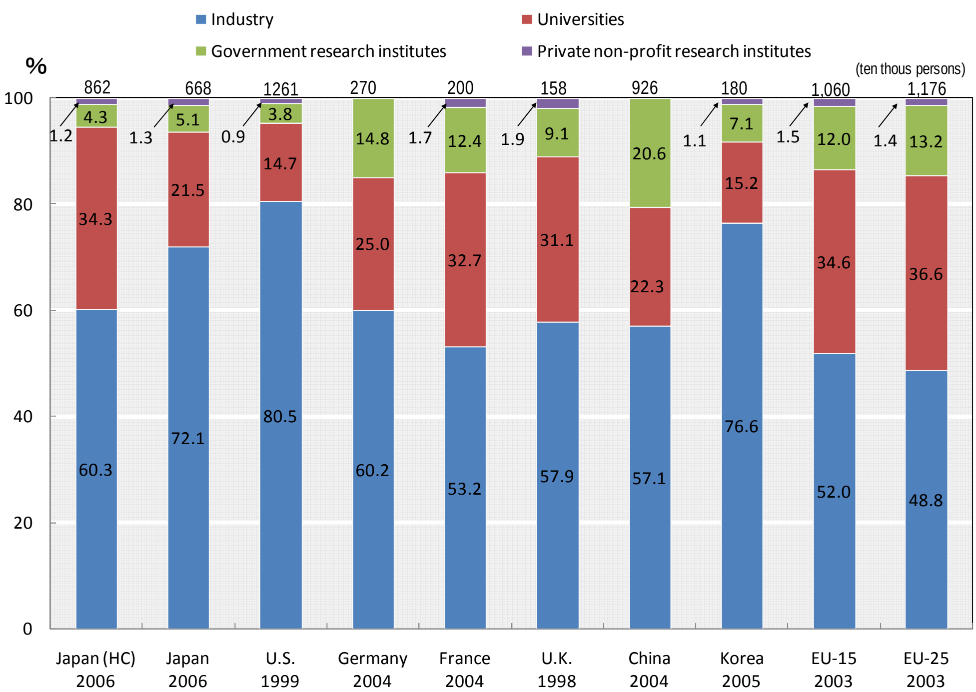
The methodology for collecting data on the number of researchers by sector differs by country and sector, and as such they are not sufficiently comparable. They are shown here as reference data to observe the general trends.

Expressed in terms of full-time-equivalent, the percentage of researchers accounted for by Japanese universities is 21.5%, which is smaller than that of Germany, France, and the U.K..

The percentage of researchers accounted for by the business sector in the U.S. is the highest of the seven countries, while the percentage employed in the U.S university sector is the lowest amongst the seven countries. However in the case of the U.S. it is possible that the number of researchers in universities has been underestimated.

The percentage of researchers in universities in France and in the U.K. is quite high. The same tendency is witnessed in all EU countries.

Figure 6-2: Number of researchers by sector for selected countries



Note: 1) Researcher in Japanese universities (FTE) were calculated based on the 'Survey on the data for full-time equivalents in universities and colleges' conducted in 2002. The HC stands for head count value.

2) The data for the private non-profit sector of Countries other than Japan and the U.S. are calculated by subtracting the shares of the Industry, Universities, and Government research institutes from the total.

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development";

Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology, "Survey on the Data Calculated in Full-Time Equivalents in Universities etc." (November 2003)

<U.S.> NSF, "National Patterns of R&D Resources: 2002 Data Update"

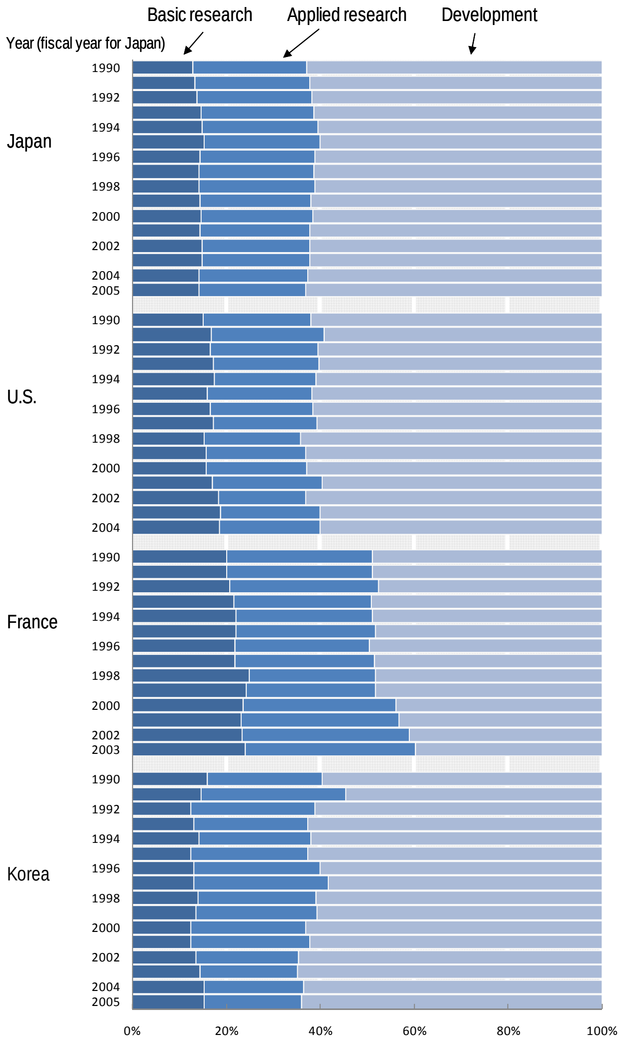
<Germany> Bundesministerium für Bildung und Forschung, "Research and Innovation in Germany 2006"

<France, U.K., China, Korea, EU> OECD, "Main Science and Technology Indicators 2006/2"

The share of basic research in total R&D expenditure for Japan and the U.S. is smaller than that of France. The smaller share of basic research expenditure in Japan and the U.S. is mainly attributable to the large contribution of the business sector to total domestic R&D expenditure. In Korea the focus is mainly upon development activities.

The share of basic research has increased recently in the U.S. In Japan, the share of basic research has been on a slight decline, while development expenditure has increased slightly.

Figure 6-3: Breakdown of R&D expenditure by character of work for selected countries



Note: R&D expenditure for Japan and Korea refers only to natural sciences. R&D expenditure for the other countries is the combined total of natural sciences and humanities.

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.>NSF, "National Patterns of R&D Resources 2004 Data Update"
<France>OECD, "Research & Development Statistics 2004/2"
<Korea>Korea National Statistical Office, Statistical DB (website)

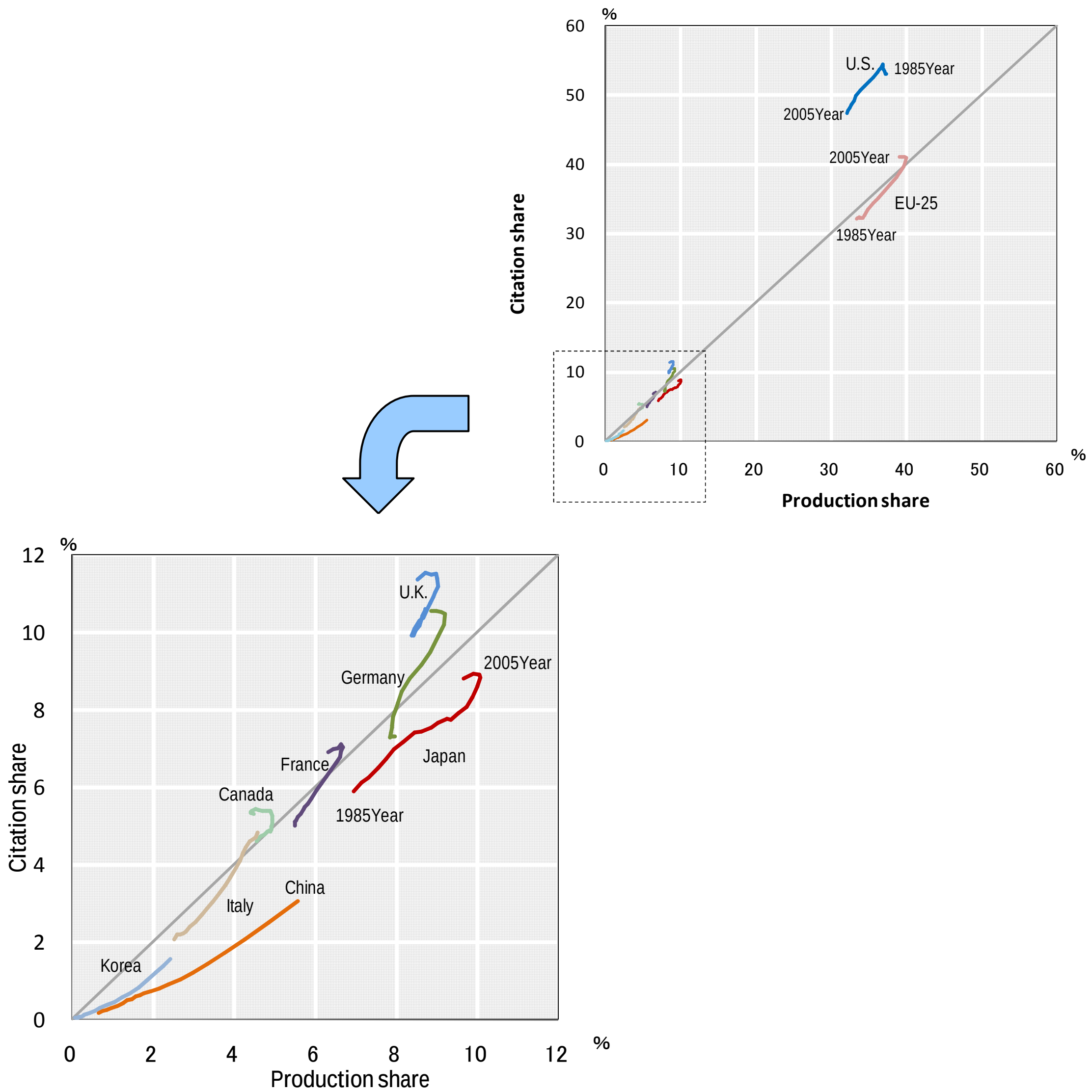
7. R&D Performance

The U.S. has the largest share of papers and its citation share is higher than its paper share, with almost half of the papers cited throughout the world being of U.S. origin.

The U. K. citation share is also higher than its paper share, and the impact of its papers is considered to be high. The country's citation share has been rising since 1989.

On the other hand, Japan's citation share is ranked fourth in the world. Its citation share, however, is small relative to its paper share, thus the impact of Japan's scientific papers is moderate.

Figure 7-1: Trends in citation for selected countries
(natural sciences and engineering; 1985-2005)



Note: 1) The data do not include the social sciences and humanities.

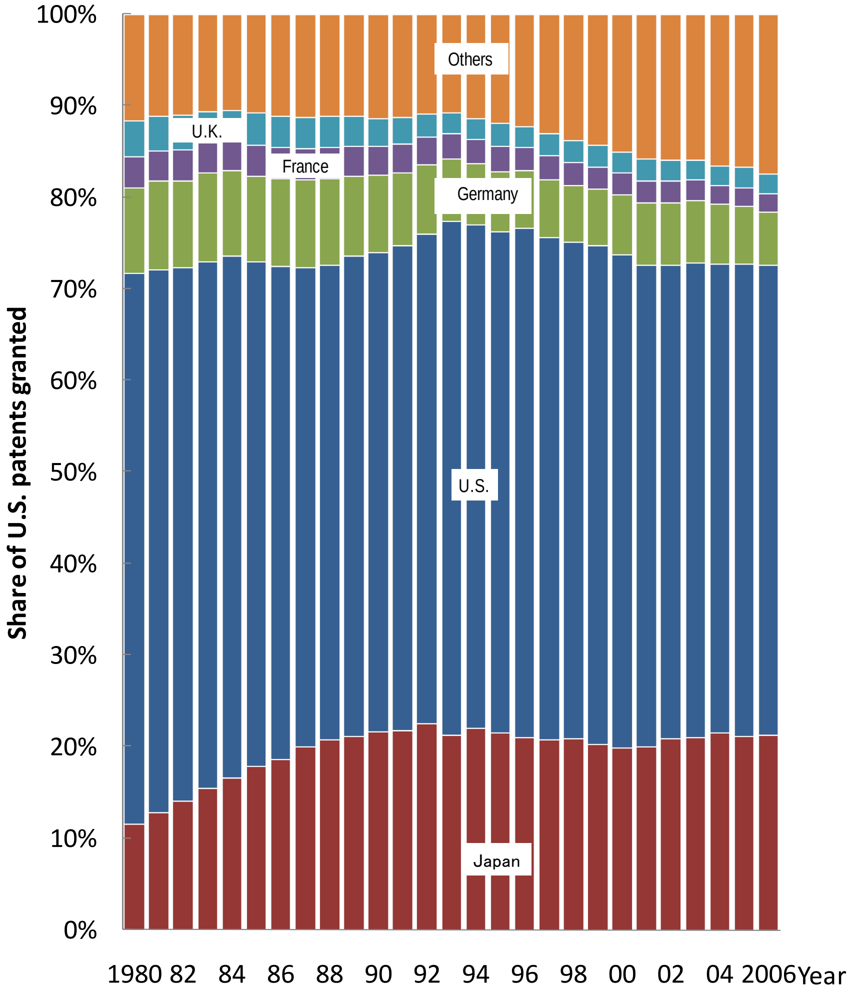
2) A five-year-window has been used for the values in the respective years to ensure a comparison of citation data on the same basis.

3) Papers published by authors from different countries have been double-counted according to each author's national affiliation.

Source: Recompiled by NISTEP based on Thomson Corporation's "National Science Indicators, 1981-2005 (Deluxe version)"

The share of patents from Japan granted in the United States increased significantly during the 1980s, although the pace of growth decelerated in the latter half of the decade. Behind the U.S., Japan has remained the second largest source of U.S. patents.

Figure 7-2: Trends in the patents granted in the U.S. by source country



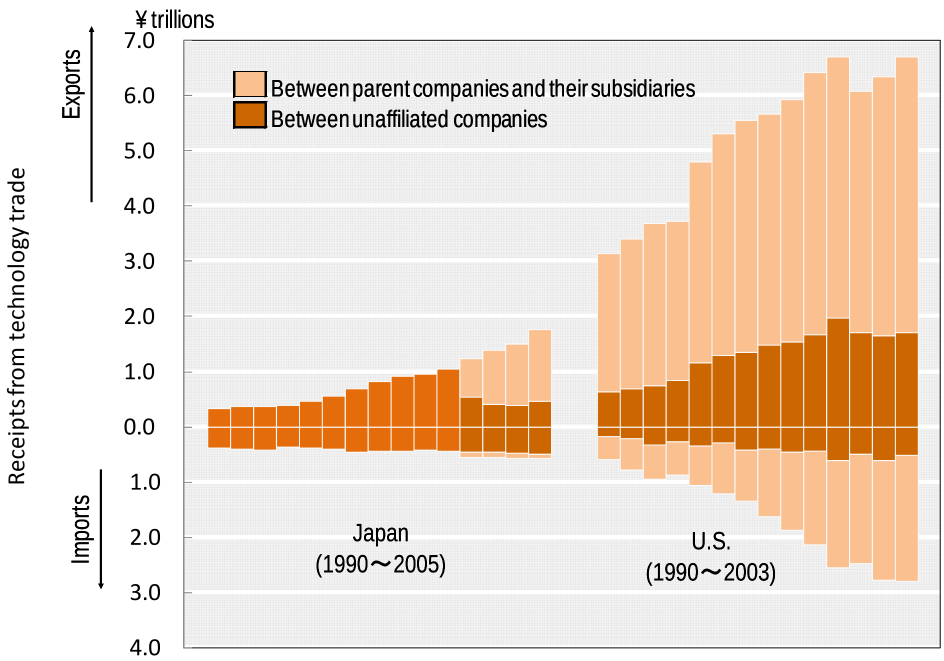
Source: Compiled by NISTEP based on the Patent Board's "Global Patent Scorecard 2007"

Accompanying the globalization of business activities, the technology trade between parent companies and their subsidiaries has also increased.

For the total value of technology exports, 75% derive from trade between parent companies and their subsidiaries in Japan and 74% in the U.S.

Excluding trade between parent companies and their subsidiaries, the export to import ratio of the technology trade for Japan is 0.8, while the ratio for the U.S. is significantly higher at 3.4.

Figure 7-3: Trends in technology trade in the U.S. and Japan
(technology trade between parent companies and their subsidiaries and between unaffiliated companies)



Note: <Japan> A parent and subsidiary relationship is acknowledged when a business enterprise is more than 50% owned by another.
<U.S.> A parent and subsidiary relationship is acknowledged when a business enterprise located in one country is directly or indirectly owned or controlled by an entity of another country to the extent of 10% or more of its voting stock.

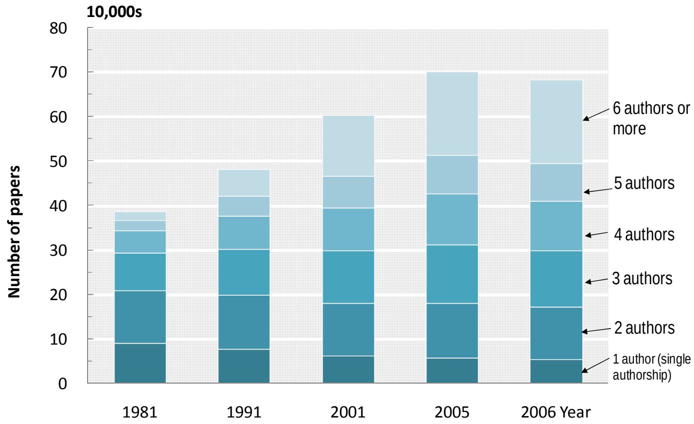
Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”
<U.S.> NSF, “Science & Engineering Indicators 2006”

8. Transformation of Knowledge Production

For the production of scientific papers, there has been an increasingly strong tendency for these to be produced by groups of researchers rather than by individual researchers.

In spite of a 1.8-fold increase in the total number of SCI papers between 1981 and 2006, the number of papers written by a single author (single authorship) has declined, accounting for no more than 7.9% of the total number of SCI papers in 2006. By contrast, the number of papers written by four or more authors has surged. In particular, articles written by six or more authors has increased 9-fold during the same period.

Figure 8-1: Trends in the authorship pattern of SCI papers

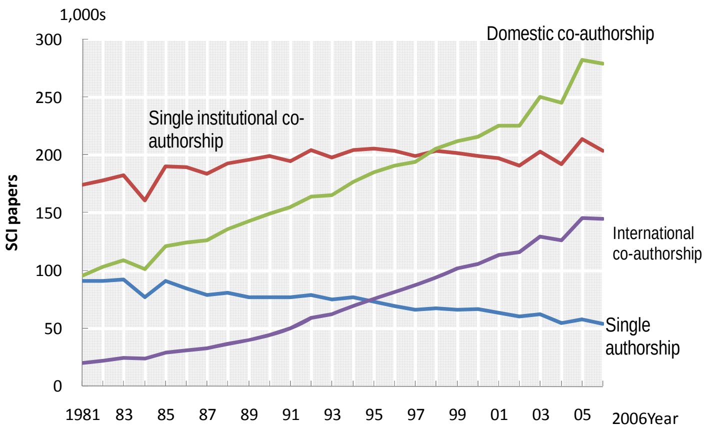


Note: Natural science only.

Source: Compiled by NISTEP based on Thomson ISI, "Science Citation Index, Compact Disk Edition"

Examining trends in the authorship of papers shows that in the years between 1980 and 2006, domestic co-authorship and international co-authorship increased 2.9-fold and 7.1-fold respectively. This suggests that networks for scientific paper authorship are developing.

Figure 8-2: Change in authorship of papers (Trends in the number of SCI papers by authorship)

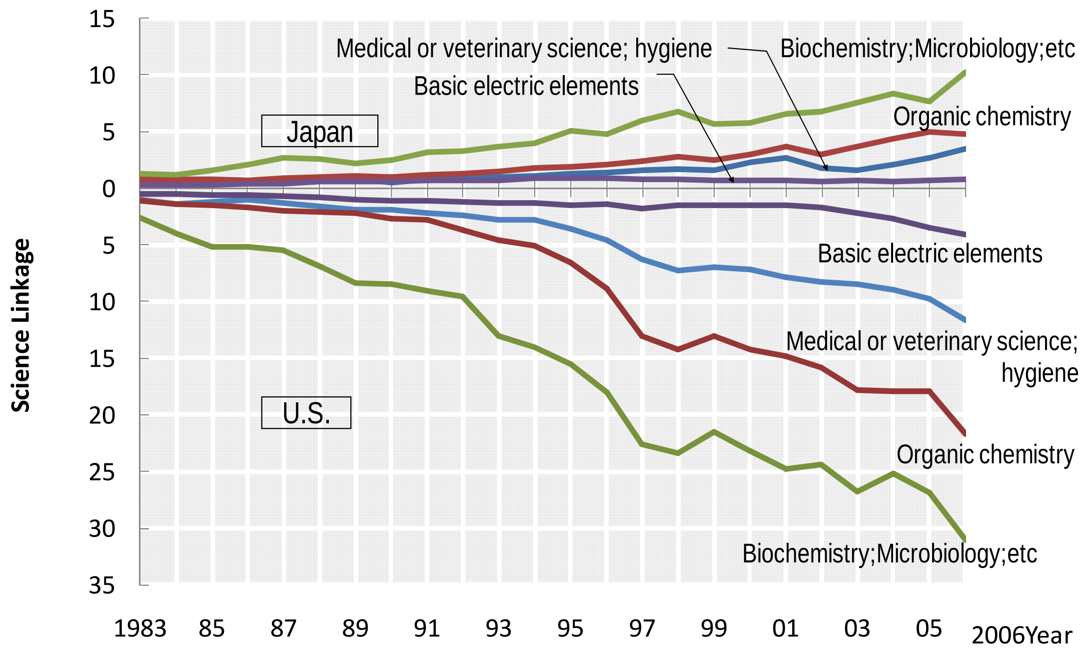


Note: Natural science only.

Source: Compiled by NISTEP based on Thompson Corporation's "Science Citation Index, Compact Disk Edition"

Science linkage is the number of scientific papers cited per U.S. patent in the U.S. patent examination report. It shows the strength of the relationship between patents and science. In 2006, the value of science linkage in the U.S. was significantly higher than that for Japan. The value of the U.S. (2006) particularly in biology and microbiology, which involves many genetic engineering patents, is an extremely large value of more than 30. To observe the science linkage trends in Japan and the U.S., in the US it is evident that there has been a significant increase in science linkage values over recent decades.

Figure 8-3: Science linkage in major fields in Japan and the U.S.



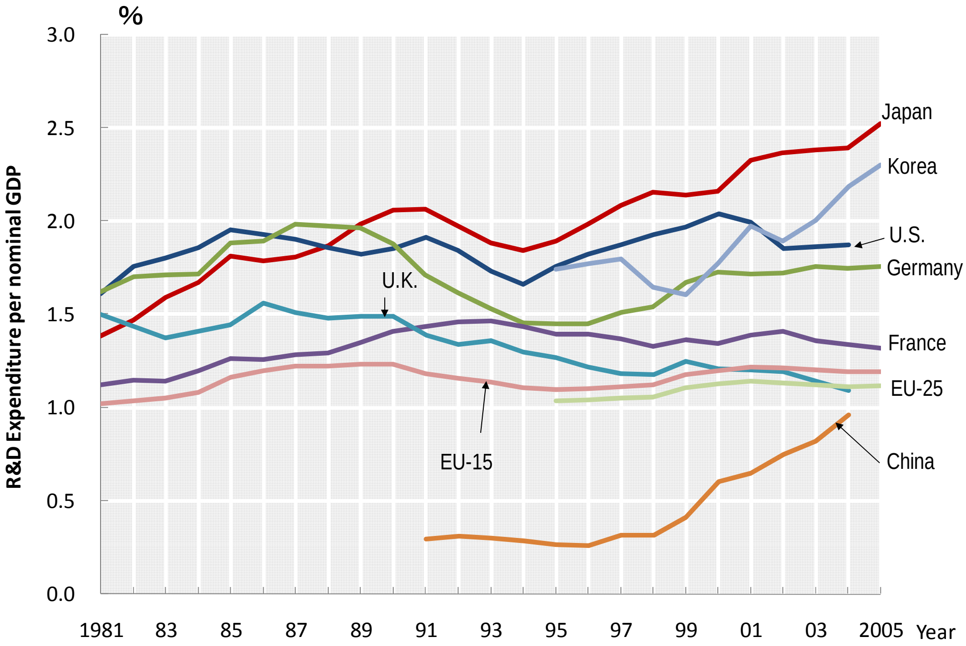
Note: (Science linkage) = (Times citing of scientific papers) / (Number of U.S. Patents)

Source: Recompiled by NISTEP based on CHI Research, Inc., "TP2-Int'l Technology Indicators Database for Data Years 1980-2003."

9. R&D in the Business Sector

Observing R&D expenditure per nominal GDP as an indicator for measuring the level of R&D investment in the business sector, it is apparent that Japan has had the largest such expenditure since fiscal year 1990.

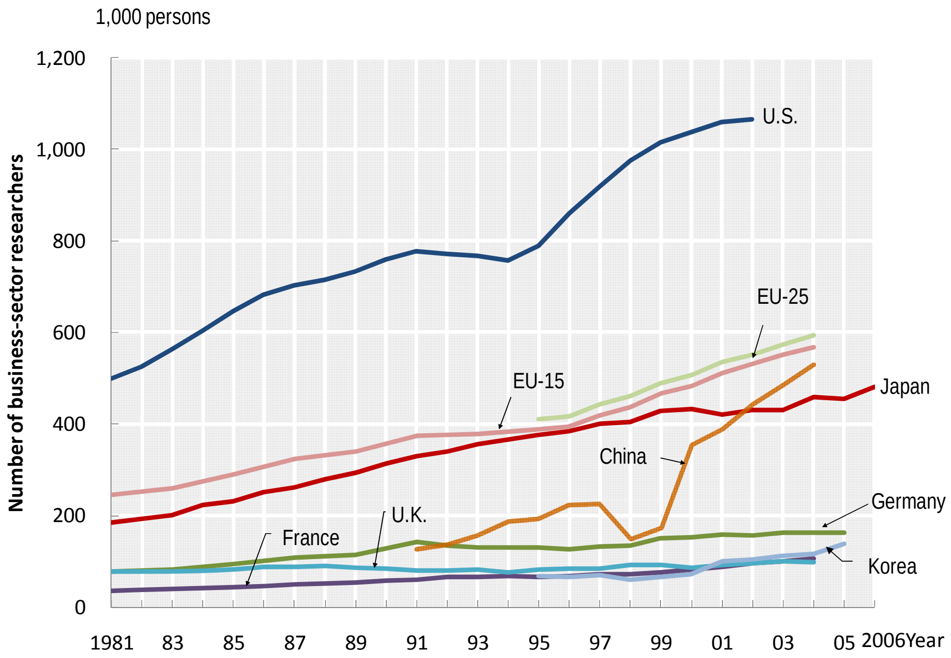
Figure 9-1: R&D expenditure in the business sector for selected countries
Trends in R&D expenditure per nominal GDP (All industries)



Note: Please refer to the Notes at the end of this digest report.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
OECD, "Main Science and Technology Indicators 2006/2"

Across all industries the number of researchers has changed, and in Japan the overall number of researchers has increased. In the U.S., the number of researchers increased by 309,000 persons between 1994 and 2002. The number in China has also increased considerably over recent years.

Figure 9-2: Trends in the number of researchers in the business sector for selected countries (All industries)

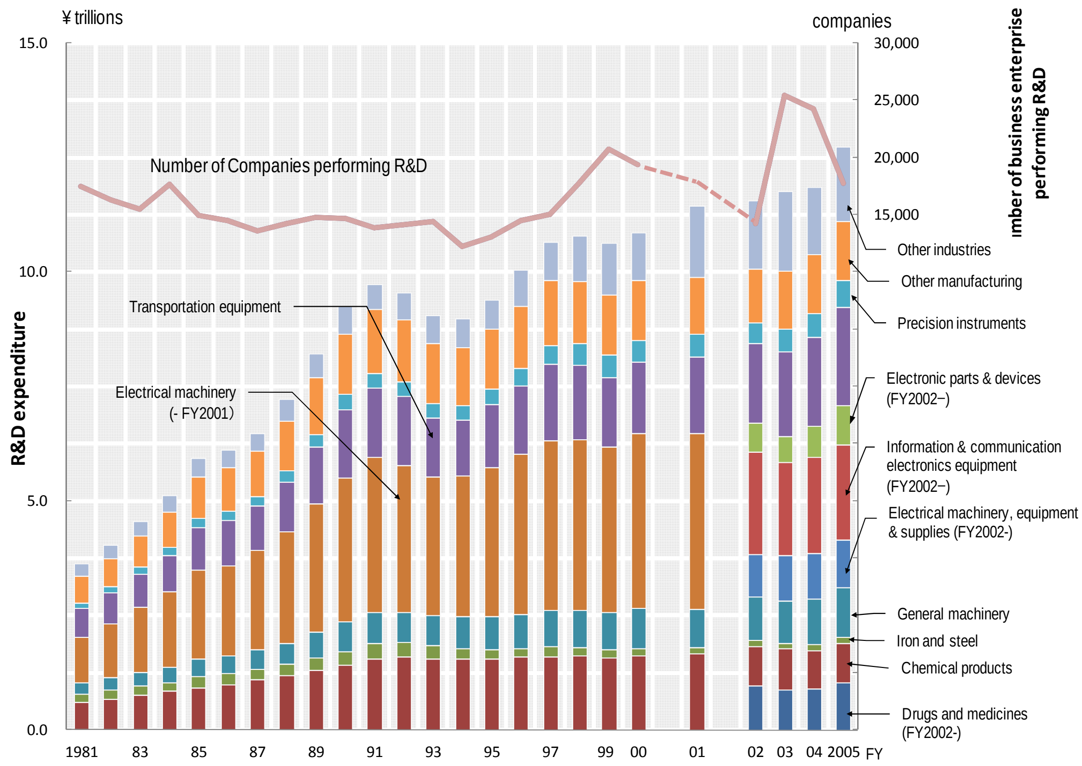


Note: Please refer to the Notes at the end of this digest report.

Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
OECD, "Main Science and Technology Indicators 2006/2"

Observing R&D expenditure by industry in Japan the transportation equipment (16.9% of all industries), information & communication electronics equipment (16.4%), and general machinery (8.5%) industries account for larger shares of R&D expenditure.

Figure 9-3: Trends in R&D expenditure by industry and the number of business enterprises performing R&D in all industries in Japan

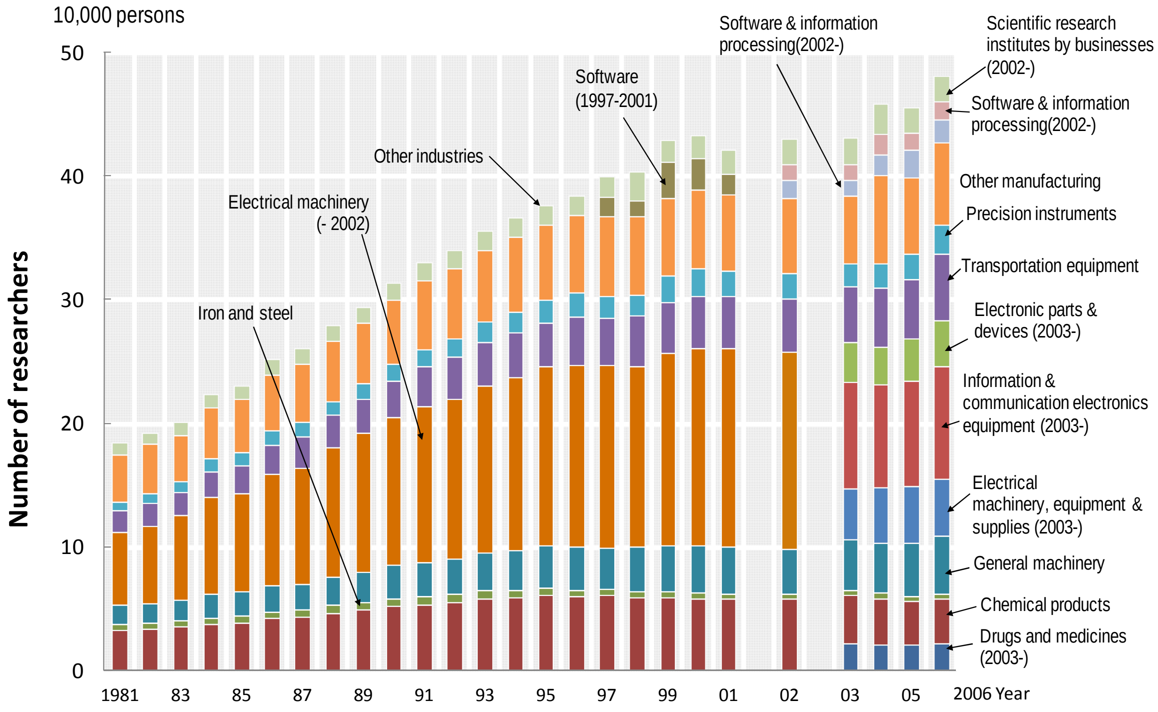


Note: Please refer to the Notes at the end of this Digest Report.

Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

In Japan, the sectors with the largest number of researchers are the information & communication electronics equipment industry (91,000 researchers, 19.0% of the total across all industries), followed by the transportation equipment industry (50,000 researchers, 10.4%), and general machinery industry (47,000 researchers, 9.7%).

Figure 9-4: Trends in the number of researchers in Japan's business sector (All industries)



Note: Please refer to the Notes at the end of this Digest Report.

Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

Notes and Sources:

【Figure 1-1】

Note: The notes on R&D expenditure are the same as those on Table 6-1-1 in the original report and the notes on GDP the same as those on Reference Statistics C.

Source: The source of R&D expenditure is the same as that of Table 6-1-1 in the original report and the source of GDP the same as Reference Statistics C.

【Figure 1-2】

Note: 1) R&D expenditures include expenditures in humanities and social sciences (except Korea).

2) The data for Germany refer only to the former federal states until 1990 and to all of Germany since 1991.

3) Purchasing power parity conversion is based on Reference Statistics E.

4) The real figures are calculated using the deflator (based on Reference Statistics D).

5) The real figures for 2005 for China were calculated using the deflator for 2004.

Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”

<U.S.> NSF, “National Patterns of R&D Resources 2004 Data Update”

<Germany> Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 2004”, “Research and Innovation in Germany 2005, 2006”

<France, EU >OECD, “Main Science and Technology Indicators 2006/2”

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<China> Ministry of Science and Technology of the People’s Republic of China, S&T Statistics Data Book 2005 (website); For figures for 2005, OECD, “Main Science and Technology Indicators 2006/2”

<Korea> Korea National Statistical Office, Statistical DB (website）

【Figure 1-4】

Note: Purchasing power parity conversion is based on Reference Statistics E. Table 1-2-3(C) was used for other countries.

<Japan> Covers patents, expertise, and technical guidance. Data lack continuity in 1996 and 2001 as several industry sectors were added for the survey.

<U.S.>Covers only royalty and license.

<Germany>West Germany until 1990.Until 1985, it covered patents, licenses, trademarks, and design. After 1986, technical services, computer services, and R&D in the industrial sector were included in addition to these.

<France, Belgium> Definition unclear.

<U.K.> Included oil business since 1984. After 1996, included patent, invention, license, trademark, design, technology-related services and R&D.

<Italy> Included R&D, technical researches, human resources development, dispatch of and technical guidance by engineers and specialists. Until 1991, R&D activities outside the country were not included.

<Switzerland> Includes current transactions, revenues, technical services, i.e., includes not only the amount of trade based on the buying and selling of patents and licenses, but also royalties and taxes required for their use.

Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”

<U.S., Germany, France, U.K., Belgium, Italy, Switzerland> OECD, “Main Science and Technology Indicators 2006/2”

【Figure 3-1】

Note: 1) With the revision of classification of occupational categories in the 1980 National Census, the Labor Survey was revised in January 1981 as follows.

(i) 'Workers in mining' have been renamed 'excavation workers.'

(ii) 'Simple manual laborers' have been renamed 'manual laborers.'

(iii) 'Sanitation workers' who have been included in 'workers in security and service businesses' have been reclassified into 'manual laborers.'

2) The figure number has been changed from 3-1-7 in “Science and Technology Indicators (NR.No.73)” developed by NISTEP.

【Figure 5-2】～【Figure 5-4】

Note: <Services>

2003 and later data is based on the total of the major groups ('information and communications', 'eating and drinking places and accommodations', 'medical, health care and welfare', 'education and learning support', 'compound services' and 'services, not elsewhere classified') similar to those in ‘services industries’ prior to the major revision of the Japan Standard Industrial Classification. These six categories are classified as 'service-related industries' herein. Also, 'service-related industries' include 'communications business' and 'eating and drinking places' categories that were not included in 'services' in the past.

<Manufacturing & finance and insurance>

These industries that did not undergo modification after revision of the classification system are shown in the pre-modification categories of 'manufacturing' and 'finance and insurance' for 2003. However, the sub-categories of 'newspaper business' and 'publishing' which were included in manufacturing in the past have now moved into the category of 'information and communications' following the modification.

Source： Ministry of Education, Culture, Sports, Science and Technology (MEXT), “Report on School Basic Survey”

【Figure 6-1】

Note: Amount of R&D expenditure is the total amount of R&D expenditure for natural science and human/social science (excluding Korea).

<Japan> 1) Source industry includes national government, local public entities, government-affiliated firms, independent administrative agencies, government financial corporation and public corporations.

2) Source government includes national government, local public entities, national and public universities (including junior colleges), national and public research institutes, research institutes of government-affiliated firms and independent administrative agencies, and others.

3) Source universities are private universities.

4) Performing government includes research institutes of national, public, and government-affiliated firms, independent administrative agencies (not run on a stand-alone basis (national government and local public entity-affiliated)).

5) Performing universities are national, public, and private universities (including junior colleges).

<U.S.> 1) R&D expenditures are preliminary figures. Source is federal government (However, part of R&D expenditure used by universities is funded by the state government).

2) Universities are private universities and state universities.

3) Performing government is federal government research institutes.

4) Figures of Federal Fund R&D Center (FFRDC’s) under the supervision of universities are compiled for each R&D-implementing department.

5) Preliminary

<Germany> 1) Source governments are federal and state government. Performing government is federal, state, local government administrative agencies and nonprofit private research organizations.

2) Itemized figures may not always be consistent.

3) Government estimates or modified as necessary to comply with the OECD standard.

4) R&D expenditure is the total expenditure for natural science and human/social science.

<France> 1) Performing government includes public research organizations. Performing universities include technical colleges (grandes ecoles) and National Science and Research Center.

2) The data lack continuity with the data until the previous year.

<U.K.> 1) Performing government includes central and local government, Research Council and Higher Education Fund Distribution Committee.

2) Universities are private universities.

<China> 1) The higher education sector as a performer includes universities, colleges, and vocational technical colleges.

2) The government sector as a performer is government research and development institutes.

<Korea> Excludes R&D expenditure for human social science.

<EU> Provisional. Secretariat estimate or projection based on national sources.

Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”

<U.S.> NSF, “National Patterns of R&D Resources 2004 Data Update”

<Germany> Bundesministerium für Bildung und Forschung， “Research and Innovation in Germany 2005, 6”

<France、Korea> OECD，“Research & Development Statistics 2004/2”

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<China> Ministry of Science and Technology of the People’s Republic of China S&T Statistics Data Book 2005 (website)

<EU> OECD，“Main Science and Technology Indicators 2006/2”

【Figure 9-1】

Note: GDP data is the same as Reference Statistics C.

Purchasing power parity is the same as Reference Statistics E.

<Japan> 1) Fiscal year basis.

2) In FY 2001, there were changes in the classification and addition of the industry sector in the Industrial Classification for the Survey of Research and Development.

3) In FY 2002, there were changes in the Japan Standard Industry Classification and the Industrial Classification for the Survey of Research and Development.

<U.S.> Excludes capital expenditure.

<Germany> Data of West Germany until 1990.

<France> 1) There was a change in industrial structure during 1991-1992. (France Télécom and GIAT Industries were moved from the category of Government to Business Enterprise).

2) The estimation method was changed in 1997.

<U.K.> 1) There was a change in industrial structure during 1985-1986, and in 2000. ("United Kingdom Atomic Energy Authority" was moved from the category of Government to Business Enterprise).

2) The Defence Evaluation and Research Agency (DERA) was dissolved and three quarters of it became a private limited company and moved to the category of Business Enterprise.

3) Research institutes were reclassified during 1991-1992.

<European Union> National currency is U.S. dollar purchasing power parity equivalents.

<China> 1) Data are of large- and medium-sized enterprises until 1999. After 2000, data are of all the industries and enterprises above a certain size.

2) Excludes human/social science field.

<Korea> The data do not include social sciences and humanities.

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

<U.S., Germany, France, U.K., EU, China, and Korea> OECD, "Main Science and Technology Indicators 2006/2"

【Figure 9-2】

Note: <U.S., Germany, France, U.K., European Union, Korea, China> The number of researchers based on FTE.

<Japan> 1) Not actual data of whole industry.

2) In 2002, the Industrial Classification for the Survey of Research and Development was changed; change of definition of 'researcher,' the addition of industry sector, and change in classification surveyed.

3) In 2003, the Japan Standard Industry Classification and the Industrial Classification for the Survey of Research and Development were changed.

4) Until 2001, the number of regular researchers (FTE), and after 2002, number of researchers (Head-counts and FTE).

5) The timing of the survey was as of April 1st until 2001, and as of March 31st after 2002.

<U.S.> 1) Annual average until 2000, and figure as of January 1st after 2001.

2) The number of researchers is the number of scientists and engineers.

3) The estimation method of the number of researchers was changed in 1985.

<Germany> Data for West Germany until 1990.

<France>1) There was a change in the classification for the survey during 1991-1992 (France Télécom and GIAT Industries were moved from the category of Government to Business Enterprise).

2) The survey procedure for managerial class researchers was changed in 1997.

<U.K.> 1) There was a change in the classification for the survey during 1985-1986 and in 2000 ("United Kingdom Atomic Energy Authority" was moved from the category of Government to Business Enterprise during 1985-1986).

2) In 2000, the Defence Evaluation and Research Agency (DERA) was dissolved and three quarters of it became private limited company and moved to the category of Business Enterprise.

3) Classification of research institutes was reclassified during 1991-1992.

<China> 1) Excludes human/social science field.

2) Until 1999, used data of large- and medium-sized enterprises. After 2000, data of all the industry and enterprises above certain size were used.

<European Union> No definition of country.

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

<U.S., Germany, France, U.K., EU, China, and Korea> OECD, "Main Science and Technology Indicators 2006/2"

【Figure 9-3】

Note: R&D expenditure:

In FY2001, there were changes in the classification and addition of the industry sector in Industrial Classification for the Survey of Research and Development. In FY2002, there were changes in the Japan Standard Industry Classification and the Industrial Classification for the Survey of Research and Development.

The number of business enterprises performing R&D:

The survey covers the industries selected from the Japan Standard Industry Classification specifically for the "Report on the Survey of Research and Development." The Japan Standard Industry Classification was revised in January 1984, October 1993, and March 2002. The business enterprises covered have been extracted from the results of the "Establishment and Enterprise Census" conducted by the Ministry of Internal Affairs and Communications. The data until FY2000 are as of April 1 each year. Business enterprises and special corporations capitalized at ¥10 million or more are covered.

The Japan Standard Industry Classification was revised in January 1984, October 1993, and March 2002. After FY2001, the data are as of March 31 each year. Business enterprises, special or independent administrative corporations capitalized at ¥10 million or more are covered. In FY2001, the industry classification for the Survey of Research and Development was revised, adding some industries and changing the coverage categories. In FY2002, the industry classification for the Survey of Research and Development was revised.

Source：Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

【Figure 9-4】

Note: The total for natural science, social science and human/social science.

Until 2001: 1) The data show the number of full-time researchers.

2) Timing of the survey is as of April 1 each year.

After 2002: 1) The definition of 'researcher' has been changed.

2) In the year 2002, there were changes in the classification and addition of the industry sector in the industry classification for the Survey of Research and Development.

3) In 2003, there were changes in the Japan Standard Industry Classification and the industry classification for the Survey of Research and Development.

4) The data show the number of researchers.

5) Timing of the survey is as of March 31 each year.

Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

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