Research Material - 198

Japanese Science and Technology Indicators 2011

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Research Unit for Science and
Technology Analysis and Indicators

National Institute of Science and Technology Policy
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Ministry of Education, Culture, Sports,
Science and Technology, Japan

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ABSTRACT

"Science and Technology Indicators" is a basic resource for understanding Japanese science and technology activities based on objective, quantitative data. It classifies science and technology activities into five categories, R&D Expenditure, R&D Personnel, Higher Education, The Output of R&D; and Science, Technology, and Innovation. The multiple relevant indicators show the state of Japanese science and technology activities. The chapter on Science, Technology, and Innovation has been enhanced with the addition of indicators such as comparison of the results of surveys of business innovation in Japan and the USA and the number of trademark applications in major countries.

Science and Technology Indicators 2011 sees a number of changes in indicators compared with the previous year. In Japan, total research and development expenditure during FY 2009 was down 8.3 percent from the previous year. Patent applications, technology trade, and high-technology industry trade also declined. Patent applications and high-technology industry trade fell not just in Japan, but in most other major countries as well. These indicator trends are likely a result of the worldwide financial crisis that began with the "Lehman Brothers shock" in 2008.

Science and Technology Indicators 2011 Table of Contents

Reference Materials

List of charts

Summary

1. R&D expenditure

(1) International comparison of each country's R&D expenditure

- Japan's total R&D expenditure during FY2009 was 17.2 trillion yen, a decrease of 8.3% from FY2008, which in turn had declined from FY2007. The ratio against GDP was 3.6%, a drop of 0.2 percentage points compared with the previous year.
- The business enterprise sector used the highest share of R&D expenditure in each country. In Japan, the U.S. and Germany it used about 70%, while in France and the U.K., it used about 60%. In China, the business enterprise sector's share has been growing. In recent years, it has accounted for approximately 70% of the whole. In South Korea, it accounted for about 80%.
- The proportion of R&D expenditure by the university and college sector in France and the U.K. is increasing while that in Japan and Germany remains flat.

(2) Government budgets

- With regard to government budget appropriations or outlays for science and technology (GBAORD) in selected countries (real values, national currencies, 2000 basis), the growth rate was lower during the 2000s than during the 1990s only in Japan and France. In all the other countries, the growth rate was higher during the 2000s.
- Japan's initial government budget (the government budget appropriation for S&T) in FY 2011 was 3.7 trillion yen.

(3) R&D expenditure in the business enterprise sector

- Looking at the ratio of R&D expenditure against GDP in the business enterprise sector (most recent available year for each country), Japan had shown an upward trend since 1990. In 2009, however, the ratio was 2.5%, a decrease of 0.2 percentage points.
- With regard to direct fund distribution (direct aid) and R&D tax incentives (indirect aid) to the business enterprise sector by the government in each country, the former accounts for a large proportion in the U.S. France, the U.K., etc., and the latter accounts for a large proportion in the in Japan, Canada, etc., respectively.

(4) R&D expenditure in the university and college sector

- The R&D expenditure in the university and college sector was 3.5 trillion yen (FY 2009), which is the equivalent of 2.0 trillion yen (FY 2008) yen if the labor cost is multiplied by FTE factor.
- Looking at the share of universities and colleges R&D expenditure covered by governments, more than 80% is covered in Germany and France, while about 70% is covered in the U.S., the U.K. and,

in recent years, Korea. In Japan, the figure is about 50%.

- Turning to the percentage of university and college R&D expenditures in selected countries covered by business enterprises, it was 12-15% in Germany and South Korea, 5-6% in the U.S. and the U.K. and 2-3% in Japan and France.

(5) R&D expenditure by type of R&D

- As for Japan's FY2009 R&D expenditures by type, basic research accounted for 15.0% of the total. The university and college sector accounted for 51.3% of that.
- Looking at R&D expenditure by type during the most recent available year for each country, the country with the highest percentage for basic research was France, at 25.4% of the total. In contrast, the proportion of R&D expenditure for basic research was smallest in China, at 4.7%. Turning to a breakdown by sector of usage of basic research expenditures, the university and college sector accounted for the highest share in France, the U.S. and Japan, the public organization sector had the highest share in China, and the business enterprise sector was highest in South Korea.

2. R&D Personnel

(1) International comparison of the number of researchers in each country

- The definition and measurement of researchers in each country are conducted in line with the Frascati Manual. However, the actual methods used for the investigations are often different in each country. In particular, the university and college sector are excluded from the coverage of R&D statistical surveys in some countries. Also some countries set special conditions regarding the scope of the range of the surveys. Furthermore, some countries apply the full-time equivalent (FTE) method in surveying the number of researchers, while others apply actual head counting (HC) for this purpose. Therefore, it could be said that there are many contributing factors which reduce potential international comparability. In addition, in the U.S., the number of researchers belonging to some sectors is not reported to the OECD. This forces the OECD to utilize estimated figures as a substitute. For the reasons given above, it is necessary to be careful in making international comparisons and trend comparisons of the number of researchers.
- In 2010, the number of researchers in Japan was 660,000, when the number of researchers working at universities and colleges is calculated using the FTE method. The number is about 890,000 with the head count method. In recent years, the number of researchers in China has greatly increased. But the number of researchers per capita still lags behind compared to the other selected countries.
- Looking at researcher mobility by sector in Japan, there are more new-graduate hires than

mid-career recruits in "Companies, etc." There had been little change in the figures in recent years, but in 2010 new-graduate hires decreased. In "Universities and colleges, etc.," there are more mid-career recruits than new-graduate hires. The figures have been flat in recent years. In every sector, intra-sector mid-career recruits have been increasing.

(2) Researchers by sector

- The number of researchers in the business enterprise sector had been continually increasing in Japan and the U.S., but growth has flattened in recent years. There were 490,000 researchers in Japan in 2010. Since the beginning of the 2000s, the number of researchers has been increasing sharply in China. In Germany and France, meanwhile, there has been a long-term upward trend, while growth in the U.K. has been flat.
- Breaking down the number of researchers in Japan's university and college sector, teachers are most common at private universities, while doctoral course students in graduate schools are most common at national universities. Breaking down researchers at national universities by field, natural sciences is the most common field. This is also true of doctoral course students in graduate schools. At private universities and colleges, on the other hand, although natural sciences is the most common field, the humanities and social sciences field is also large, with little difference between the two.

(3) Research assistants

- With regard to the number of research assistants per researcher by sector, in the business enterprise sector it varies by country. The figures for the most recent available years were 0.3 assistants per researcher in Japan and China, 0.8 in Germany and the U.K., 0.7 in France and 0.1 in South Korea. Over time, there has been a long-term downward trend, although the trend has been flat in the U.K. Figures in the university and college sector in the most recent available years were 0.2 in Japan, 0.4 in Germany, 0.5 in France, 0.1 in the U.K. and 0.7 in South Korea. Over time, growth has been flat in Japan, France and China, Germany has been on a downward trend, and South Korea has been rising in recent years.
- In Japanese universities and colleges, the number of research assistants per researcher has been flat, although the number of assistants has grown in absolute terms. Since entering the 2000s, "clerical and other supporting human resources" have shown an increase. In recent years, "Assistant research workers" have also shown an increase.

3. Higher Education

(1) The status of students in Higher Education institutions

- The number of newly enrolled undergraduates in Japan had been roughly unchanged since about 2000, but in FY2010 it increased by 1.7% over the previous year, to about 619,000. The number newly enrolled in private universities and colleges was high, and constituted about 80% of the total. Classified by field, students majoring in "Natural science and engineering" comprised about 30% of the total.
- The number of students newly enrolled in master’s programs had been roughly unchanged since about 2005, but in FY2010 it increased by 5.4% over the previous year, to 82,000. Those newly enrolled in national universities and colleges constituted about 60% of the total. Classified by field, students majoring in "Natural science and engineering" accounted for about 60% of the total.
- The number of people newly enrolled in doctoral programs had been decreasing since peaking in 2003, but it increased by 3.6% over the previous year in FY2010, to 16,000. The number newly enrolled in national universities and colleges was high and constituted about 70% of the total. Classified by field, students majoring in Natural science and engineering accounted for about 70% of the total.

(2) Career options for students in Natural sciences and Engineering

- Looking at the career paths of students in "Natural sciences and engineering" after graduation, until recently, about 60% of students receiving bachelor's degrees obtained employment, while 40% proceeded with further education. In 2010, however, only 45.8% of those receiving bachelor's degrees obtained employment. This is different from the situation that had prevailed in recent years.
- As for the career paths of those obtaining master's degrees in "Natural sciences and engineering," about 80% have been obtaining employment. This percentage has been increasing since entering the 2000s, but in 2010, 83.3% obtained employment, a decline of 3.8 percentage points compared with the previous year.
- Looking by industrial classification at graduates in "Natural sciences and engineering" who obtain employment, since 2000, "manufacturing industry," "Service type industries" and "Others" had each accounted for about one-third of those receiving bachelor's degrees. In 2010, however, the percentage obtaining employment in "Manufacturing industry" fell to 27.4%.
- In the case of those receiving master's degrees in "Natural sciences and engineering," since the mid-1990s, the percentage of students obtaining employment in "Manufacturing industry" had

been over 60%, with around 20% entering employment in "Service type industries." In 2010, however, the percentage obtaining employment in "Manufacturing industry" declined to 55.5%.

(3) The number of degree-awarded

- Looking at the number of persons who have degrees per one million of the population, bachelor's degree awarded in Japan are about 4,246. This is less than Korea, the U.S. and the U.K., however, it greatly surpasses Germany and France. Meanwhile, the number of doctoral degree awarded is about 135, which is half as many as that in the U.K. and Germany and falls below that of the U.S., Korea and France.

4. The output of R&D

(1) Scientific Papers

- Research activities themselves have changed from the activities of a single country into joint activities that are conducted by multiple countries. Now internationally co-authored papers have increased, and a difference has emerged between the "degree of participation (whole counting) in the production of papers in the world" and the "degree of contribution (fractional counting) to the production of papers in the world".
- Regarding the numbers of papers produced in Japan (the average from 2008–2010), in terms of the "degree of participation in the production of papers in the world" Japan is ranked fifth in the world, after the U.S., China, the U.K. and Germany. Meanwhile, in terms of "degree of contribution to the production of papers in the world," Japan ranks third, behind the U.S. and China and slightly ahead of the U.K. in fourth place and Germany in fifth.
- China has increased both in terms of the "degree of participation in the production of papers in the world" and the "degree of contribution to the production of papers in the world" since the late 1990s, becoming second in the world during the latter half of the 2000s.
- Looking at the balance of the fields in Japan, the share of Chemistry has decreased and that of Clinical medicine has increased.
- Looking at the field portfolios by world share, Japan is weighted towards Physics, Chemistry, and Material science, with low weight on Computer science/Mathematics and Environment/Geoscience.
- The percentage of international co-authorship for 2010 was 51% for Germany, 52% for the U.K. and 53% for France, while the U.S. was 33% and Japan was 27%.

(2) Patents

- The number of world patent applications showed steady growth until 2008. However, patent applications in the selected countries decreased markedly in 2009 as a result of the recession that began with the "Lehman Brothers shock."
- The number of annual applications to Japan (about 350,000) is second only to those to the U.S., but it has been on a downward trend in recent years. In 2009 in particular, the number of applications fell by 10% compared with 2008. The number of applications to the U.S. (about 450,000), has roughly doubled over the past 10 years, but in recent years this trend has leveled off. The number of applications to China has been increasing rapidly. Over the past 10 years (1999–2009), the number of applications has risen at an annual rate of 20%. In 2009, the number of applications was 310,000, third behind the U.S. and Japan.
  - As for patent applications to a country of non-residence by patent applicants from the selected countries, the impact of the recession has been apparent. In 2009, they decreased in every one of the countries but China. Compared with 2008, the rate of decrease in the number of applications to countries of non-residence was 33% in the U.S. and 26% in Japan. The number of applications to other countries from China, where domestic applications have also been increasing, increased by 26% on a year-on year basis. At only about 10,000, however, the number remains small.
  - Looking at the numbers of patent applications to JPO, USPTO and The European Patent Office (hereinafter EPO), Japan has shown a big presence since 10 years ago. Looking at the applications by technical field, Japan has a big share in Nanotechnology and Information and communication technology.
  - The relation between patents and scientific papers has been getting stronger. The Science Linkage, which indicates the degree to which patent literature cites scientific literature, has been increasing. From 1997–1999 to 2007–2009, the Science Linkage in all manufacturing industries increased from 2.0 to 3.4. Medical and chemical manufacturing has the highest Science Linkage value. In recent years, Science Linkage has been increasing in Petroleum/Coal product manufacturing and Primary metals manufacturing.

5. Science, technology and innovation

(1) Technology trade

- Japan’s technology trade balance was 3.8 in 2009, with an export surplus continuing since 1993. However, the amount of trade decreased during the most recent two years. Technology trade exclusive of trade with overseas affiliates, i.e., that between parent companies and subsidiaries, can be considered a better indicator of technology strength. Using that criterion, Japan’s technology trade balance in 2009 was 1.3. Japan has had a surplus since 2006.
- Looking at partners for technology exports from Japan, the U.S. accounts for 35.6% of the total. Compared with 2004, however, both the share and the amount have decreased. China has the next highest share at 13.8%. China's share and amount have both been increasing. Regarding technology imports, on the other hand, the U.S. accounts for 71.9% of all imports, followed by Germany, France and the U.K. with 5% or less.

(2) The High Technology Industry Trade

- World high-technology trade consistently increased from 2001 to 2008, roughly doubling overall. The "Radio, Television and Communication Equipment" accounts for the largest share at about 40%.
- Looking by country, the trade scale of the U.S. was large and is tending to expand. However, China has in-creased its trade amount rapidly during recent years and to the value of its exports has surpassed that of the U.S. The trade amount of Germany has also rapidly expanded. Japan has followed it, and is in fourth place. However, high-technology trade declined in each country in the most recent year, 2009.

(3) Trademark applications and trilateral patent families

- The number of applications for trademarks is related to new products and services, as well as marketing activities. In that sense, it is conceivable that it is data that reflects the state of innovation to some degree.
- Looking at the per-capita numbers of transnational trademark applications and trilateral patent families (patents with the same content submitted in Japan, the U.S. and Europe), in 2006–2008, Japan, Germany and South Korea had relatively high numbers of trilateral patent families. The U.S. and the U.K., on the other hand, had more trademark applications than trilateral patent families.
- Comparing 2000–2002 with 2006–2008, the number of trademark applications increased sharply in Germany and the U.K., while the number of trilateral patent families increased slightly in those countries. In Japan, on the other hand, the number of trademark applications and the number of

trilateral patent families both decreased slightly. In the U.S., the number of trademark applications has been decreasing.

(4) Japan-U.S. comparison of the innovation activities of business enterprises

- Looking at the achievement of innovation in business enterprises that carry out R&D activities, in both Japan and the U.S., enterprises with higher R&D expenditures achieve innovation at a higher rate.
- In the case of Japanese business enterprises that carry out R&D activities, "product innovation related to services" has a lower rate of innovation than "product innovation related to goods" and "process innovation," regardless of the size of R&D expenditures.
- In the case of the U.S. business enterprises that carry out R&D activities, "product innovation related to services" has a lower rate of innovation than "product innovation related to goods" and "process innovation," regardless of the size of R&D expenditures. However, the difference is not as large as it is for Japan.

Notes concerning Science and Technology Indicators 2011

1 Clarification of points of attention regarding international comparisons and time-series comparisons

The reminder marks, "Attention to international comparison" and "Attention to trend" have been attached where they are required. Generally, the data for each country conforms to OECD guidelines. In some cases, however, attention to comparisons is necessary due to differences in methods of collecting data or the range of objects. Such cases are marked "Attention to international comparison." For some time series data, data could not be continuous collected under the same conditions due to changes in statistical standards. Cases where special attention is required in reading trends of increases and decreases are marked "Attention to trend" Details of such points for attention are described in the notes of individual charts.

2 Adjustment of statistical assumptions in each country's metadata

Every effort has been made to clarify each country's method of collecting statistics and how it differs from other country's methods.

3 Integration of databases used

Data regarding scientific papers are integrated with data from *Web of Science*, and the increase in internationally co-authored papers is analyzed. Regarding patents, patent applications to Japan/U.S./Europe are analyzed in order to heighten international comparability.

4 Color-coding of charts

Charts are color-coded such that, to the extent possible, a given color will correspond to the same country in every chart.

Main parts

Chapter 1 : R&D expenditure

In this chapter, the status of R&D expenditure in Japan and other selected countries, which is a basic index for R&D activities, is reviewed. R&D expenditure is the expenditure used for conducting R&D operations in an organization. It is widely used as quantitative measurement data regarding R&D inputs. This chapter also examines data on R&D expenditures from various angles, including each country's total R&D expenditures, their breakdown by sector and type, cost-sharing structures, and so on. The contents of this chapter also include mention of a part of the government budget appropriations or outlays for R&D (hereinafter referred to as GBAORD).

1.1 International comparison of each country's R&D expenditure

Key points

- ○Japan's total R&D expenditure was approximately 17.2 trillion yen in FY 2009. This is a decrease of 8.3% from the previous year, which decreased from FY 2007. The ratio to GDP was 3.6%, a drop of 0.2 percentage points from the previous year.
- ○The business enterprise sector accounted for the highest usage ratio of R&D expenditure in each country. In Japan, the U.S. and Germany, it was approximately 70%. In France and the U.K., it was approximately 60%. It has been increasing in China, reaching about 70% in recent years. In South Korea, it accounts for around 80%.
- ○The proportion of R&D expenditure by the university and college sector in France and the U.K. is increasing while that in Japan and Germany remains flat.

1.1.1 Trend of R&D expenditure in each country

First of all, the total R&D expenditure in selected countries is examined in order to provide an overview of their sizes and trends. A precise comparison of R&D expenditures among different countries is difficult because surveying methods for R&D expenditures differ by country; however, the comparison of the data in each country over time is considered to represent the trend of the country.

For a comparison of R&D expenditures in each country, currency conversion is necessary. But, because of the conversion, the comparison inevitably falls under the influence of each country's economic conditions. Therefore, converted values are used for the international comparison of each country's R&D expenditure, and the value of each national currency is used for examining the change of R&D expenditure over time in the corresponding country.

Japan's R&D expenditures are shown with two types of values. One of such values was obtained from the Survey of Research and Development conducted and published by the Ministry of Public Management, Home Affairs, Posts and Telecommunications. And the other values were obtained from materials published by the OECD[1]. The difference between both the values is how to obtain labor costs in the university and college sector. Strict separation of expenditures for research and for education in the university and college sector is difficult. Thus, in the Survey of Research and Development, expenditures in the university and college sector include faculty personnel expenses for non-research work (education). As for the OECD, personnel costs within total R&D expenditure in Japan's university and college sector are provided on an FTE basis (for more details,

[1] The Organization for Economic Co-operation and Development (OECD) is the organization in which countries supporting democracy and market economy engage in activities for the purpose of 1) economic development, 2) aid to developing countries and 3) expansion of multilateral free trading. OECD is currently composed of 34 member countries, and gathers statistics, economic and social data which can be internationally compared, and also conducts prediction and analysis.

refer to Section 1.3.3, the R&D expenditure in the university and college sector). In this chapter, the status of R&D investment in each country is studied using the data estimated by the OECD (referred to as "Japan (estimated by the OECD)") and others.

The total amounts of R&D expenditure in each country are shown in Chart 1-1-1. (A) is nominal values (in yen, of R&D expenditure representing each year's nominal price,) and (B) is real values (in yen, of R&D expenditure on the basis of the standard price values in 2000). (C) and (D) are the nominal values and real values (on 2000 base) represented by the national currencies of each country respectively.

Japan's total R&D expenditure was approximately 17.2463 trillion yen in FY 2009[(2)]. This is a decrease of 8.26% from the previous year and a continuation of the decline from its 2007 peak. It is due mainly to a decline in the business enterprise sector.

Looking at the most recent year for each country, the U.S. has an overwhelming lead. It is followed by China and Japan at roughly the same level, then by Germany. Then come France, the U.K. and South Korea, all roughly at an equivalent level.

All the selected countries apparently experienced a trend of slowdown or a decline in the first half of the 1990s. But in the latter half of the 1990s, the trend in the U.S. and Japan took an upturn followed by Germany, the U.K. and France little later. Recently, the figures leveled off in Germany, France and the U.K. China showed a significant rise both in nominal and real values.

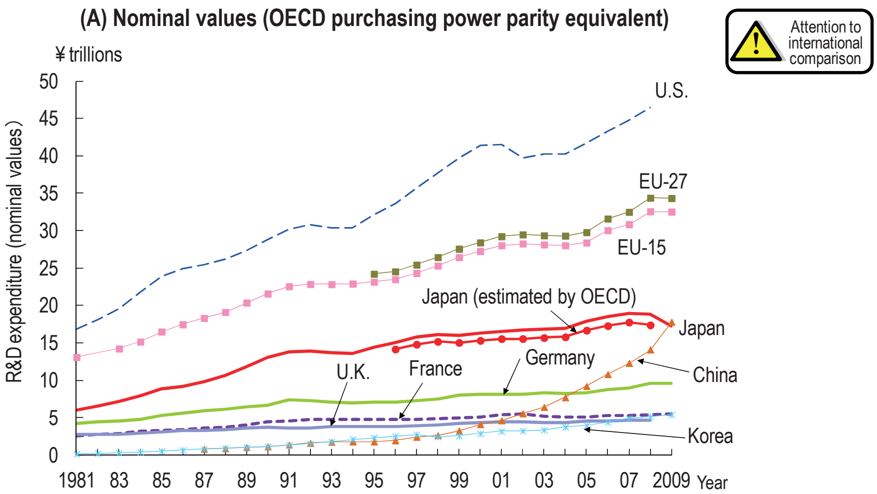
Chart 1-1-1 (C) shows a comparison of the investment status of each country in terms of the annual average growth rate of R&D expenditure in the 1990s (1991 to 2000) and the 2000s (2000 to the latest available year) on the basis of each national currency.

According to the comparison of the annual average growth rate of R&D expenditure (nominal values) between the 1990s and the 2000s, the growth rate increased more in the 2000s than in the 1990s in France, the U.K. and China. Of these countries, the growth rate increased the most rapidly in China. In Japan, the annual average growth rate during the 2000s was 0.64%, a decline from the 1990s.

Chart 1-1-1 (D) shows annual average growth rates in (real) R&D expenditures on a 2000 base in order to eliminate the influence of price fluctuations. Growth was higher during the 2000s than in the 1990s in Germany, France, the U.K., China and South Korea. The rate was particularly high in China and South Korea. Japan also showed growth at 1.78%.

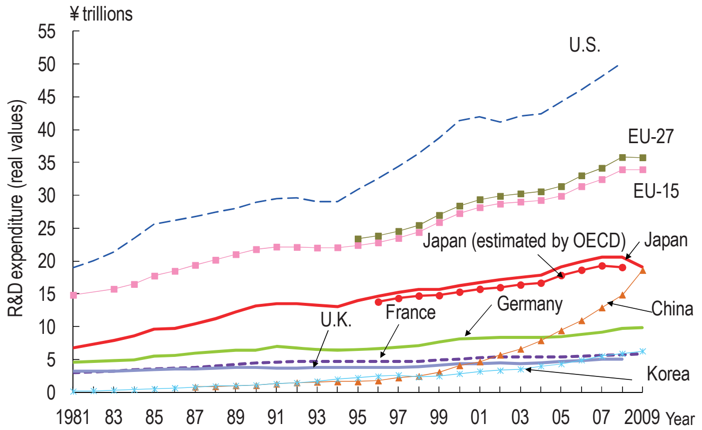
(2) Since the period covered to collect yearly total domestic R&D expenditure data differs depending on the country, this report in principle uses the calendar year for international comparison. In the case of Japan, however, fiscal years are used. The term "fiscal year" is used regarding GBAORD.

Chart 1-1-1: Trend in total R&D expenditure in selected countries



(B) Real values (2000 base: OECD purchasing power parity equivalent)

Attention to international comparison



(C) Nominal values (national currency)

National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	13.8	16.3	17.2 (2009)	1.88%	0.64%
Japan (estimated by OECD) (¥ trillions)	14.2 (1996)	15.3	17.4 (2008)	0.87% ('96→'00)	1.60%
U.S. ($ billions)	161	267	398 (2008)	5.80%	5.09%
Germany (€ billions)	37.8	50.6	67.7 (2009)	3.28%	3.28%
France (€ billions)	24.9	31.0	42.1 (2009)	2.46%	3.47%
U.K. (£ billions)	12.0	17.7	25.6 (2008)	4.41%	4.72%
China (¥ billions)	15.9	89.6	580 (2009)	21.1%	23.1%
Korea (₩ trillions)	4.16	13.8	37.9 (2009)	14.3%	11.8%

(D) Real values (2000 base; national currency)

National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	13.6	16.3	19.1 (2009)	2.06%	1.78%
Japan (estimated by OECD) (¥ trillions)	13.8 (1996)	15.3	19.1 (2008)	1.16% ('96→'00)	2.78%
U.S. ($ billions)	191	267	325 (2008)	3.82%	2.45%
Germany (€ billions)	43.4	50.6	61.2 (2009)	1.72%	2.14%
France (€ billions)	27.8	31.0	35.3 (2009)	1.19%	1.46%
U.K. (£ billions)	15.1	17.7	20.7 (2008)	1.83%	1.93%
China (¥ billions)	28.2	89.6	827 (2009)	13.7%	28.0%
Korea (₩ trillions)	6.32	13.8	47.4 (2009)	9.11%	14.6%

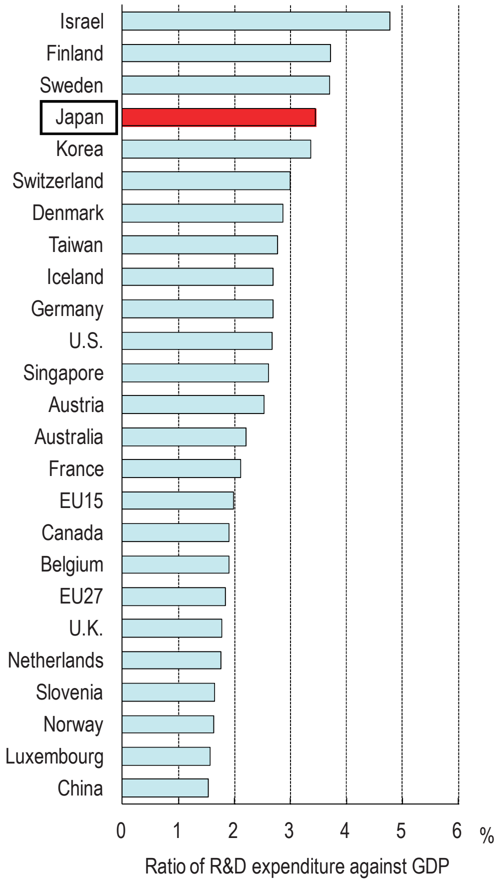
Note: 1) The total R&D expenditure is the sum of each sector's expenditure, and the definition of each sector occasionally differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected country.
2) Includes the expenditure in the field of social sciences and humanities (in the case of Korea, until 2006, natural sciences only).
3) The former West Germany until 1990, and the unified Germany since 1991, respectively.
4) Reference statistics E were used for the conversion to obtain purchasing power parity equivalent.
5) Real values were obtained by calculations with a GDP deflator (reference statistics D were used).
6) Value for Japan (estimated by the OECD) represents the total R&D expenditure in which the labor cost comprising a part of R&D expenditure in the university and college sector was converted to FTE. The value was corrected and estimated by the OECD.

Sources: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "National Patterns of R&D Resources 2008 Data Update"
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2010/2" for information since 2008
<Japan (estimated by the OECD), France and EU> OECD, "Main Science and Technology Indicators 2010/2"
<U.K> National Statistics website: www.statistics.gov.uk
<China> Ministry of Science and Technology of the People's Republic of China, S&T Statistics Data Book 2009 (website)
<Korea> Korea National Statistical Office, Statistical DB (website) KISTEP, Statistical DB (website)

Next, the "Ratio of total R&D expenditure against GDP (gross domestic product)" is shown below for comparison of R&D expenditures in light of the influence of the size of economy (Chart 1-1-2).

The ratio of total R&D expenditures to GDP in Japan was fourth among the listed countries and regions and stands at a high level.

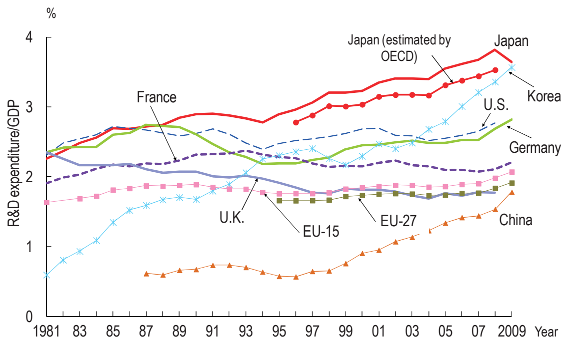
Chart 1-1-2: Ratio of the total R&D expenditure against GDP in each country (2008)



Note: 1) Defense expenditure in Israel was excluded.
2) The values for Israel, the U.S., Iceland, Austria, and Belgium were figures from 2007.
3) Capital expenditure in the U.S. was almost all excluded.
4) Secretariat estimate or projection based on national sources was used with regard to EU15 and 27.
5) Value for Sweden was estimate.
Source: OECD, "Main Science and Technology Indicators 2010/2"

Chart 1-1-3: Trend in the ratio of the total R&D expenditure against GDP for each country

Attention to international comparison



Note: Refer to the note on international comparisons and the details of the R&D expenditures in Chart 1-1-1. GDP is the same as that for reference statistics C.
Source: The details of the R&D values are the same as those given in the notes to Chart 1-1-1. GDP is the same as for reference statistics C.

Also, trends in investment levels for total R&D expenditure in selected countries are shown in another chart by examining changes in the ratio of R&D expenditure to GDP (Chart 1-1-3).

In Japan, the ratio to GDP exceeded 3% in 1997 and continued increasing until FY 2008. In 2009, however, it fell by 0.2 percentage points from the previous year, to 3.64%. According to OECD estimates, the ratio in Japan passed 3% in 1998.

The value in Korea surpassed 3% in 2006. Its 2009 figure of 3.57% was close to Japan's.

The U.S. and Germany experienced slowing trends during the 1990s but grew during the 2000s. In contrast, both France and the U.K. showed little change.

In China, which has experienced rapid industrial development in recent years, the ratio has been increasing since the upturn in 1996. There is still a gap between China and the other selected countries, but it is narrowing.

1.1.2 Trend of R&D expenditure by sector in each country

In this section, R&D expenditure is classified to four performing sectors, and the change and proportion of R&D expenditure over time for each sector are examined. The classification into four sectors is in accordance with “Frascati Manual[(3)]” by the OECD, and for the naming of sectors, the naming used in the “Report on the Survey of Research and Development” by the Ministry of Internal Affairs and Communications is adopted.

What is problematic in the classification by sector and the international comparison is the discrepancy among the national R&D systems, the methods of survey, or the scope of target organizations of each country. Accordingly, the comparison should be made in accordance with a correct understanding of the differences among each country. Chart 1-1-4 shows a rough summary of each country’s specific breakdown of the sectors. Expressions used in the chart are the same as those which are used in each country’s R&D statistics.

Chart 1-1-4: The definition of the performing sector in R&D expenditure in selected countries

Country	Business enterprises	Universities and colleges	Public organizations	Non-profit institutions
Japan	・Companies ・Special corporations or independent administrative corporations (for-profit)	・University faculties (including advanced research cources at graduate schools) ・Junior colleges ・University research institutes ・Others	・National research institutes ・Special corporations or independent administrative corporations (non-profit) ・Public research institutes	・Non-profit institutions
U.S.	・Companies and others	・University & Colleges (organizations which each conduct R&D equivalent to $150,000 or more)	・Federal government ・FFRDCs *** Local governments are not included**	・Other non-profit institutions
Germany	・Enterprises ・Public research institutes (IfG)	・Universities ・Comprehensive universities ・Colleges of education ・Colleges of theology ・Colleges of art ・Universities of applied sciences ・Colleges of public administration	・Federal government ・Non-profit institutions (institutions which each obtain public funds of €160,000 or more) ・Legally independent university research institutes ・Local government research institutes	
France	・Enterprises ・Government investment institution	・National Science and Research Center (CNRS) ・Grandes ecoles (not administered by Ministère de l'éducation nationale (MEN)) ・Higher education institutions (administered by Ministère de l'éducation nationale (MEN))	・Scientific and technical research public establishment "Etablissement public a caractere scientifique et technologique" (other than CNRS) ・Commercial and industrial research public establishment "Etablissement public a caractere industriel et commercial" ・Administrative research public establishment "Etablissement public a caractere administratif" (other than higher education institutions) ・Departments and agencies belonging to ministries *** Local governments are not included**	・Non-profit institutions
U.K.	・Enterprises	・Universities	・Central government (U.K) ・Decentralized governments (Scotland, etc.) ・Research councils * Local governments are not included	・Non-profit institutions
China	・Enterprises	・Universities	・Government research institutes *** Local governments are not included**	・Other non-profit institutions
Korea	・Enterprises ・Government investment institution	・Universities and colleges offering majors in the field of natural scienses and engineering (including extention campuses and local campuses) ・University research institutes ・University hospitals (only if a school of medicine and its accounting are integrated)	・National ・or public research institutes ・Government suported research institutes ・National ・public hospitals *** Local governments are not included**	・Private hospitals ・Other non-profit institutions

Notes: 1) Detailed information by sector for the U.K. and China was not obtained.
2) EU data are not included because they were available only as totals for each country.
<U.S. >FFRDCs: Federally funded research and development centers
<Germany> IfG : Institutions for co-operative industrial research and experimental development
<EU> No breakdown by sector; only totals for each country's sectors.
Sources: NISTEP," Metadata of R&D-related statistics in selected countries: Comparative study on the measurement methodology"
Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”
BMBF, “Bundesbericht Forschung und Innovation 2008

(3) The Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development): International standards with regard to the method of surveying R&D statistics are stated in this manual. In 1963, a meeting on surveying research and experimental development (R&D) in Frascati, Italy was held by experts from member countries of the OECD. The summary of the result is the proposed standard practice for surveying research and experimental development. The latest publication was the sixth version (2002). Most surveys of R&D statistics in each country are mainly conducted following this manual.

In Chart 1-1-5, each selected country's total R&D expenditure was classified by sector, and the proportion of each sector was shown. In every selected country, the business enterprise sector accounted for the largest proportion of the total R&D expenditure: 70% in Japan, the U.S. and Germany, and 60% in France and the U.K. On the other hand, the proportion used by the business enterprise sector is increasing in China, recently accounting for about 70%. In recent years, Korea has reached about 80%.

In Japan over the long term, the portion used by the public organization sector has been decreasing while that used by the business enterprise sector had been increasing, but in the most recent year there has been a decline in the business sector as well. The significant decrease in the non-profit institution sector since FY 2001 was due to a change in classification method for statistics.

In the U.S., from a long run perspective, the proportion for the public organization sector is on the decrease and for the non-profit institution sector is small but increasing. Over the long term, the proportion of the university and college sector has tended to decrease, with a gradual decline in recent years.

In Germany, the data of public organization sector and the non-profit institution sector are integrated because these have not been classified.

The proportions of these sectors have not fluctuated remarkably over time. Their status is considered to be influenced by the statuses of the business enterprises and university and college sectors.

In France, the proportion of the public organization sector is always relatively large. This proportion has been decreasing in the long term and has recently leveled off. Over the long term, the university and college sector is on an upward trend.

In the U.K., the proportion of the public organization sector has decreased and that of the university and college sector has increased, respectively since the 1990s.

In China, the proportion of the public organization sector is large compared to other (five) countries; however it has been decreasing since 1999. On the other hand, the proportion of the business enterprise sector is rising over time instead.

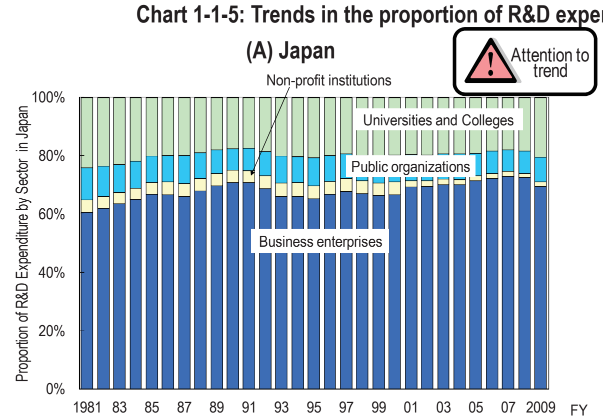
In Korea, the proportion of the public organization sector has been large, but is recently on the decrease.

EU-15 and 27 show the same characteristics as the U.K. and France. That is to say, the proportion of the public organization sector has tended to decrease in the long run and that of the university and college sector has tended to increase, respectively

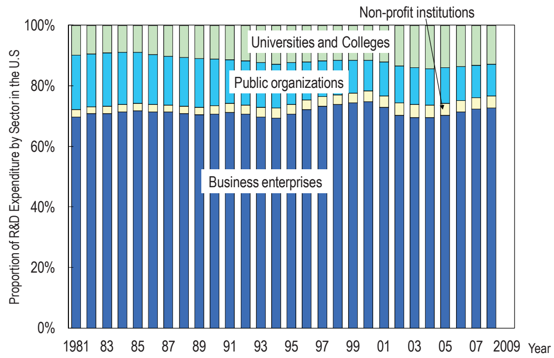
Chart 1-1-5: Trends in the proportion of R&D expenditure by performing sector in selected countries

Attention to international comparison

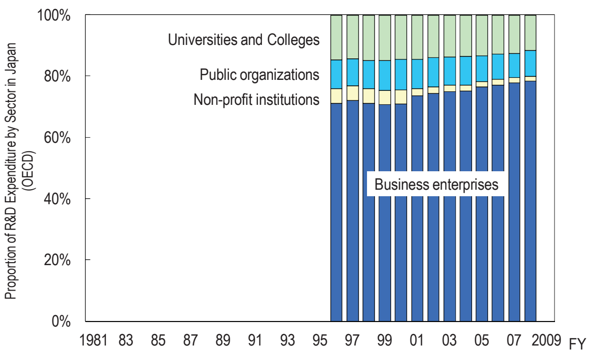
(A) Japan



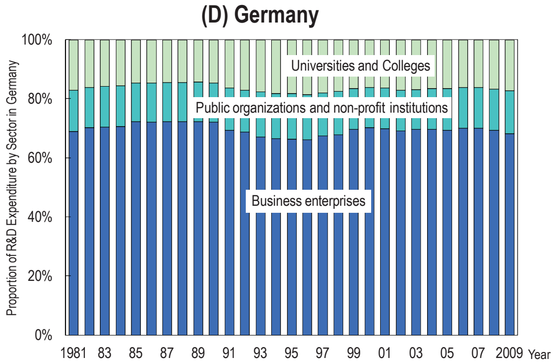
(C) U.S.



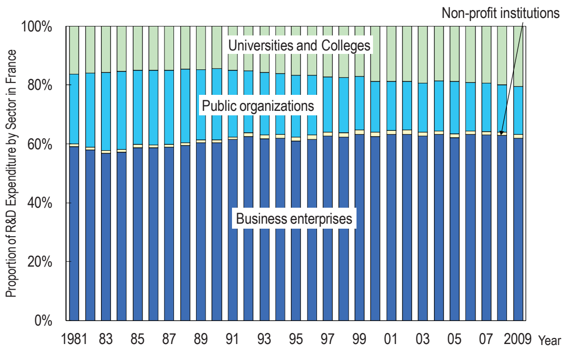
(B) Japan (estimated by OECD)



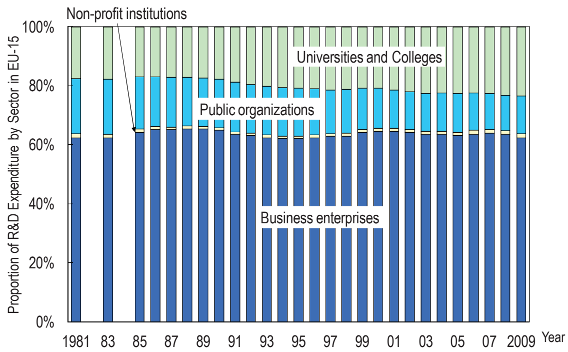
(D) Germany



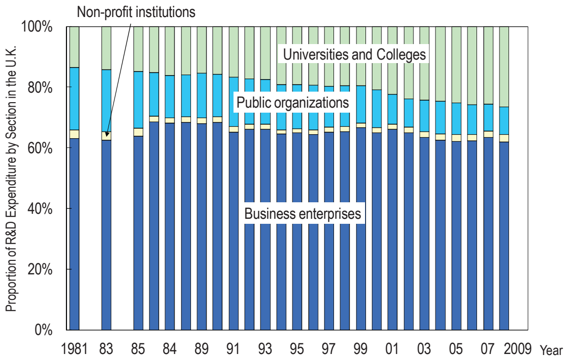
(E) France



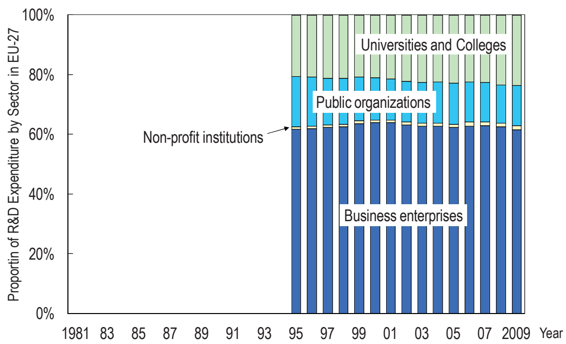
(I) EU-15



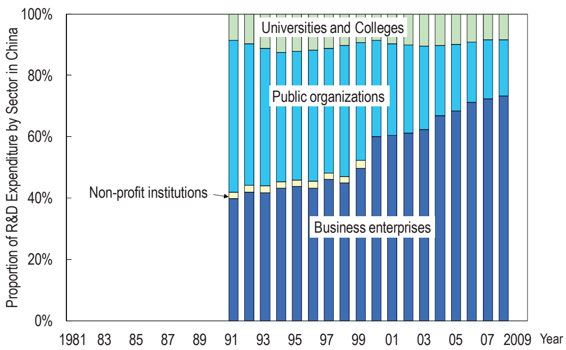
(F) U.K.



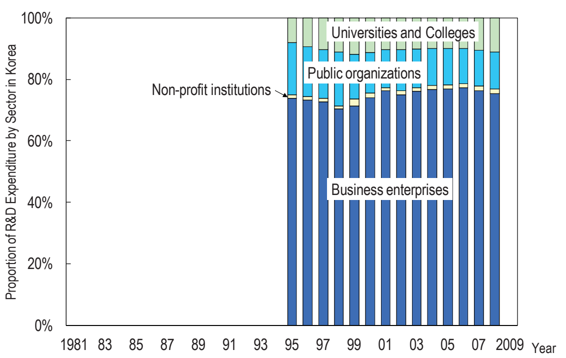
(J) EU-27



(G) China



(H) Korea



Note: 1) The total R&D expenditure is the sum of each sector's expenditure, and the definition of each sector occasionally differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected country.

2) R&D expenditures include humanities and social sciences (for Korea, beginning in 2007).

3) For Japan (OECD estimate), France, China, Korea and EU, non-profit institution totals minus the business enterprises; public organizations; and universities and colleges.

<Japan and Japan (estimated by the OECD)> In FY 2001, a part of non-profit institutions moved into the business enterprise sector.

<Japan (estimated by the OECD)> The total R&D expenditure in which labor cost consisting a part of R&D expenditure in the university and college sector was converted to FTE. The value was corrected and estimated by the OECD.

<Germany>Former West Germany until 1990, and the unified Germany since 1991, respectively.

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development; OECD, "Main Science and Technology Indicators 2010/2"

<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"

<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004,2006"; "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2010/2" for 2008 or later

<U.K.>National Statistics website: www.statistics.gov.uk

<France, China, Korea and EU> OECD, "Main Science and Technology Indicators 2010/2"

1.2 Government budgets

Key points

○With regard to the GBAORD (government budget appropriations or outlays for Science & Technology), the growth rate was lower during the 2000s than in the 1990s in Japan and France. In all the other countries, the growth rate was higher during the 2000s than in the 1990s.

○Japan's initial government budget (the government budget appropriation for S&T) in FY 2011 was 3.7 trillion yen.

In this chapter, each country's GBAORD included in the government budget are examined.

In this report, Japan's "government budget appropriations for Science & Technology (S&T)" are treated as the GBAORD. The government appropriations for S&T are composed of (1) funds for promoting science and technology (a part of the general account, with the main purpose of appropriation in the promotion of science and technology) (2) other research expenditure included in the general account, and (3) the government budget appropriation for S&T included in the special account.

1.2.1 GBAORD in each country

Chart 1-2-1(A), "Total GBAORD (OECD purchasing power parity equivalent) in selected countries," shows that Japan's amount of appropriations or outlays is approximately a fifth of U.S.'s amount (2010). With regard to change over time, Japan's GBAORD growth rate became flat during the 2000s. In the case of the U.S., the budget rose significantly between 2000 and 2004, but since then has shown little change.

In international comparisons of GBAORD, defense-related expenses are frequently removed. In many cases, it is appropriate to remove such expenses, especially when comparing Japan and other countries, because the expenses for the purpose of defense and others are different in character. Chart 1-2-1(B) shows the amount obtained by subtracting defense-related expenses from the GBAORD (non-defense GBAORD).

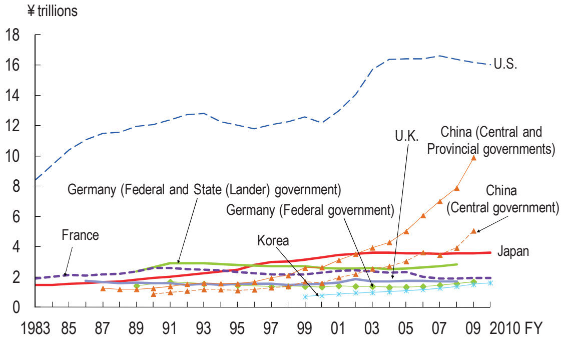
The ratios of the non-defense GBAORD against the GBAORD in Japan and the U.S. accounted for 95.2% (2010) and only 40.2% (2010) respectively. As a result of the comparison of the non-defense GBAORD, Japan's amount of appropriations or outlays jumps up to a half of U.S.'s amount.

From the perspective of change over time, in the 1990s (1991 to 2000), Japan and China had the highest annual average growth rates of the total GBAORD using national currency. On the other hand, the growth rates in Germany (Federal Government) and France were negative. In the 2000s (2000 to the latest available year of each country), annual average growth rate of the total GBAORD was strikingly high in China and Korea. Japan's growth rate was 0.89%. Those of the U.S. and the U.K. were high at 6.22% and 5.04%, respectively (Chart 1-2-1(C)).

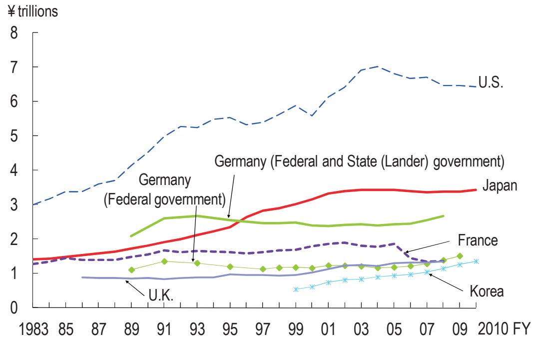
Furthermore, the change in real values, which reduces the influence of price fluctuations, shows that the growth rate was lower in the 2000s than in the 1990s only in Japan and France. In the other countries, the growth rate was higher in the 2000s. During the 2000s, Japan, the U.S. and France demonstrated higher growth rates in their defense-related budgets than in their non-defense budgets, while Japan, Germany, the U.K. and Korea demonstrated higher growth rates in their non-defense budgets (Chart 1-2-1(D)).

Chart 1-2-1: Trend in the GBAORD in selected countries

(A)Total GBAORD
(OECD purchasing power parity equivalent)



(B) Non-defense GBAORD
(OECD purchasing power parity equivalent)



(C) Nominal values (national currency)

National Currencies	Government Budget Appropriations or Outlays for R&D	1991	2000	2010	Annual Average Growth Rate '91→'00	Annual Average Growth Rate '00→'10
Japan (¥ trillions)	Total	2.02	3.29	3.59	5.54%	0.89%
	Non-defense	1.91	3.15	3.42	5.73%	0.82%
	Defense	0.12	0.14	0.17	1.88%	2.33%
U.S. ($ billions)	Total	65.9	78.7	144	1.99%	6.22%
	Non-defense	26.6	36.1	59.2	3.46%	5.08%
	Defense	39.3	42.6	86.1	0.89%	7.29%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	15.1	16.3	19.8 ('08)	0.85%	2.50% (→'08)
	Non-defense	13.4	15.0	18.6 ('08)	1.25%	2.75% (→'08)
	Defense	1.65	1.27	1.19 ('08)	-2.92%	-0.81% (→'08)
Germany(Federal Govenment) (€ billions)	Total	8.63	8.47	12.7	-0.21%	4.14%
	Non-defense	7.00	7.28	11.5	0.44%	4.70%
	Defense	1.63	1.19	1.19	-3.43%	-0.06%
France (€ billions)	Total	14.2	13.8	14.4 ('08)	-0.28%	0.45% ('08)
	Non-defense	9.08	10.9	10.3 ('08)	2.04%	-0.70% ('08)
	Defense	5.12	2.96	4.06 ('08)	-5.90%	4.03% ('08)
U.K. (£ billions)	Total	5.58	6.69	9.92 ('08)	2.04%	5.04% ('08)
	Non-defense	3.02	4.45	7.32 ('08)	4.40%	6.40% ('08)
	Defense	2.56	2.24	2.60 ('08)	-1.46%	1.88% ('08)
China (Central and Provincial governments) (¥ billions)	Total	16.1	57.6	323 ('09)	15.2%	21.1% ('09)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	11.5	35.0	165 ('09)	13.1%	18.8% ('09)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	-	3.75	12.0	-	12.3%
	Non-defense	-	2.98	10.0	-	12.9%
	Defense	-	0.77	1.92	-	9.54%

(D) Real values (2000 base, National currency)

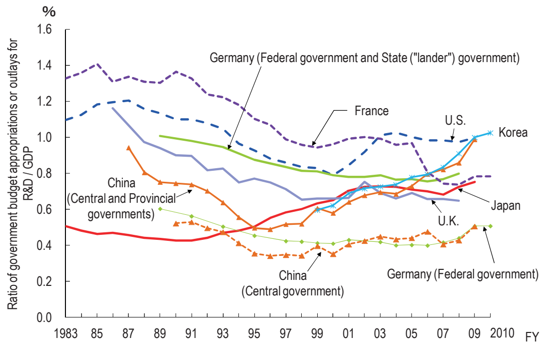
National Currencies	Government Budget Appropriations or Outlays for R&D	1991	2000	2010	Annual Average Growth Rate '91→'00	Annual Average Growth Rate '00→'10
Japan (¥ trillions)	Total	1.99	3.29	4.05	5.72%	2.11%
	Non-defense	1.88	3.15	3.85	5.92%	2.04%
	Defense	0.11	0.14	0.19	2.06%	3.57%
U.S. ($ billions)	Total	78.1	78.7	115	0.08%	3.89%
	Non-defense	31.5	36.1	47.4	1.52%	2.77%
	Defense	46.6	42.6	68.9	-1.00%	4.93%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	17.3	16.3	18.4 ('08)	-0.67%	1.53% (→'08)
	Non-defense	15.4	15.0	17.3 ('08)	-0.29%	1.78% (→'08)
	Defense	1.90	1.27	1.09 ('08)	-4.39%	-1.87% (→'08)
Germany(Federal Govenment) (€ billions)	Total	9.90	8.47	11.4	-1.72%	3.02%
	Non-defense	8.03	7.28	10.35	-1.09%	3.58%
	Defense	1.87	1.19	1.06	-4.90%	-1.13%
France (€ billions)	Total	15.9	13.8	12.1 ('08)	-1.52%	-1.68% ('08)
	Non-defense	10.2	10.9	8.67 ('08)	0.77%	-2.80% ('08)
	Defense	5.73	2.96	3.42 ('08)	-7.07%	1.82% ('08)
U.K. (£ billions)	Total	7.04	6.69	8.08 ('08)	-0.55%	2.24% ('08)
	Non-defense	3.81	4.45	5.96 ('08)	1.75%	3.57% ('08)
	Defense	3.22	2.24	2.12 ('08)	-3.97%	-0.83% ('08)
China (Central and Provincial governments) (¥ billions)	Total	28.5	57.6	227 ('09)	8.15%	16.5% ('09)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	20.4	35.0	116 ('09)	6.15%	14.3% ('09)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	-	3.75	9.28	-	9.48%
	Non-defense	-	2.98	7.79	-	10.1%
	Defense	-	0.77	1.49	-	6.80%

Note: <Japan>Data for all the fiscal years are of initial budget amounts.
<U.S.>The value for FY 2009 is a preliminary budget amount. The value for 2010 is the requested amount.
<Germany>Estimation for the value of the federal government and local governments ("lander governments") in 2007, and for the federal government in 2008 and 2009.
<France>Data for 1984, 1986, 1992, 1997 breaks in series with previous year for which data is available. Data for 2008 are estimates.
<U.K.>Data for FY 2006 are estimates. Data for FY 2007 and 2008 are planned values by cross cutting review.
Reference statistics E was used for the conversion to obtain purchasing power parity equivalent.
Source: <Japan>MEXT, "Indicators of Science and Technology"
<U.S.>NSF, "Federal R&D Funding by Budget Function Fiscal Years 2008–2010"
<Germany>Bundesministerium für Bildung und Forschung, "Faktenbericht Forschung 2002", "Bundesbericht Forschung 2004, 2006", "Research and Innovation in Germany 2005, 2007,"Bundesbericht Forschung und Innovation 2010"
<France and Korea>OECD, "Main Science and Technology Indicators 2010/2"
<U.K.>OST, "SET Statistics"
<China> China Science and Technology Statistics; "S&T Statistics Data Book" (website)

Next, each country's ratio of GBAORD against GDP is shown for comparison to reduce the effect of the scale of the country's economy (Chart 1-2-2). The value for Japan increased during the 1990s and was flat during the 2000s, but in recent years it has been rising again. Since the 2000s, growth in Korea and China (central and provincial governments) has been remarkable. Ratios in the other countries had been flat or falling, but in recent years there has been a slight upward trend.

The ratios for the latest available year were 0.75% in Japan, 1.00% in the U.S., 0.51% or 0.80% in Germany with or without including the local governments ("Lander governments") respectively, 0.78% in France and 0.65% in the U.K. Korea had the highest ratio at 1.03% (2010 figure). China showed remarkably high growth, at 0.51% for the central government and 0.99% when provincial governments are included.

Chart 1-2-2: Trends of the ratio of Government budget appropriations or outlays for R&D against GDP in selected countries



Note: <GBAORD>Same as Chart 1-2-1
<GDP>Same as Reference statistics C
Source: <GBAORD> Same as Chart 1-2-1
<GDP>Same as the reference statistics C

1.2.2 Ratio of R&D expenditure funded by the government in each country

The following are two types of methods for surveying government funded R&D expenditure:

(1) Sum up the results of the survey conducted by each performing sector to obtain its government funded R&D expenditure

(2) Obtain R&D related expenditure (the GBAORD[(4)] out of the government expenditure. (See Section 1.2.1.)

Of the above mentioned two, method (1) which is conducted by the side of performing sectors can provide the total R&D expenditure, even if the flow of the expenditure is complicated, under the condition that the targets of the survey cover the entire country. However, the sources of the R&D expenditure are not always precisely identifiable. On the other hand, it is difficult for method (2) which is conducted from the side of expenditure source (the GBAORD) to obtain accurate R&D expenditure because it is unknown whether or not the entire amount was used for the purpose of R&D in actuality.

In this section, method (1) by the side of performing sectors is used to show the status of each government's R&D expenditure. With this method, the ratio of the R&D expenditure which was funded by the government for each sector against the total R&D expenditure in each country is examined. The expression "the government" here mainly represents the central government, but what is represented depends on the country. Chart 1-2-3 shows a simple definition of "the government" for each country.

As indicated in Chart 1-2-4, the ratio of government-funded R&D expenditures was highest in France. The ratio in Japan was the lowest among the seven countries. In 2009, the ratio of government expenditure in Japan was 20.3%.

The growth rate for most countries was decreasing during the 2000s. Since then, it has been flat in France and South Korea, and flat overall with fluctuations in the U.S. and the U.K. However, Germany and China have continued showing a decreasing trend.

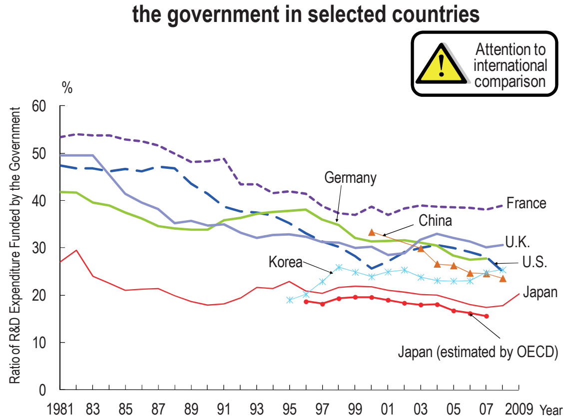
(4) Ordinarily, only the part of the S&T budget devoted to R&D (the R&D budget) should be studied, but there are no data on Japan's R&D budget. This report therefore uses S&T budget data. However, R&D accounts for most of Japan's S&T budget. R&D budget data are available for most countries other than Japan.

Chart 1-2-3: Definition of "the government" as a source of expenditure in selected countries

Country	Government
Japan	(1) National government, local public governments (2) National research institutes, public research institutes, and the institutes run by special corporations or independent administrative corporations (non-profit) (3) National and public universities (including junior colleges and university research institutes, etc.)
Japan (OECD)	(1) National governement, local public government (2) National research institutes, public research institutes and the institutes run by special corporations or independent administrative corporations (non-profit)
U.S.	Federal government
Germany	Federal government (Federal, Länder)
France	Government
U.K.	(1) Central government (including decentralized governments such as the Scottish government and the Welsh government) (2) Research councils (3) Higher education funding councils
China	Government
Korea	(1) Government (2) Government supported research institute

Source: NISTEP, "Metadata of R&D-related statistics in selected countries: Comparative study on the measurement methodology" (Oct. 2007); Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

Chart 1-2-4: Trend in the ratio of R&D expenditure funded by the government in selected countries



Note: 1) When an international comparison is conducted, it should be noted that the R&D expenditure which is investigated by the side of performing sectors may be funded exclusively by the central government, or by both central and local governments, depending on the country. The definition of each country's "government" is referred to in Chart 1-2-3.

2) R&D expenditure is the sum of the expenditure in the field of natural sciences and engineering, and of social sciences and humanities (since 2007 for Korea).

<Japan>The government refers to the national government, local public governments, national research institutes, public research institutes, research institutes run by special corporations, national and public universities (including junior colleges etc.).

<Japan (estimated by OECD)>The government refers to national government, local public governments, national research institutes, public research institutes and institutes run by special corporations.

<U.S.>R&D expenditure in 2008 is a preliminary budget amount. The government refers to the federal government.

<Germany>West Germany and unified Germany until 1990 and since 1991 respectively. The government refers to the federal government and local (lander) governments.

<France>The government refers to public research institutes.

<U.K.>The government refers to the central government (including decentralized governments) , research conferences, and higher education funding councils.

<Korea>The government refers to government research institutes and government supported research institutes

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 2008 Date Update"

<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006"; "Bundesbericht Forschung und Innovation 2010"

<Japan (OECD estimate), France and Korea> OECD, “Research & Development Statistics 2010”
<U.K.>National Statistics website: www.statistics.gov.uk
<China>Ministry of Science and Technology of the People’s Republic of China, "China Science and Technology Indicators"; S&T Statistics Data Book (website)

Next, differences in national policy on R&D expenditure for each country are examined by means of observing the breakdown of R&D expenditure (funded by the government) by performing sector. In other words, they are examined by understanding what proportion of government funds was used in each performing sector (Chart 1-2-5).

In the case of Japan, no significant change in each sector occurred. The university and college sector and the public organization sector accounted for the major portion of R&D expenditure through the period of the chart. Limited spending on the business enterprise sector as compared to other countries is characteristic of Japan.

The U.S. previously funded the business enterprise sector to a high proportion. In the 1980s, the percentage remained in the 40s. But since the latter half of the 1980s, the proportion of the business enterprise sector has been reduced significantly, while the proportion of the university and college sector has been on the rise. In the same period, the proportion for the non-profit institution sector has increased although the ratio versus the total is still small.

In Germany, the proportion for the business enterprise sector has decreased since the mid-1980s, while that for the university and college sector, the public organization sector and the non-profit institution sector has increased. The university and college sector in particular has consistently increased.

In France, previously the proportion for the public organization sector was large, and that for the university and college sector was relatively small. But starting in the 1990s, the proportion for the university and college sector has increased while that for the public organization sector and the business enterprise sector decreased until the 2000s, when it stabilized.

In the U.K., spending for the university and college sector is sharply on the rise. Spending for the business enterprise sector tended to decrease from 1981 to 1996, and was followed by continuous fluctuation. The proportion for the business enterprise sector has gradually been declining since the latter half of the 1990s.

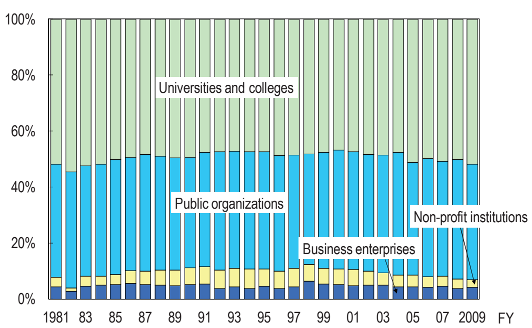
In summary, the ratio of government-funded R&D expenditure changed little in Japan. In Germany and the U.K., spending for the business sector decreased, but spending for the university and college sector increased relatively. France had been following the same trend as Germany and the U.K., but during the 2000s it experienced no major change in its ratios. The same trend can be seen in the U.S. in recent years.

Chart 1-2-5: Trend of the proportion of R&D expenditure funded by the government by sector in selected countries

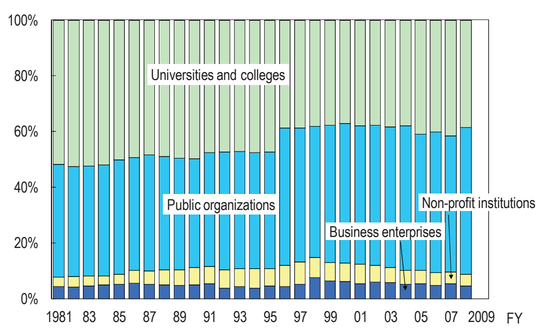
Attention to international comparison

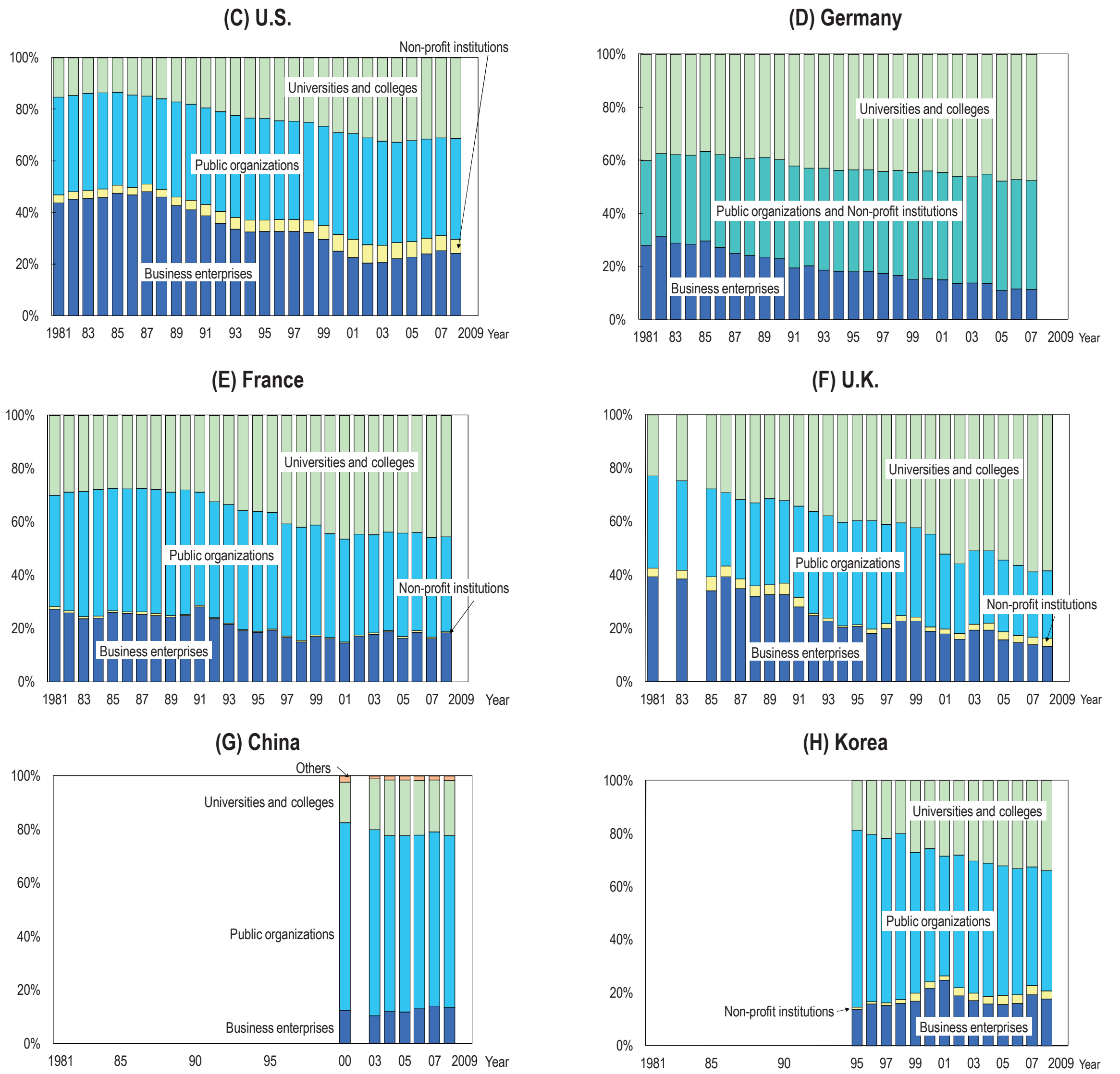
Attention to trend

(A) Japan



(B) Japan (estimated by OECD)





Note: 1) Attention is required for international comparison as in Chart 1-2-4

2) R&D expenditure is the sum of expenditure in the field of natural sciences and engineering, and of social sciences and humanities (only the field of natural science and engineering in Korea)

<Japan> The government refers to the national government, local public governments, national research institutes, public research institutes, research institutes run by special corporations and independent administrative corporations, national and public universities (including junior colleges etc.).

<Japan (estimated by OECD)>1) Attention is required for observing the change in a time series because the value which OECD adjusted and estimated (by converting the labor costs of the university and college sector in R&D expenditure with FTE) has been used since 1996.

2)The government refers to national government, local public government, national research institutes, public research institutes and research institutes run by special corporations and independent administrative corporations.

<U.S.>The 2008 figure is preliminary budget amount. The government refers to the federal government.

<Germany>Former West Germany and unified Germany until 1990 and since 1991 respectively. The government refers to the federal government and local governments.

<France> The government refers to public research institutes.

<U.K.> The government refers to the central government (including decentralized governments), research councils and the higher education funding council.

<Korea>The government refers to government research institutes and government supported research institutes.

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 2008 Data Update"

<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006"; "Bundesbericht Forschung und Innovation 2010"

<Japan (OECD estimate), France, Korea>OECD, "Research & Development Statistics 2010"

< U.K.>OECD, "Research & Development 2009"; National Statistics website: www.statistics.gov.uk since 1992

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

1.2.3 GBAORD (the government budget appropriations for S&T) in Japan

Science and Technology Basic Plans are based on the Science and Technology Basic Act proclaimed and implemented in November 1995. They are basic plans for the comprehensive and systematic advancement of policies designed to promote science and technology. With a view towards the coming 10 years or so, the government creates them to realize S&T policy over five years.

This section will examine changes in GBAORD under each Science and Technology Basic Plan (Chart 1-2-6).

The First Science and Technology Basic Plan covered FY 1996–2000. It required the ratio of GBAORD to GDP to be raised at least to the level of the U.S. and major European countries. It indicated the necessity of total GBAORD of about 17 trillion yen.

Actual GBAORD for the five years covered by the First Science and Technology Basic Plan totaled 17.6 trillion yen. Looking at the trend over the five years, initial budgets followed a rising trend. Substantial supplemental budgets were also added. The supplemental budget added during FY 1998 as economic stimulus made a major contribution to the total five-year budget.

The Second Science and Technology Basic Plan covered FY 2001–2005. It indicated that GBAORD needed to reach approximately 24 trillion yen. The actual sum of the budgets during this period was about 21.1 trillion yen. It was composed of approximately 18.8 trillion yen from the central government and about 2.3 trillion yen from local governments.

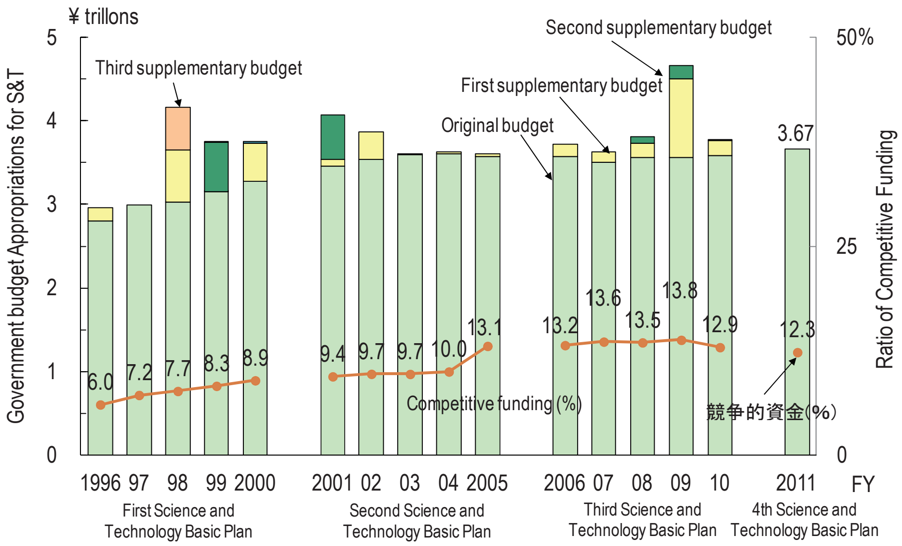
In the Third Science and Technology Basic Plan, a total budget about 25 trillion yen for the five years from FY 2006 through FY 2010 was considered necessary (This was predicated on a ratio of GBAORD to GDP during the period of 1%, with an average nominal GDP growth rate of 3.1%).

Initial budgets during the period totaled 19.6 trillion yen. The growth trend over the five years was flat for initial budgets, but FY 2009 added about 1 trillion through supplemental budgets. The five-year total of GBAORD in both initial and supplemental budgets exceeded those for the term of the Second Science and Technology Basic Plan.

The initial budget for GBAORD in FY 2011 is 3.7 trillion yen.

Turning next to the ratio of competitive funding in GBAORD, it increased under the First and Second Science and Technology Basic Plans, but changed little under the Third.

Chart 1-2-6: Trend of the government budget appropriation for S&T under the Science and Technology Basic Plans



Note: 1) The supplementary budgets were composed of only additional amounts.
2) In accordance with the formulation of the science and technology basic plans (from the first to the third) , the range of targeted costs were reviewed in FY 1996, 2001 and 2006.
Source: Data from the Ministry of Education, Culture, Sports, Science and Technology.

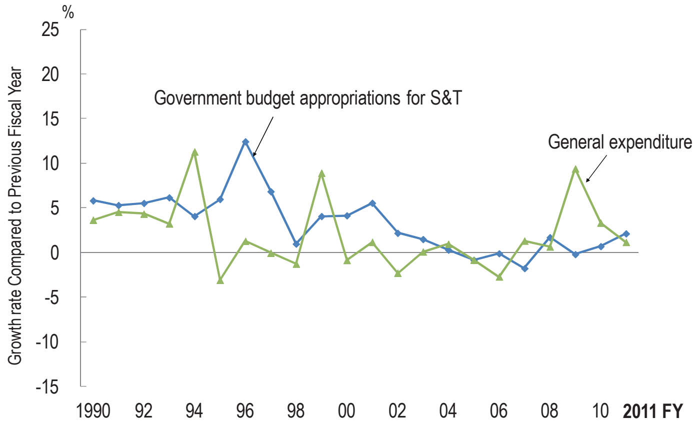
Some basic indexes regarding GBAORD are shown below.

Chart 1-2-7 compares the growth rate compared to the previous fiscal year in GBAORD with the growth rate in general expenditures. "General expenditures" as used here is total general account expenditures minus debt servicing costs, local allocation tax and so on. Because their content and scale are decided at the government's discretion according to economic conditions, they can be considered government spending. By comparing their growth rate with that of GBAORD, the priority assigned to GBAORD in the budget can be discerned.

During the 1990s, the annual growth rate of GBAORD was high and it was usually higher than that of general expenditures. From about the middle of the 2000s, the GBAORD growth rate was about equal to that of general expenditures. In recent years, it has been lower. GBAORD tending to become less important.

The ratio of the general account to special accounts in Japan's FY 2011 GBAORD is 83.4% to 16.6% (Chart 1-2-8). The general account comprises costs for national universities and public research institutes, "Funds for promoting science and technology" consisting of several grants and other research related costs, etc. Of the special accounts, those for supply and demand of energy (special accounts for the measures for structural improvement of petroleum and energy supply and demand) and for promotion of power development (special accounts for electric power development promotion measures) account for large shares.

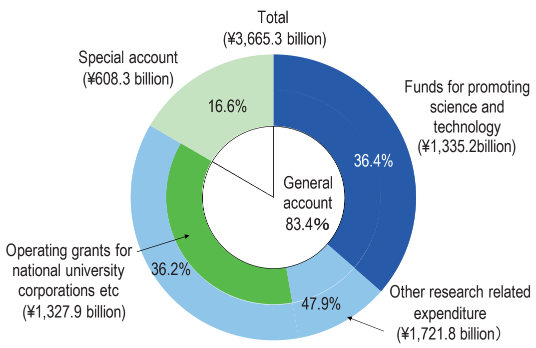
Chart 1-2-7: Trend of the growth rate of the total government budget appropriations for S&T and the general expenditure, both compared to previous fiscal years in Japan



Note: 1) These are initial budgets.
2) The expenses covered were revised in FY 1996, FY 2001 and FY 2006 with the setting of the Science and Technology Basic Plans (First through Third).
3) The FY 2011 budget compilation does not use "general expenditures". Instead, it uses "expenditures subject to the basic fiscal balance," which are general account expenditures minus debt servicing costs. The equivalent of general expenditures for FY 2011 is therefore obtained by subtracting debt servicing costs and local allocation tax from general account expenditures.

Source: Data from the Ministry of Education, Culture, Sports, Science and Technology; the Ministry of Finance; the Ministry of Finance: Fiscal Statistics (Budget and Balance Sheets) (from the official website)

Chart 1-2-8: Breakdown of the Government appropriations for S&T (FY 2010)

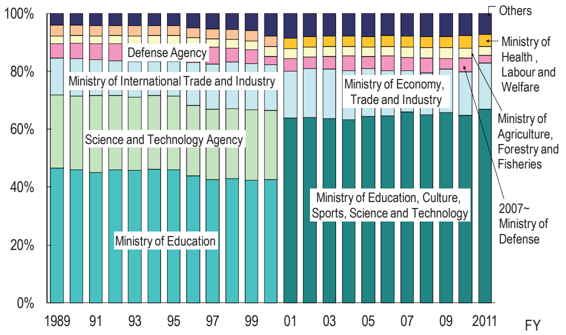


Note: With regard to national university corporations, until FY 2006, the budget appropriation was calculated in accordance with the sum of operating grants, subsidies for capital expenditure and self income (by hospital income, tuition fees and commission projects, etc.). This amount is the equivalent of the government budget appropriation for S&T in the national school special account system prior to the time when national universities, etc. were turned into corporations. The calculation method was changed not to include self incomes since FY 2006.

Source: Data from the Ministry of Education, Culture, Sports, Science and Technology

With regard to the breakdown of the government appropriations for S&T by ministry and agency, the proportion has not significantly varied, except for the case of FY 1996, when the scope of the costs which is entitled to the government budget appropriation for S&T was reviewed, and the case of FY 2001, when ministries and agencies were reorganized. Of all ministries and agencies, the Ministry of Education, Culture, Sports, Science and Technology (having been separated into the Ministry of Education, Science and Culture and the Science and Technology Agency through FY 2000) accounted for the highest share in FY 2011 at 66.8%. It was followed by the Ministry of Economy, Trade and Industry (16.0%), the Ministry of Health, Labor and Welfare (4.1%) and the Ministry of Agriculture, Forestry and Fisheries (3.1%) and the Ministry of Defense (2.6%). (See Chart 1-2-9.)

Chart 1-2-9: Trend in the breakdown of the government budget appropriation by ministry and agency

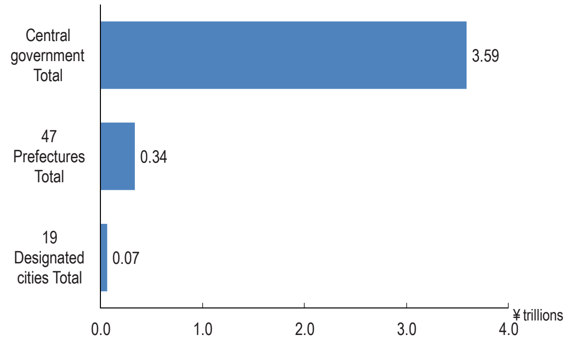


Note: 1) Data for each fiscal year is for initial budgets.
2) In accordance with the formulation of the science and technology basic plans (from the first to the third) , the range of targeted costs were reviewed in FY 1996, 2001 and 2006.
3) Until FY 2000, the expenditure on the Japan Key Technology Center (established on Oct. 1, 1985 and dissolved in Apr.1, 2003) was earmarked by both the Ministry of International Trade and Industry and the Ministry of Post and Telecommunications. (But the total was not doubly counted)
4) The government budget appropriations for S&T were compiled by the Ministry of Education, Culture, Sports, Science and Technology in accordance with materials submitted by each ministry.
5) The expenditure, etc. for each special corporation from the government budget appropriations for S&T which is included in the special account for Industrial investment under the jurisdiction of the Ministry of Finance is earmarked to the ministries etc. which have jurisdiction over the special corporations. But with regard to the National Agriculture and Bio-oriented Research Organization under the jurisdiction of the Ministry of Finance and the Ministry of Agriculture, Forestry and Fisheries, the expenditure is earmarked to only the latter.
6) The Defense Agency was upgraded to the Ministry of Defense on Jan. 9, 2007.
Source: MEXT, "Indicators of Science and Technology"; Data from the Ministry of Education, Culture, Sports, Science and Technology

For an international comparison of government budget appropriations for S&T, it is necessary to include not only that of the central government, but also that of the local governments.

The original government budget appropriation for S&T allocated by 47 prefectures and 19 designated cities was approximately 402.8 billion yen in FY 2010. This amount was the equivalent of 11.2% out of the original government budget appropriation for S&T allocated by the national government (approximately 3,589 billion yen) in the same fiscal year (Chart 1-2-10).

Chart 1-2-10: Government budget appropriations for S&T by the central government and by local governments (FY 2010)



Note: 1) The amount is the initial budget.
2) The national treasury disbursements were not included in the budget for local governments.
Source: Data from the Ministry of Education, Culture, Sports, Science and Technology

1.3 R&D expenditure by sector

1.3.1 R&D expenditure in the public organization sector

Key points

○The growth rate of Japan's R&D expenditure (real values) in the public organization sector in the 1990s was high at 4.36% but reduced to 0.71% in the 2000s.

○With regard to the status of each country, R&D expenditure by the public organization sector is on the rise for the U.S., Germany, China and Korea, and flat since the 1990s for the U.K.

(1) R&D expenditure in the public organization sector for each country

In this section, the public organization sector as a performing sector of R&D expenditure is explained.

The public organizations of each country analyzed here include the research institutes as follows: In Japan, "National" research institutes (national experimental and research institutes, etc.), "Public" research institutes (public experimental and researching institutes, etc.), and research institutes run by "Special and independent administrative corporations" (non-profit) are included.

In the U.S., research institutes (NIH etc.) run by the federal government, and those which belong to FFRDCs (government-funded, with R&D carried out by the industrial, university and non-profit institution sectors) are included.

In Germany, public research facilities run by the federal government; local governments and others; non-profit institutions (granted public funding of 160,000 Euros or more); and research institutes other than higher education institutions (research institutes belonging to legally independent universities) are included. It must be noted that in Germany, the public institution sector and the non-profit institution sector are not separated.

In France, research institutes run by certain types of foundation such as scientific and technical research public establishment ("Etablissement Public a Caractere Scientifique et Technologique" (EPST)) (other than CNRS) and commercial and industrial research public establishment ("Etablissement Public a Caractere Industriel et Commerce") (EPIC), etc. are included.

In the U.K., research institutes run by the central government, decentralized governments and research councils are included.

In China, research institutes run by the central government are included.

In Korea, national and public research institutes, government supported research institutes and national and public hospitals (refer to Chart 1-1-4) are included.

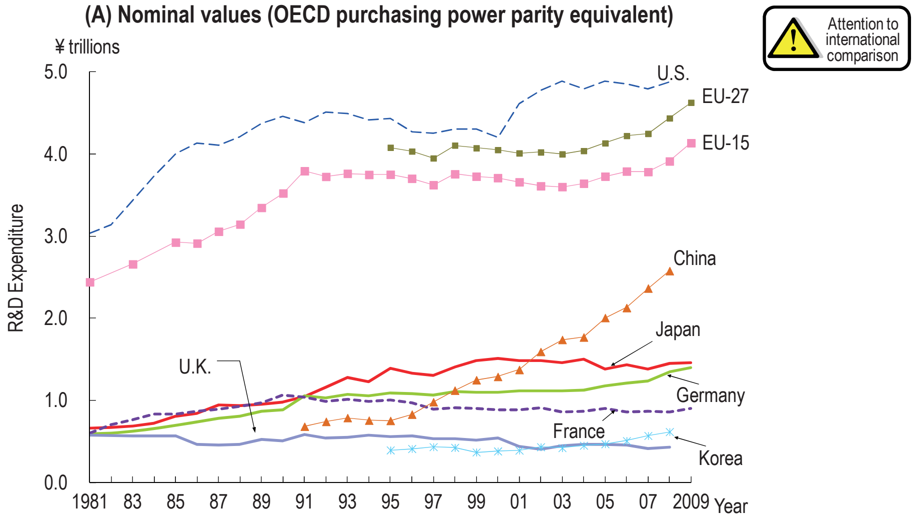
Chart 1-3-1(A) shows the trend of R&D expenditure (by OECD purchasing power parity equivalent) in the public organization sector for selected countries. The R&D expenditure in the public organization sector in Japan was approximately 1.46 trillion yen in FY 2009. Since the 2000s, the trend has been flat. Although R&D expenditure has remained flat in many countries since the 1990s, China started rapidly increasing its R&D expenditure during the middle of the 1990s. Its growth rate rose beyond that of Japan in 2002, and is currently in second position, following the U.S.

Chart 1-3-1(B) shows the annual average growth rate of R&D expenditure (nominal values) in each country on a national currency basis. During the 1990s, every country but France saw growth. Japan's growth rate was 4.18%. Looking at the average annual growth rate in the 2000s (2000 to the latest available year in each country), the growth rate in Japan was negative, while that in the U.K. was less than 1%. Growth rates in all the other countries were positive.

Looking at a comparison of real values adjusted to remove the influence of price fluctuations on a national currency basis (Chart 1-3-1(C)), countries in which the growth rate increased in the 1990s were Japan, Germany and China. The U.S. and the U.K. showed negative growth in the 1990s. Countries in which the growth rate increased faster in the 2000s than in the 1990s were the U.S., Germany, China and Korea. The country with the worst negative growth since the beginning of the 2000s was the U.K.

Chart 1-3-1: Trend of R&D expenditure in the public organization sector for selected countries

(A) Nominal values (OECD purchasing power parity equivalent)



(B) Nominal values (national currency)

National Currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	1.05	1.51	1.46 (2009)	4.18%	-0.42%
U.S. ($ billions)	23.3	27.1	41.8 (2008)	1.68%	5.54%
Germany (€ billions)	5.46	6.87	9.84 (2009)	2.60%	4.07%
France (€ billions)	5.63	5.36	6.88 (2009)	-0.55%	2.81%
U.K. (£ billions)	1.95	2.24	2.35 (2008)	1.58%	0.58%
China (¥ billions)	7.90	28.2	84.4 (2008)	15.2%	14.7%
Korea (₩ trillions)	1.60 (1995)	1.84	4.16 (2008)	1.58% ('95→'00)	10.7%

(C) Real values (2000 base, national currency)

National Currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	1.03	1.51	1.61 (2009)	4.36%	0.71%
U.S. ($ billions)	27.7	27.1	34.1 (2008)	-0.22%	2.89%
Germany (€ billions)	6.26	6.87	8.91 (2009)	1.04%	2.92%
France (€ billions)	6.30	5.36	5.77 (2009)	-1.78%	0.81%
U.K. (£ billions)	2.44	2.24	1.89 (2008)	-0.93%	-2.09%
China (¥ billions)	14.0	28.2	59.5 (2008)	8.10%	9.78%
Korea (₩ trillions)	1.74 (1995)	1.84	3.44 (2008)	0.62% ('95→'00)	8.12%

Note 1) The definition of the public organization sector differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected country.
2) Includes expenditures in the field of social sciences and humanities (until 2006, only natural sciences in Korea)
3) For Japan (OECD estimate), France, Korea and EU, non-profit institution totals minus the business enterprises, universities and colleges and public organization sectors
4) Purchasing power parity is the same as Reference Statistics E.
<Japan and Japan (OECD estimate)> In 2001, part of non-profit institutions was moved to the business enterprise sector.
"Germany" represents the former West Germany until 1990 and unified Germany since 1991.

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; OECD, "Main Science and Technology Indicators 2009/2"
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010; OECD, "Main Science and Technology Indicators 2010/2" since 2008
<France, Korea, and EU> OECD, "Main Science and Technology Indicators 2010/2"
<U.K.>National Statistics website: www.statistics.gov.uk

(2) R&D expenditure in Japan's public organization sector

Chart 1-3-2(A) shows the trend of R&D expenditure in Japan's public organization sector by type of organization. R&D expenditure in all the research institutes had been increasing until FY 2000 in spite of some slight fluctuations. Out of all sectors, the amount in that of special corporations (the proportion shown by "Special corporations and independent administrative corporations" until FY 2000 in the chart) is the highest. Another matter which should be mentioned is the discontinuity between the data for "National" research institutes and that for "Special corporations and independent administrative corporations" due to the fact that former national research institutes and special corporations turned into independent administrative corporations in FY 2001.

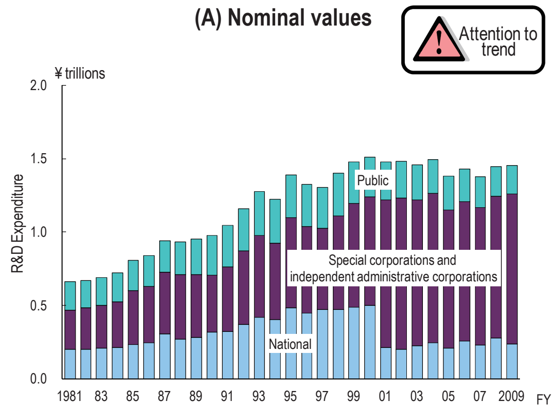
Chart 1-3-2(B) shows the trend in R&D expenditure for each of two types of institutes which compose the entire public organization sector, with the values on a 2000 base, which was adjusted considering the influence caused by price. One type of public institutes is run only by local governments, and the other is run by the other organizations.

From 1991 to 2000, the annual average growth rate of R&D expenditure in public institutes run by local governments showed a decrease of -0.21%, while that in the other public organizations showed an increase of 5.71%.

From 2000 to 2009, the annual average growth rate of R&D expenditure in public institutes run by local governments was -2.51%, showing further dwindling, while that in the other public organizations was 1.32%, showing a shrinking rise.

Chart 1-3-2: Trend of R&D expenditure used by public organization sector in Japan

(A) Nominal values



(B) Real values (2000 base)

(Unit: ¥ trillions)

FY	1991	2000	2009	Annual average growth rate 91→'00	Annual average growth rate 00→09
Public institutes (run by local government)	0.28	0.27	0.22	-0.21%	-2.51%
Public organizations other than public institutes	0.75	1.24	1.40	5.71%	1.32%
Total public organizations	1.03	1.51	1.61	4.36%	0.71%

Note: 1) Part of the national research institutes were turned into independent administrative corporations in FY 2001, so care is needed when examining changes in time series.
2) The values for "Special corporations and independent administrative corporations" represent the values for only "Special corporations" until FY 2000.
3) Reference Statistics D were used as a GDP deflator.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

1.3.2 R&D expenditure in the business enterprise sector

Key points

○Turning to the ratio of R&D expenditure to GDP in the business enterprise sector (most recent available year for each country), it has been rising since 1990 in Japan. The ratio to GDP in 2009 was 2.53%, a drop of 0.24 percentage points from the previous year.

○With regard to direct fund distribution (direct aid) and R&D tax incentives (indirect aid) to the business enterprise sector by the government in each country, the former accounts for a large proportion in the U.S. France, the U.K., etc., and the latter accounts for a large proportion in the in Japan, Canada, etc., respectively.

(1) R&D expenditure in the business enterprise sector for each country

R&D expenditure in the business enterprise sector accounts for the dominant proportion of the total R&D expenditure of each country. Accordingly, fluctuations in the amount in the business enterprise sector have a significant influence on a country's R&D expenditure. As shown in Chart 1-3-3(A), Japan's R&D expenditures for 2009 were 12 trillion yen, a 12.1% decline from the previous year.

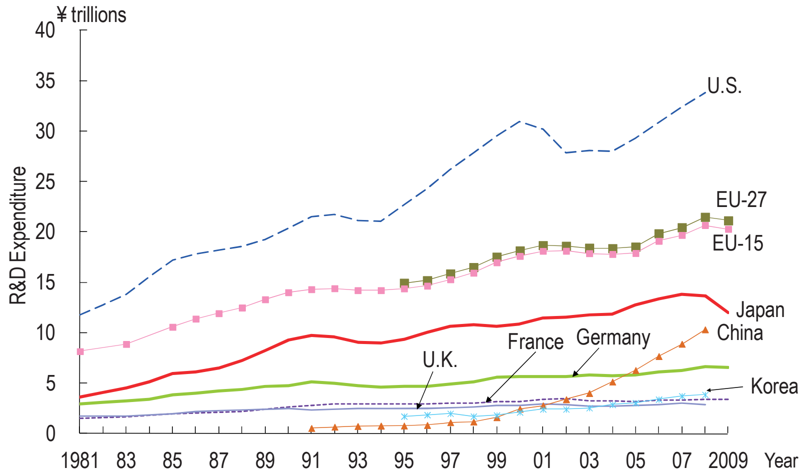
By examining the R&D expenditure in the business enterprise sector for selected countries with OECD purchasing power parity equivalents, it is found that the expenditure is increasing in every country in the long term. While little change can be seen in Germany, France and the U.K., China's growth since 2000 stands out.

In accordance with the annual average growth rate with each country's national currency (nominal values) (Chart 1-3-3(B)), the R&D expenditure increased at a relatively high rate in every country in the 1990s (1991 to 2000) while Japan's growth rate was low at 1.21%. Only France and South Korea had higher growth rates in the 2000s (2000 to the latest available year for each country) than in the 1990s. In every other country, the rate was lower.

Annual average growth rates for real values (2000 base, national currency) adjusted in light of commodity price trends in each country (Chart 1-3-3(C)) show that Japan, China and South Korea had higher growth rates in the 2000s than in the 1990s. Japan's real value rose from 1.39% to 2.25%.

Chart 1-3-3: R&D expenditure in the business enterprise sector for selected countries

(A) Nominal values (OECD purchasing power parity equivalent)



(B) Nominal values (national currency)

National Currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	9.74	10.9	12.0 (2009)	1.21%	1.10%
U.S. ($ billions)	115	200	289 (2008)	6.37%	4.18%
Germany (€ billions)	26.2	35.6	46.1 (2009)	3.45%	2.92%
France (€ billions)	15.3	19.3	26.1 (2009)	2.65%	3.36%
U.K. (£ billions)	8.14	11.5	16.2 (2009)	3.93%	3.85%
China (¥ billions)	6.35	53.7	338 (2008)	26.8%	25.9%
Korea (₩ trillions)	6.96 (1995)	10.3	26.0 (2008)	4.40% ('95→'00)	12.3%

(C) Real values (2000 base, national currency)

National Currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
Japan (¥ trillions)	9.59	10.9	13.3 (2009)	1.39%	2.25%
U.S. ($ billions)	136	200	236 (2008)	4.38%	2.09%
Germany (€ billions)	30.1	35.6	41.7 (2009)	1.88%	1.78%
France (€ billions)	17.1	19.3	21.8 (2009)	1.38%	1.35%
U.K. (£ billions)	10.2	11.5	12.9 (2009)	1.37%	1.23%
China (¥ billions)	11.2	53.7	238 (2008)	19.0%	20.5%
Korea (₩ trillions)	10.6 (1995)	10.3	21.5 (2008)	-0.34% ('95→'00)	9.71%

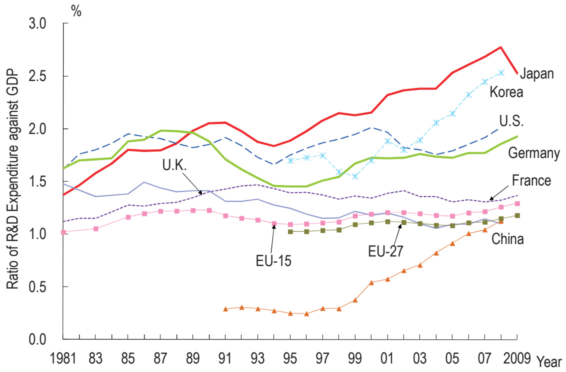
Note: 1) Refer to Chart 1-1-4 for the definition of the business enterprise sector in each country.
2) Includes expenditure in the field of social sciences and humanities (until 2006, only natural sciences in Korea)
3) Purchasing power parity equivalent is the same as Reference Statistics E.
4) Real values were calculated with a GDP deflator (using Reference Statistics D).
<Japan>Fiscal year is used as a year scale.
<Germany> Data for former West Germany until 1990 and unified Germany since 1991.

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; OECD, "Main Science and Technology Indicators 2009/2"
<U.S.>NSF, "Science and technology Indicators 2010"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2010/2" since 2008
<U.K.>National Statistics website: www.statistics.gov.uk
<France, China, Korea and EU> OECD, "Main Science and Technology Indicators 2010/2"

Chart 1-3-4 shows the "Ratio of R&D expenditure against GDP" for an international comparison considering the difference in the economy size of each country.

Looking at the trend of the ratio of R&D expenditure to GDP in the business enterprise sector, Japan has been near the top since 1990. However, the ratio to GDP for 2009 was 2.53%, a decline of 0.24 percentage points from the year before. South Korea has maintained second position since 2002, and its ratio in recent years has been drawing near to that of Japan. The U.S. has been on an upward trend in recent years, while the U.K. and France have shown little change. China's ratio against GDP is low, however, it is gradually reaching the level of other countries recently.

Chart 1-3-4: Trend in the Ratio of R&D expenditure in the business enterprise sector against GDP for selected countries



Note: 1) GDP is the same as Reference Statistics C.
2) Same as in Chart 1-3-3.
Source: Same as in Chart 1-3-3.

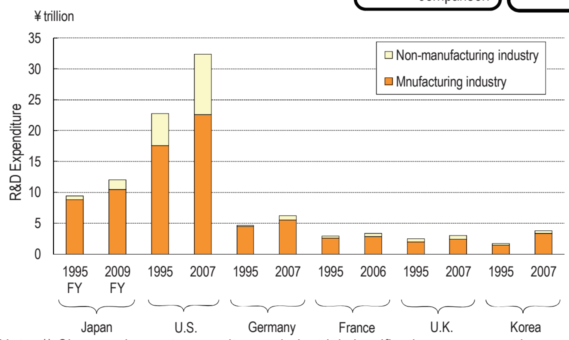
(2) By-industry R&D expenditures in selected countries

Further, R&D expenditure in manufacturing and non-manufacturing industries, which comprise the business enterprise sector, for 1995 and in the latest year are compared. Due to the fact that industrial classifications are different by country, the comparison among countries was made only between the manufacturing and non-manufacturing industries.

The ratio of R&D expenditure in the manufacturing industry against the total accounts for 80 to 90% in almost all the countries. However, this ratio in the U.S. was only 70%, and means that the proportion of R&D expenditure in the non-manufacturing industry is relatively large in the U.S. compared to that in other countries. Also the ratio of R&D expenditure in non-manufacturing industry in the latest year was higher compared to that for 1995 in every country (Chart 1-3-5).

Chart 1-3-5: Comparison between R&D expenditure in the manufacturing industry and in all industries in selected countries

Attention to international comparison | Attention to trend



Note: 1) Since each country uses its own industrial classifications, care must be taken when making international comparisons. Furthermore, since each country revises its industrial classifications, caution is needed when making comparisons over time as well.
2) See Chart 1-1-4 for definitions of the business enterprise sector in each country.
3) Purchasing power parity is the same as in Reference statistics E.
<Japan> 1) The industrial classification was made in accordance with the classification in the survey of research and development based on the Japan standard industry classification. The data of FY 1995 was based on the "Japan standard industry classification" revised in 1993 (the 10th edition), and the data of FY 2007 was based on that revised in 2007 (the 12th edition). Beginning in 2002, the scope of the non-manufacturing sector in the survey of research and development was expanded by adding the categories "academic research institution" and "financial industry."
2) Fiscal year was used as a year scale.
<U.S.> Industrial classifications for 1995 use SIC. Those for 2009 use NAICS.
<Germany> For the data for 1995 and for the data of 2007, German industrial classification, "Classification of Economic Activities", revised in 1993 and in 2003 was used respectively.
<France> For the classification of the data of 1995 and 2006, France activity classification table, "Nomenclature d'activités française (NAF), revised in 1993, and revised in 2003 was used respectively.
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S..>NSF, "R&D in Industry" for each year; S&E Indicators 2010
<Germany> Bundesministerium für Bildung und Forschung, "Forschung und Innovation in Deutschland 2007,2008", "Bundesbericht Forschung und Innovation 2008,2010"
<France>OECD, "STAN Database"
<U.K.>OST, "SET Statistics"
<Korea> Korean Science and Technology Statistics Service (website)

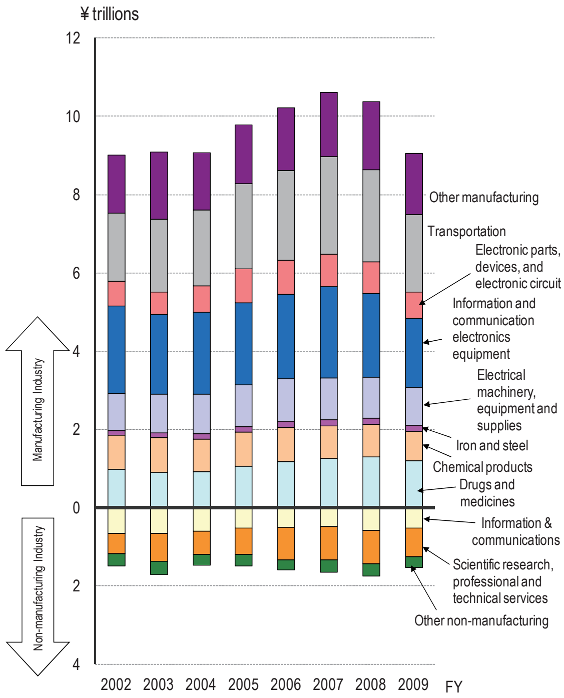
Chart 1-3-6 shows by-industry R&D expenditures for Japan, the U.S. and Germany. The business types used here were set for surveys of R&D statistics in the business enterprise sector, with reference to the classifications used in each country. The standard industry types in each country generally follow the ISIC (International Standard Industrial Classification), but there is some variation by country. The data are therefore considered poorly suited to international comparison. Rather than attempting to compare individual industries, this report instead looks at R&D expenditures according to the industrial structures of the countries. When the R&D expenditures of Japan, the U.S. and Germany are looked at in this way, in Japan the manufacturing industry accounts for a very large share and has a significant impact on the overall increase in R&D expenditures. On the other hand, no major changes were seen in R&D expenditures in non-manufacturing industries. There was a large drop in R&D expenditures in Japan during FY 2009. They declined by 12% in both the manufacturing industry and non-manufacturing industries. By type of industry, R&D expenditures were high in the transportation machinery manufacturing industry and the information and communication electronics equipment manufacturing industry. Their declines in FY 2009 were large as well.

In the U.S., non-manufacturing industries were quite large. Since 2004, however, the manufacturing industry has also become large.

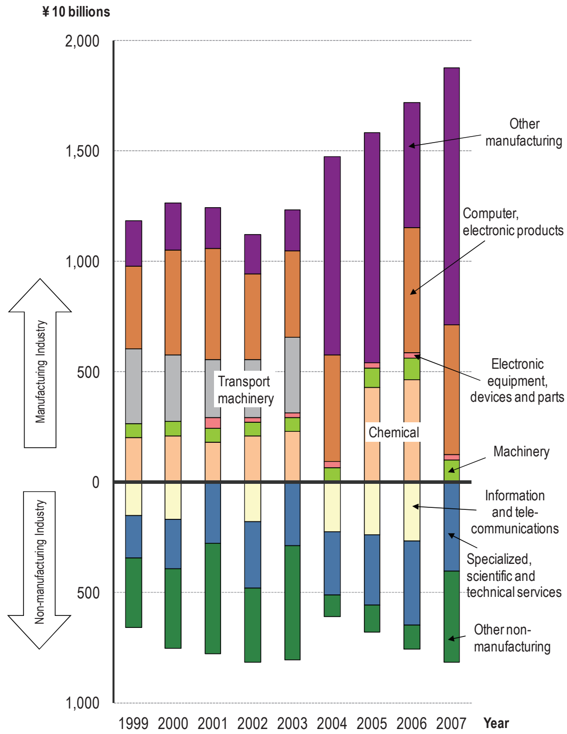
In Germany, both the manufacturing and non-manufacturing industries increased. In Germany's non-manufacturing industries, "software" and "R&D" are classed in the "real estate, leasing and business activities" category. Caution regarding such differences among countries' standard classifications is necessary.

Chart 1-3-6: By-industry R&D expenditures in Japan, the U.S. and Germany

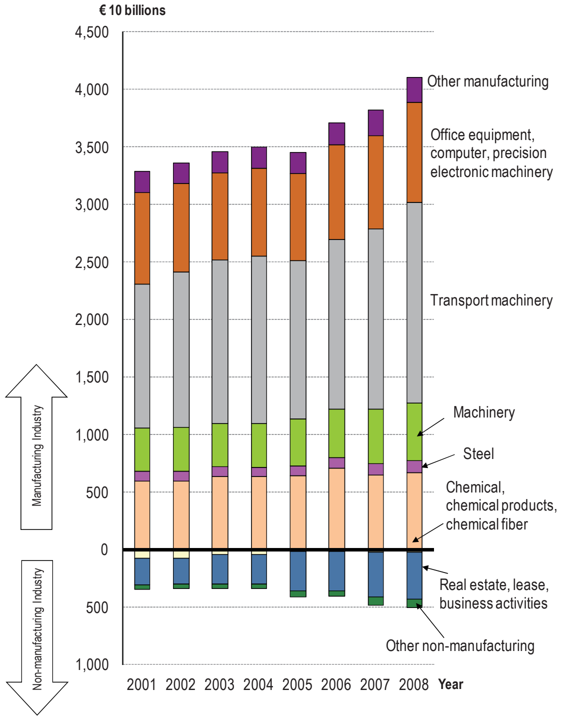
(A) Japan



(B) U.S.



(C) Germany



Notes: <Japan> Industrial classifications in the Survey of Research and Development were changed in the 2002 and 2008 editions in accordance with changes in industry classifications.
<U.S. > Industrial classifications are those in the NAICS. They were revised in 2002 and 2007. Continuity of industries is therefore lost from 2004. From 2001 on, FFRDCS is not included.
<Germany> Germany's industrial classifications were changed in 1993 and 2003.

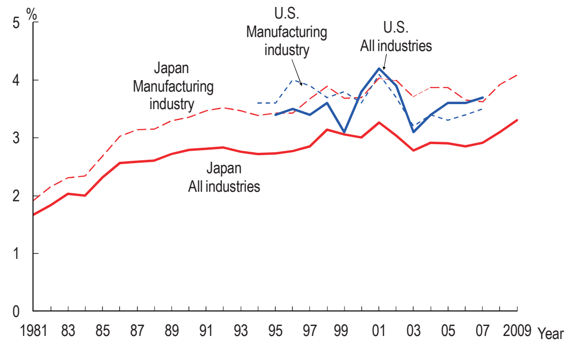
Sources: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S. > NSF, "Industrial R&D," various years
<Germany> BMBF, "Research and Innovation in Germany 2007," "Bundesbericht Forschung und Innovation 2008, 2010"

(3) R&D expenditure per turnover amount in the business enterprise sector

Chart 1-3-7 shows the trend of the ratio of the R&D expenditure against turnover in Japan and the U.S. The ratios are shown for both all industries together and for the manufacturing industry.

As far as Japan is concerned, the ratio in the manufacturing industry was higher than the ratio in all industries, showing Japan's stronger R&D intensity in the manufacturing industry compared to that in the non-manufacturing industry. On the other hand, in the U.S., the ratios for all industries and that for the manufacturing industry varied together at almost the same level of values.

Chart 1-3-7: R&D per turnover in the business enterprise sector



Note: Same as for Chart 1-3-6.
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "R&D Industry"; "Science and Engineering Indicators 2010" beginning in 2003.

(4) Direct and indirect government support for business enterprises

The ratio of the amount of business enterprises' R&D expenditures borne by the government (direct fund distribution; direct support) to GDP and the ratio of the amount of corporate taxes to be paid to the government that is exempted through R&D tax incentives (indirect support) to GDP are discussed.

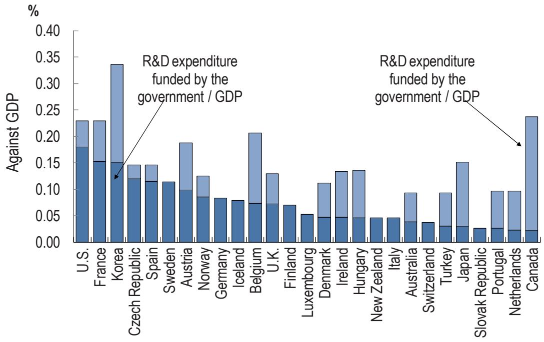
Countries in which direct government support to businesses is large include the U.S., France and South Korea. Countries in which indirect support is large include Canada, South Korea, Belgium and Japan. Both direct support and indirect support are large in South Korea (Chart 1-3-8(A)).

Turning to Japan, Chart 1-3-8(B) shows changes in government direct and indirect support. As seen in the chart, direct support from the government for business enterprises has declined year by year. Indirect support increased sharply in 2004, and decreased in 2008.

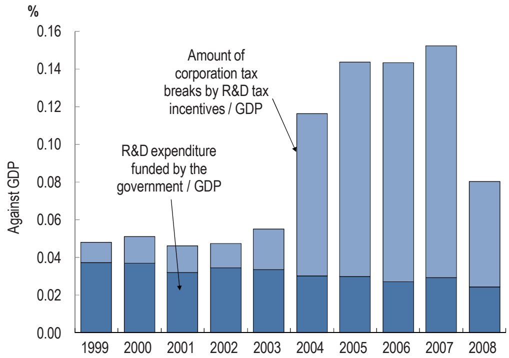
The sharp increase in indirect support in 2004 likely stems mainly from a tax credit for total experimental and research expenses that was adopted in 2003. The number of business enterprises utilizing them is thought to have increased in 2004. The decrease in 2008 is probably because of a decrease in total corporate taxes, which caused a decrease in deductions. In addition, the business enterprise sector R&D expenditures that are the target of tax incentives also decreased slightly in 2008.

Chart 1-3-8: Government direct fund distribution and R&D tax incentives for corporate R&D

(A) Comparison of major countries (2008)



(B) Changes in Japan



Notes: 1) Values estimated by each country (in accordance with the survey for R&D tax incentives by NESTI). Preliminary budget values are also included.
2) Values for Spain, Sweden, Austria, Luxemburg, Ireland, New Zealand, Australia, Japan and the Netherlands are from 2007.

Sources: OECD, "STI Outlook 2010," Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development," National Tax Agency, "Corporation Sample Survey"

1.3.3 R&D expenditure in the university and college sector

Key points

○The R&D expenditure in the university and college sector was 3,549.8 billion yen (FY 2009), which is the equivalent of 2,022.1 billion (FY 2008) yen if the labor cost is multiplied by FTE factor.

○With regard to the annual average growth rate of R&D expenditure by real value (2000 base, national currency), Japan, the U.S. and France showed a lower rise in the 1990s than in the 2000s.

○Looking at the share of universities and colleges R&D expenditure covered by governments, more than 80% is covered in Germany and France, while about 70% is covered in the U.S., the U.K. and, in recent years, Korea. In Japan, the figure is about 50%.

○As for the share of university and college R&D expenditures borne by businesses in major countries, in Germany and South Korea it accounted for 12–15%. In the U.S. and the U.K., the share was 5–6%. In Japan and France, it was 2–3%.

○By observing the R&D expenditure in the university and college sector in Japan by field, it was found that national universities used approximately 50% of the total R&D expenditure in the field of natural science and engineering, While private universities used approximately 70% of the total R&D expenditure in the field of social sciences and humanities.

(1) R&D expenditure in the university and college sector in each country

Higher education institutions such as universities, which have a function as R&D institutions, play an important role in R&D systems in every country. As stated in Section 1.1.2, R&D expenditure used in higher education institutions in each selected country accounts for approximately 10% to 30% of the total.

The scope of higher education institutions depends on the country, but in every country the main institutions are universities. The institutions under survey also depend on the country. The summary of targeted institutions is as follows: For Japan, universities (including graduate schools), junior colleges, technical colleges, university research institutes and other institutions were targeted[5] [6]. For U.S., universities & colleges (institutions which perform R&D which is the equivalent of 150,000 dollars or more; FFRDCs are excluded) were targeted. For Germany, universities, comprehensive universities, and colleges of theology, etc. were targeted. For France, the National Center for Scientific Research (CNRS), and higher education institutions including universities and Grandes Ecoles not under the jurisdiction of the Ministry of National Education "Ministere de I'Educationale") (MEN) were targeted. In most countries, all fields were covered by the statistics. In the U.S., S&E[7] fields were covered, while in Korea, only the field of natural sciences and engineering was included until 2006 (see Chart 1-1-4).

In order to obtain R&D expenditure in the university and college sector, it was necessary to calculate the costs after separating R&D activities from educational activities; however, this separation is generally difficult.

The figures for R&D expenditure in Japan's university and college sector are those according to the "Survey of research and development" compiled by the Ministry of Internal Affairs and Communications. In these surveys, the breakdown of the R&D expenditure includes labor cost. However, the total labor cost is composed of elements including "duties other than research (such as education)".

(5) According to "Report on School Basic Survey (FY 2010)" by MEXT in FY 2010, 778 universities (86 national, 95 public and 597 private universities), 395 junior colleges (0 national, 26 public and 369 private junior colleges) and 58 technical colleges are covered.

(6) In "Report on the Survey of Research and Development" compiled by the Ministry of Internal Affairs and Communications, which was used as the materials for the statistics of Japan's universities and colleges sector in this chapter, universities are surveyed by faculty (by course in the case of graduate schools), and the total number is 2,341 as of March 31, 2010. "Other institutions" include Inter University Research Institutes Corporation, the National Institution for Academic Degrees and University Evaluation, the Center for National University Finance and Management, National Institute of Multimedia Education, and the museum, center and facility at universities.

(7) Science and Engineering: computer sciences, environmental sciences, life sciences, mathematical sciences, physical sciences, psychology, social sciences and engineering; education and humanities are not included.

Statistics for R&D expenditure in the university and college sector in Japan do not adopt a full-time equivalent, and almost all teachers are measured as researchers. However, it not true that the duties of all teachers are exclusively limited to research. Therefore, it is natural to consider that the situation in which the labor cost of all the teachers is measured as R&D expenditure is an over-estimation with regard to R&D expenditure.

The OECD understands the actual situation, and multiplied 0.53 and 0.465 to the labor costs of Japan's R&D expenditure in 1996 to 2001 and since 2002 respectively in the OECD statistics. Adjustment factor 0.465 for the data since 2002 is the Full Time Equivalent coefficient obtained from the "Survey on the Data for full-time equivalents in universities and colleges" in 2002 compiled by the Ministry of Education, Culture, Sports, Science and Technology. This survey was carried out again in 2008. The FTE equivalent coefficient in that survey was 0.362. OECD data from 2008 on use the FTE coefficient from the 2008 survey.

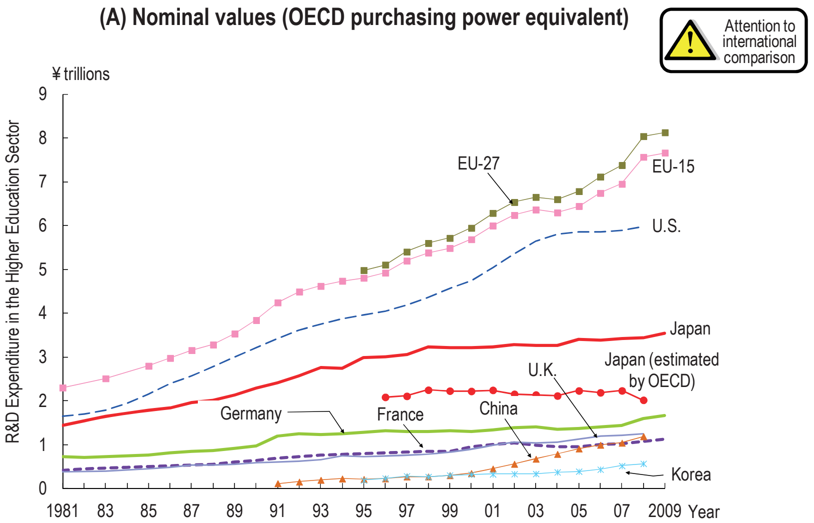
Hereinafter, both these values provided by the OECD (clearly referred to as "Japan (estimated by OECD)") and the values provided by the "Report on the Survey of Research and Development" compiled by the Ministry of Internal Affairs and Communications (referred to as "Japan") are given.

Chart 1-3-9(A) shows the nominal values of R&D expenditure in the university and college sector. The values of R&D expenditure in the university and college sector for "Japan" and "Japan (estimated by OECD)" were 3,549.8 billion yen (FY 2009) and 2,022.1 billion yen (FY 2008), respectively. Japan's values have been slightly increasing since 1996. With regard to other countries, the rise in the U.S. and the EU is remarkable. Out of the EU countries, in Germany, France and the U.K., where R&D expenditure is large, the amount is gradually increasing in the long term although the size of the change is not significant. In China, R&D expenditure is steadily increasing and recently the level has reached the same as that of France. Turning next to the average annual growth rate (nominal values) of R&D expenditure by country with each country's national currency (Chart 1-3-9(B)), countries in which it was lower during the 2000s (2000 to the latest available years) than the 1990s (1991–2000) were Japan, France and South Korea.

Looking at real values in light of prices (Chart 1-3-9(C)), countries with lower growth rates in the 2000s than in the 1990s were Japan and France. The U.S. showed almost no change. Countries in which growth was higher during the 2000s were Germany, the U.K., China and South Korea, with China particularly separated from the rest.

Chart 1-3-9: Trend of R&D expenditure in the university and college sector for selected countries

(A) Nominal values (OECD purchasing power equivalent)



(B) Nominal values (national currency of each country)

National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
[Japan (¥ trillions)	2.41	3.21	3.55 (2009)	3.24%	1.13%]
Japan (estimated by OECD) (¥ trillions)	2.09 (1996)	2.22	2.02 (2008)	1.57% ('96→'00)	-1.18%
U.S. ($ billions)	18.2	30.7	51.2 (2008)	5.98%	6.59%
Germany (€ billions)	6.15	8.15	11.7 (2009)	3.18%	4.10%
France (€ billions)	3.75	5.80	8.65 (2009)	4.97%	4.53%
U.K. (£ billions)	2.02	3.69	6.79 (2008)	6.93%	7.93%
China (¥ billions)	1.37	7.67	39.0 (2008)	21.1%	22.5%
Korea (₩ trillions)	0.77 (1995)	1.56	3.84 (2008)	15.2% ('95→'00)	11.9%

(C) Real values (2000 base; national currency of each country)

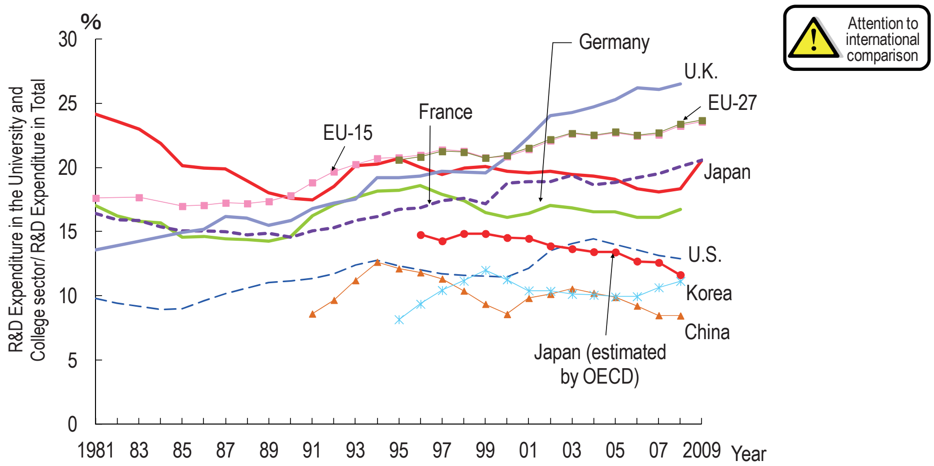
National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	Annual average growth rate '00→Latest year
[Japan (¥ trillions)	2.37	3.21	3.93 (2009)	3.42%	2.28%]
Japan (estimated by OECD) (¥ trillions)	2.04 (1996)	2.22	2.22 (2008)	2.23% ('96'→'00)	-0.03%
U.S. ($ billions)	21.6	30.7	41.8 (2008)	3.99%	3.92%
Germany (€ billions)	7.05	8.15	10.6 (2009)	1.62%	2.96%
France (€ billions)	4.20	5.80	7.25 (2009)	3.67%	2.50%
U.K. (£ billions)	2.53	3.69	5.48 (2008)	4.29%	5.06%
China (¥ billions)	2.43	7.67	27.5 (2008)	13.6%	17.3%
Korea (₩ trillions)	1.17 (1995)	1.56	3.18 (2008)	5.93% ('95→'00)	9.31%

Note: 1) The definition of the university and college sector is different depending on the country. Therefore, it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definitions of the university and college sector.
2) The purchasing power parity used here is the same as that in Reference statistics E.
3) Includes the fields of social sciences and humanities (for Korea, only natural sciences until 2006)
<Japan (estimated by OECD)>These values were adjusted and estimated by the OECD (Labor cost included in the R&D expenditure for the university and college sector was converted to FTE to obtain the total R&D expenditure).
<Germany>Former West Germany until 1990 and unified Germany since 1991, respectively.
Source: Same as for Table 1-1-5; Korea: KISTEP, S&T statistics database (website)

The trend of the ratio of R&D expenditure in the university and college sector against the total R&D expenditure for each country is shown in Chart 1-3-10.

In Japan, the ratio had tended to decrease in recent years, but it increased during 2009. (However, this was because R&D expenditures in the business enterprise sector decreased, lowering overall R&D expenditures. This resulted in an increase in the university and college sector's share.) On the other hand, in the U.K., the ratio has tended to increase, and the growth has been especially remarkable since 2000. The increase is considered to be influenced by the rise in R&D expenditure in the university and college sector and the fall in that in the business enterprise sector. In the U.S. and Germany, the ratio has repeated ups and downs in the long term, and has recently remained flat.

Chart 1-3-10: Trend of the ratio of total R&D expenditure in the university and college sector against the total R&D expenditure for selected countries



Note: Same as for Chart 1-1-1 and Chart 1-1-5.
Source: Same as for Chart 1-1-1 and Chart 1-1-5

(2) Structure of source of funds for R&D expenditure in the university and college sector in selected countries

Chart 1-3-11 shows a breakdown of the percentages of the costs of intramural universities and colleges R&D expenditures borne by various sectors in selected countries. In other words, of universities and colleges R&D expenditures used intramurally, it shows how much of the burden of research funding is borne by different sectors. It also shows what percentages of funds borne by government and the business enterprise sector are accounted for by funding provided to universities and colleges.

Looking first at the shares of costs for university and college intramural R&D expenditures borne by different sectors (Chart 1-3-11(A), (i), (ii)), more than 80% is covered by the government in Germany and France, while about 70% is covered in the U.S., the U.K. and, in recent years, South Korea. In Japan, the figure is about 50%. Countries where business enterprises bear a relatively large share of the costs are Germany and Korea at 12–15%. Countries where business enterprises bear a relatively low share are Japan and France at about 2–3%. In the U.S. and the U.K., the share is 5–6%.

In 2007–2009, the share of costs borne by the Japanese government was 49.6%, while that borne by business enterprises was 2.7%. Compared with 2000–2002, the government share decreased by 1.5 percentage points, while the business enterprise share increased by 0.1 percentage points.

In the U.S., government's share of the cost for all universities and colleges was 66.6% during 2006–2008, while the business enterprise sector's share was 5.6%. This was a 0.6 percentage points increase for government and a 0.8 percentage points decrease for business compared with 2000–2002.

In Germany, government and non-profit institution bear large percentages of the costs. In 2005–2007, they accounted for 81.6% of the whole. The business enterprise sector also accounts for a large share relative to the other countries at 14.5%. Compared with 2000–2002, the share borne by government and non-profit institution fell by 4.2 percentage points, while that of business enterprises rose by 2.6 percentage points.

The government's share in France is also large. During 2006–2008, it accounted for 88.9%, the largest share of any of the selected countries. On the other hand, the business enterprise sector's share was only 1.9%, the smallest of any of the selected countries. The government share decreased by 2.1 percentage points, and the business enterprise share decreased by 1.0 percentage points compared with 2000–2002.

In the U.K., government's percentage of costs is large as well, at 68.8% in 2006–2008. The business enterprise share is 4.6%. Compared with 2000–2002, the government share of costs rose 2.4 percentage points, while the business enterprise share fell 1.5 percentage points.

In Korea, the government share of costs increased by 12.6 percentage points in 2006–2008 (77%) compared with 2000–2002 (64.4%). This was the largest increase in any of the selected countries.

Next, the percentage of R&D expenditure by the government and business enterprise sectors that goes to universities and colleges is examined (Chart 1-3-11(A), (iii), (iv)).

About 50% of government R&D expenditures go to universities and colleges in Japan, Germany, France and the U.K. About 30% goes to universities and colleges in the U.S. and Korea. Only a small percentage of the business enterprise sector's R&D expenditures go to universities and colleges in any of the selected countries. Universities and colleges account for about 3% in Germany and the U.K., about 2% in Korea and about 1% in Japan, the U.S. and France.

Comparing 2000–2002 to the latest available year, the largest increase in the share of government R&D expenditure that went to universities and colleges was in the U.K. In the business enterprise sector, growth was negative in almost every country. Only Germany was flat. As shown in Charts 1-3-11(B)–(G), the share borne by foreign countries was small. The largest share, 9%, was in the U.K.

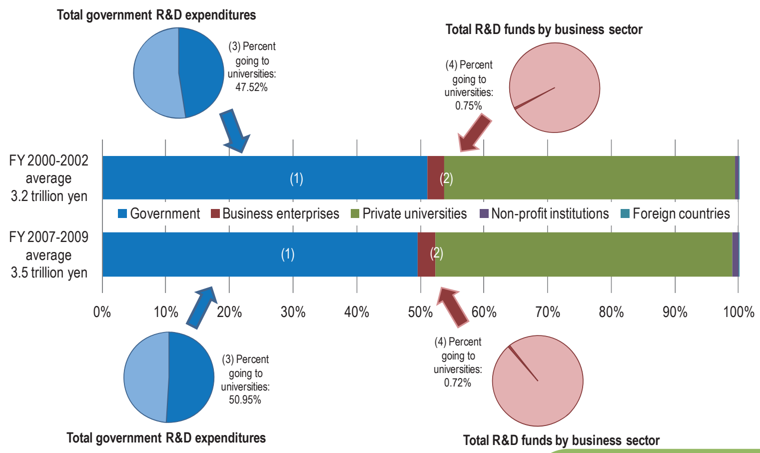
Chart 1-3-11: Changes in the cost-sharing structure for universities and colleges research funding in selected countries

(A) Table

Attention to international comparison

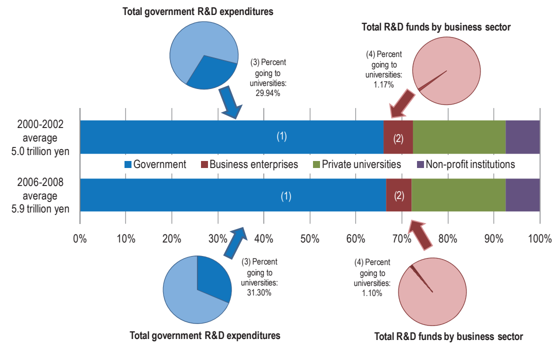
Country / Most recent year (3-year moving average)	Total university research expenditures (OECD purchasing power parity basis)	Break down of university research expenditures				3) Percentage of total government R&D expenditures going to universities	Change from 2000–2002	4) Percentage of total business sector R&D expenditures going to universities	Change from 2000–2002
		1) Percentage received from government	Change from 2000–2002	2) Percentage received from business sector	Change from 2000–2002				
Japan '07-09	¥3.5 trillion	49.63%	△1.54%	2.71%	0.09%	50.95%	3.43%	0.72%	△0.03%
Japan (OECD) '06-08	¥2.2 trillion	51.54%	1.51%	2.99%	0.44%	40.13%	2.47%	0.47%	△0.02%
U.S. '06-08	¥5.9 trillion	66.62%	0.61%	5.55%	△0.87%	31.30%	1.36%	1.10%	△0.07%
Germany '05-07	¥1.4 trillion	81.58%	△4.15%	14.48%	2.60%	47.59%	2.65%	3.46%	0.48%
France 06-08	¥1.0 trillion	88.87%	△2.13%	1.85%	△1.03%	45.19%	△0.01%	0.70%	△0.32%
U.K. '06-08	¥1.2 trillion	68.76%	2.39%	4.64%	△1.50%	58.13%	7.13%	2.62%	△0.39%
Korea '06-08	¥0.5 trillion	77.02%	12.57%	13.21%	△1.42%	33.39%	5.73%	1.90%	△0.25%

(B) Cost-sharing structure for universities and colleges R&D expenditures in Japan

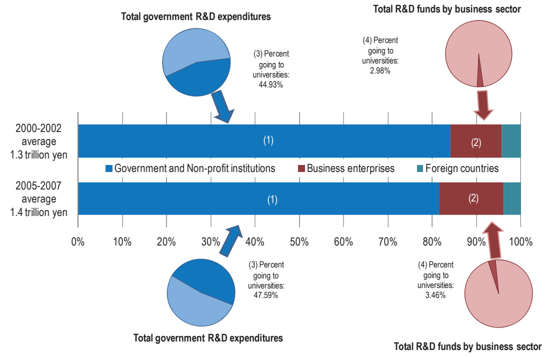


For the Japanese statistics, of R&D expenditures used at universities and colleges, the share of costs borne by universities and colleges refers to funding by private universities and colleges. Most of that is R&D expenditures self-funded by the private universities and colleges.

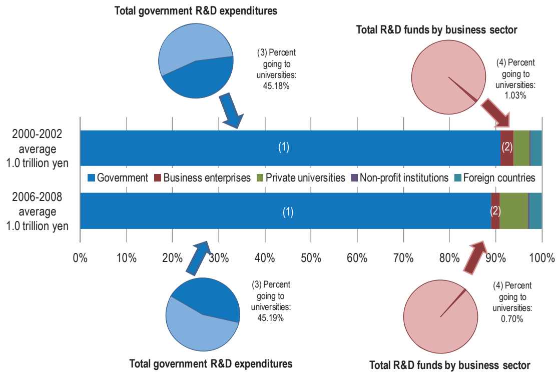
(C) Cost-sharing structure for universities and colleges R&D expenditures in the U.S.



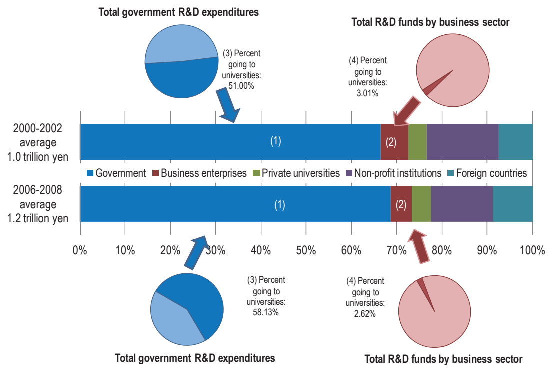
(D) Cost-sharing structure for universities and colleges R&D expenditures in Germany



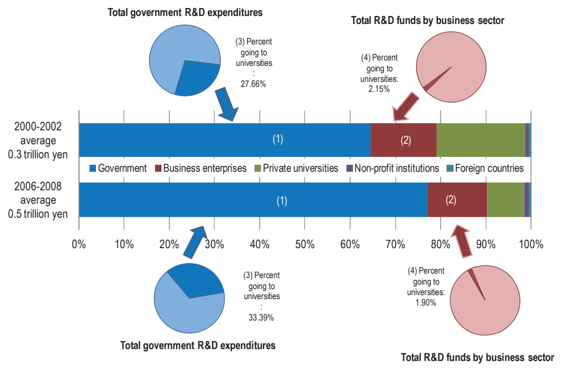
(E) Cost-sharing structure for universities and colleges R&D expenditures in France



(F) Cost-sharing structure for universities and colleges R&D expenditures in the U.K.



(G) Cost-sharing structure for universities and colleges R&D expenditures in Korea



Notes: 1) Three-year averages are used. For example, 2007–2009 refers to the average value for the years 2007 through 2009.
2) Numbers by the arrows refer to the percentage of funds from each sector's R&D expenditures going to the university and college sector. For example, during FY 2007–2009 in Japan, of costs borne by government, 50.95% went to universities and colleges.
3) Other notes, regarding international comparison, etc., are as for Charts 1-2-3 and 1-2-4.

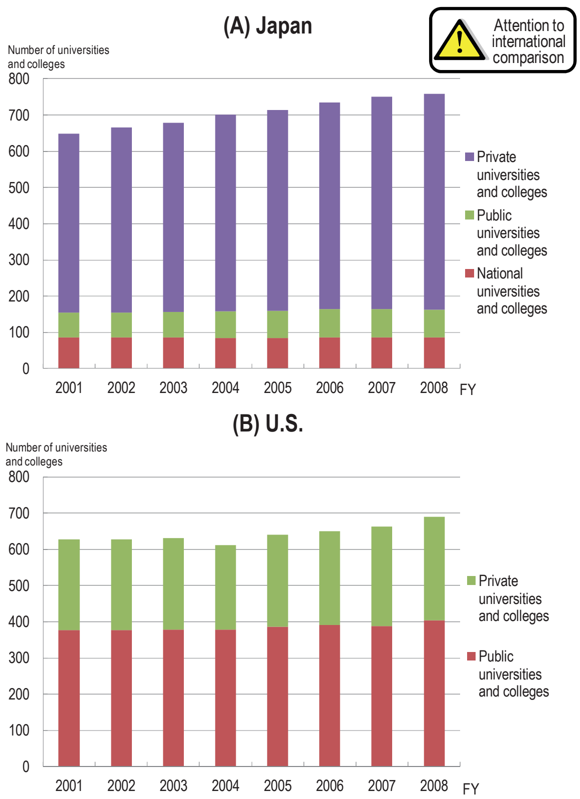
Sources: Same as for Chart 1-2-4.

(3) Funding structure for universities and colleges R&D expenditures by form of institution in Japan and the U.S.

Chart 1-3-12 shows changes in the number of universities and colleges in Japan and the U.S. covered by R&D statistics. The U.S. (NSF) does not cover all universities and colleges. It covers only universities and colleges with annual R&D budgets of at least 150,000 dollars. While Japan's Survey of Research and Development, in contrast, includes junior colleges, for the sake of comparison between Japan and the U.S., only four-year universities and colleges will be discussed here.

In the most recent year available, Japan had 86 national universities, 76 public universities and 596 private universities. Looking at trends, the number of private universities is increasing. In the U.S., there are 404 state universities and 286 private universities. The number of private universities is increasing.

Chart 1-3-12: Number of universities and colleges



Note: There are differences in the scope covered by universities in Japan and the U.S., so caution is needed when making international comparisons. In Japan's case, they are four-year schools. Junior colleges, joint-use institutions, etc., are not included. In the case of the U.S., they are institutions utilizing annual research budgets of at least 150,000 dollars.

Sources: <Japan> Recalculated by NISTEP from individual data in Ministry of Internal Affairs and Communications, "Report on Survey of Research and Development"

<U.S.> NSF, "Academic R&D Expenditures"

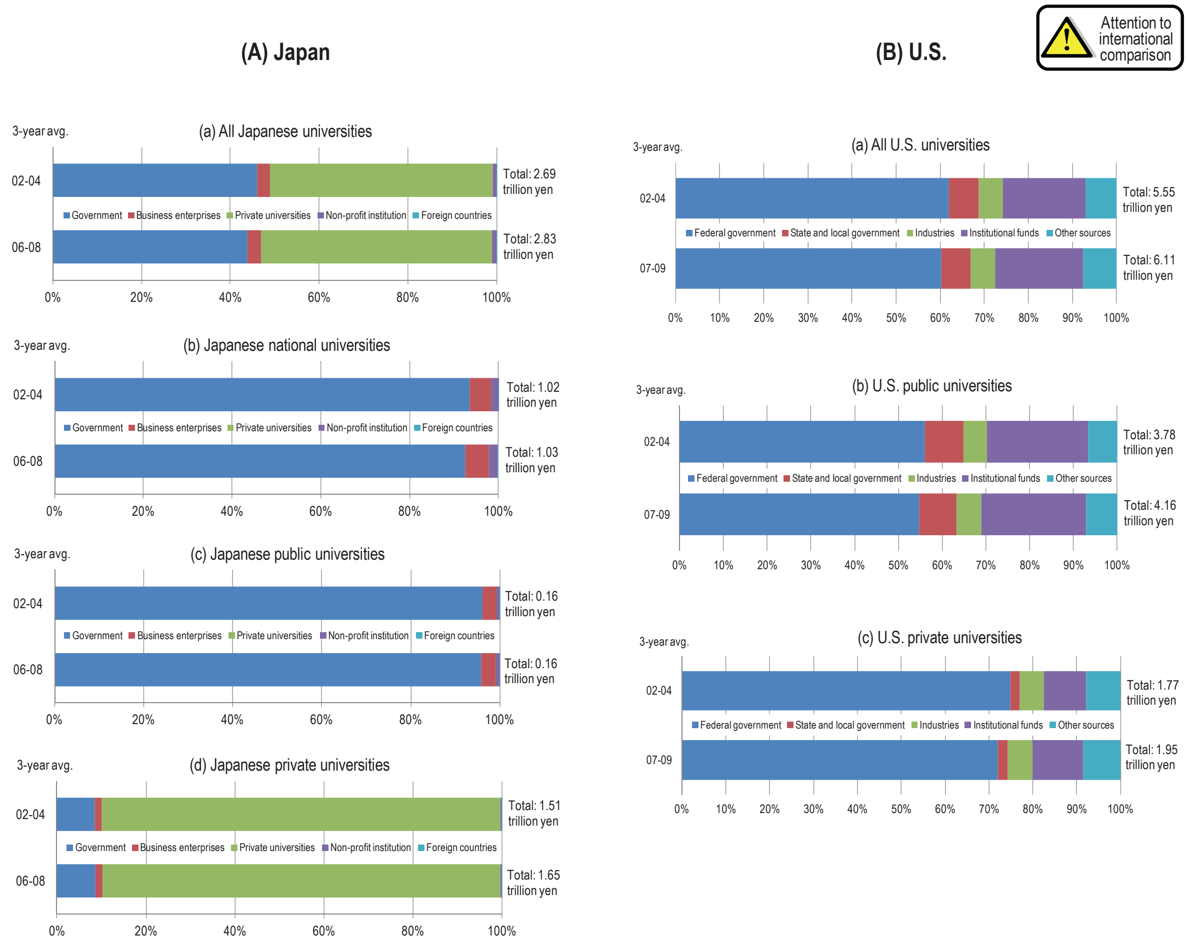
Next, the funding structures of universities and colleges in Japan and the U.S. and changes therein will be examined.

Chart 1-3-13(A) shows the funding structures for Japanese universities (four-year universities) according to type, i.e., national, public and private universities. At national and public universities, more than 90 % of funding comes from government. Little funding comes from business enterprises or other sectors. Looking at the share for national universities in 2006–2008, government funding accounted for 92.5% of funding. This was a decrease of 1.1 percentage points from 2002–2004.

As for private universities in 2006–2008, 89.5% of funding for R&D expenditures came from private universities, indicating that their R&D is mostly self-funded. Funds from government accounted for 8.6% during 2006–2008, an increase of 0.1 percentage points from 2002–2004. There was very little funding from the business enterprise sector, which accounted for only 1.5%.

Chart 1-3-13(B) shows the R&D expenditure funding structure of U.S. universities and colleges divided into public and private universities and colleges. In the U.S. during 2007–2009, shares of funding from federal, state and local governments were large, 63.3% at public universities and colleges and 74.2% at private universities and colleges. In contrast, the shares from institutional funds (funds of unspecified purpose that come from business enterprises, foundations, and other outside funding sources; this includes indirect costs of projects) were higher at public universities and colleges (24.0%) than at private universities and colleges (11.7%).

Chart 1-3-13: Funding structures for universities and colleges in Japan and the U.S.



Notes: See Chart 1-3-11 for caution on international comparison.
<U.S.> 1) Institutional funds are funds of unspecified purpose that come from business enterprises, foundations, and other outside funding sources. This includes indirect costs of projects.
2) Other funding refers to other unclassified sources. It includes, for example, funds donated by individuals for research use.

Sources: <Japan> Recalculated by NISTEP from individual data in Ministry of Internal Affairs and Communications, "Report on Survey of Research and Development"
<U.S.> NSF, "Academic R&D Expenditures"

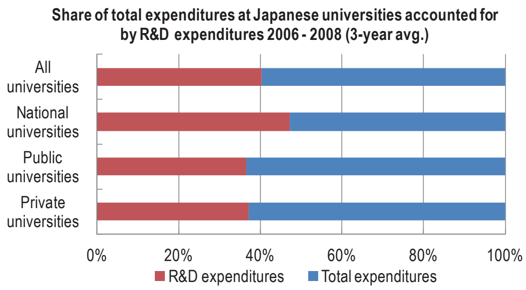
(4) Comparison of share of R&D expenditures in total operating costs at Japanese and U.S. universities and colleges

The shares of total operating costs (total expenditures) at Japanese and U.S. universities and colleges accounted for by R&D expenditures were compared. Three-year averages from 2006 through 2008 at degree-granting four-year universities and colleges in Japan and the U.S. were used.

In Japan's case, data on total expenditures and R&D expenditures from R&D statistics by the Ministry of Internal Affairs and Communications were used. Looking at Chart 1-3-14, R&D expenditures accounted for 40.3% of total expenditures at all universities. By type of university, the highest share was at national universities with 47.1%, while public universities are at 36.5% and private universities at 37.3%.

Chart 1-3-14: Share of total expenditures at Japanese universities accounted for by R&D expenditures

(A) Percentage



(B) Amount

2006-2008 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥7.0 trillion	¥2.8 trillion	40.3%
National universities	¥2.2 trillion	¥1.0 trillion	47.1%
Public universities	¥0.4 trillion	¥0.2 trillion	36.5%
Private universities	¥4.4 trillion	¥1.6 trillion	37.3%

Note: Four-year universities and colleges; junior colleges and university joint-use facilities, etc., are not included.
Source: Ministry of Internal Affairs and Communications, "Report on Survey of Research and Development"

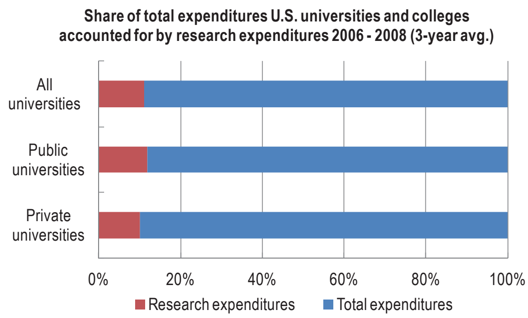
In the case of the U.S., the NSF's R&D statistics do not include total operating costs (total expenditures) at universities and colleges, so National Center for Education Statistics (NCES) IPEDS data was used. IPEDS is a database on postsecondary education (including higher education) in the U.S. It has data on total expenditures and research expenditures, so those figures were used for comparison with Japan. Research-related budget items that cannot be clearly differentiated from instructional or other purposes are counted as instruction expenditures by IPEDS. This results in the underestimation of research expenditures. This results in the underestimation of research expenditures. In addition, IPEDS also includes "academic support," including running costs of computer center and library, as a category. Some research-related expenditures may be included in that category as well. IPEDS statistics for research expenditures and other categories include salaries and wages, so personnel costs are included in the figures.

Looking at Chart 1-3-15, the share of all expenditures accounted for by research at all universities and colleges was 11.2%. At public universities and colleges, it was 11.9%, and at private universities and colleges, it was 10.1%.

Comparing Japan and the U.S., R&D expenditures account for 40% of total operating costs at Japanese universities and 10% at U.S. universities and colleges. In both Japan and the U.S., R&D expenditures account for higher shares at public universities. R&D at Japanese national universities accounts for about four times as large a share as it does at U.S. public universities and colleges.

Chart 1-3-15: Share of total expenditures at U.S. universities and colleges accounted for by research expenditures (IPEDS data)

(A) Percentage



(B) Amount

2006-2008 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥42.9 trillion	¥4.8 trillion	11.2%
Public universities	¥25.6 trillion	¥3.0 trillion	11.9%
Private universities	¥17.3 trillion	¥1.7 trillion	10.1%

Note: These are four-year universities and colleges (four-year institutions). In the case of some for-profit private universities and colleges, figures for public service are included in the calculation of research expenditures. However, these figures account for only about 0.03% of research expenses at all private universities and colleges.
Sources: NCES, IPEDS, "Digest of Education Statistics"

Next, U.S. universities' R&D expenditures according to the NSF will be used for comparison in place of IPEDS research expenditures.

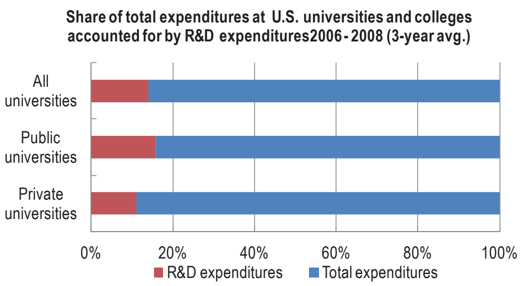
The NSF's R&D statistics cover universities and colleges with annual R&D expenditures of at least 150,000 dollars. There are a little under 700 such universities and colleges in the U.S. The NSF total is still about 1 trillion yen higher than for IPEDS' research expenditures, which cover about 2,774 universities and colleges (including about 672 public universities and colleges). As noted above, this must be because IPEDS' research expenditures are under-estimated. Furthermore, because the universities and colleges that the NSF does not include each have R&D expenditures of less than 150,000, their total contribution is small. A comparison between the NSF's R&D expenditures and IPEDS' total expenditures therefore seems rational.

Looking at Chart 1-3-16 in this case, the share of total expenditures at all universities and colleges accounted for by R&D expenditures is 14.0%. By type of institution, the share is 15.9% at public universities and colleges and 11.1% at private universities and colleges.

The NSF's survey was conducted under the condition that the R&D expenditure category does not include anything that cannot be differentiated from categories such as instruction.

Chart 1-3-16: Share of total expenditures at U.S. universities and colleges accounted for by R&D expenditures (NSF data)

(A) Percentage



(B) Amount

2006-2008 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥42.9 trillion	¥6.0 trillion	14.0%
Public universities	¥25.6 trillion	¥4.1 trillion	15.9%
Private universities	¥17.3 trillion	¥1.9 trillion	11.1%

Note: These are four-year universities and colleges (four-year institutions).
Sources: Total expenditures: NCES, IPEDS, "Digest of Education Statistics"
R&D expenditure: NSF, "Academic R&D Expenditures"

In the case of Japanese universities, R&D expenditures are overestimated because they include personnel costs for researchers (faculty, medical staff and other researchers) without regard to the percentage of time they spend on research. Using the OECD's R&D expenditures that corrects labor costs by adjusting them by the percentage of time devoted to research reduces the figure by about 40%. Even so, R&D expenditures account for about 30% of total expenditures.

Even with these attempted corrections, there are large differences related to total operating costs and R&D expenditures in Japanese and U.S. universities and colleges. There are still points that need to be examined in order to carry out a proper comparison of R&D expenditures in Japanese and U.S. universities and colleges (Chart 1-3-17).

Chart 1-3-17: Comparison of statistics on R&D expenditures at Japanese and U.S. universities and colleges

	Name of statistical survey	How R&D expenses are measured	Researcher personnel costs	Scope of academic fields
Japan	Ministry of Internal Affairs and Communications, “Report on Survey of Research and Development”	In addition to research activity by researchers, also includes all necessary related support work, e.g., office work such as general affairs and accounting, cleaning of research facilities and security.	1) and 2) below are added. 1) Personnel costs for researchers, research assistants and technicians are their total remuneration including that for non-research work (e.g., instruction-related work). 2) Personnel costs for clerical support staff and other related workers are that portion of their remuneration that applies to research-related work.	All fields (natural sciences, humanities, social science and other)
U.S.	NCES, “IPEDS” (educational statistics)	Expenditures that cannot be clearly differentiated as research expenses are classified as instructional expenses.	Personnel costs (“Salaries and wages”) are indicated as an item of research expenditure.	All fields (all fields at all universities are likely included for educational statistics)
	NSF, “Survey of Research and Development Expenditures at Universities and Colleges”	Expenses separately budgeted for R&D in science and engineering (including indirect expenses) as at right are counted.	Unknown. (There are no separate data on university R&D expenditures, so it is not known how personnel costs are handled.)	Science and engineering (social sciences are included, but not humanities, education, etc.)

Source: <Japan>Ministry of Internal Affairs and Communications, “Report on Survey of Research and Development”
<U.S.> NCES, IPEDS
NSF, “Survey of Research and Development Expenditures at Universities and Colleges”

Column: The status of U.S. universities and colleges' revenue and expenditures

Chart 1-3-18 shows revenues and expenditures of U.S. colleges and universities. Looking at revenue by source during 2006–2008, tuition accounted for 27.7% of overall revenue for all universities and colleges. The next largest sources were state and local governments (19.2%), followed by the federal government (14.2%).

Breaking down universities and colleges by type, 30.2% of the revenue of public universities and colleges come from state and local governments, more than is received from tuition. At private universities and colleges, tuition accounted for a large share at 42.7%. The federal government also provided a large share at 14.7%. Compared with 2003–2005, investment income (or loss) accounted for a much smaller share. At private universities in particular, it shrunk from 21.6% to 0.5%.

Looking at expenditures by purpose, at 28.2%, expenditures on instruction account for the largest overall share for all universities and colleges. This is followed by related support expenses at 24.0%, and research expenditures at 11.2%. At 9.8%, hospitals also account for a relatively large share.

The ratio between instruction expenditures and research expenditures at public universities and colleges is roughly 2:1. At private universities and colleges, in contrast, it is 3:1.

(Yumiko Kanda)

Chart 1-3-18: Financial status of U.S. universities and colleges

(A) Shares of revenue by source of fund

2006–2008 (3-year moving average)	Total revenue	Tuition	Federal government	State/local government	Investment income (loss)	Hospitals	Subsidiary enterprises	Other
All universities	100.0	27.7	14.2	19.2	1.1	10.6	8.8	18.4
Public universities	100.0	18.2	13.9	30.2	1.5	11.3	8.5	16.3
Private universities	100.0	42.7	14.7	1.6	0.5	9.5	9.2	21.8

(B) Shares of expenditure by purpose

2006-2008 (3-year moving average)	Total expenditures	Instructional expenditures	Research expenditures	Related support expenses	Subsidiary enterprises	Hospitals	Grants and scholarships	Other
All universities	100.0	28.2	11.2	24.0	8.6	9.8	2.1	16.1
Public universities	100.0	25.5	11.9	17.8	8.2	11.3	3.1	22.3
Private universities	100.0	32.1	10.1	33.2	9.3	7.7	0.6	7.0

Notes: 1) Data are for four-year universities and colleges (four-year institutions).
2) Data on grants and scholarships are for scholarships and fellowships at public universities and colleges and net grant aid to students at private universities and colleges.
3) Some for-profit private universities and colleges have no hospital category and are thus tabulated as zero.
Sources: NCES, IPEDS, "Digest of Education Statistics"

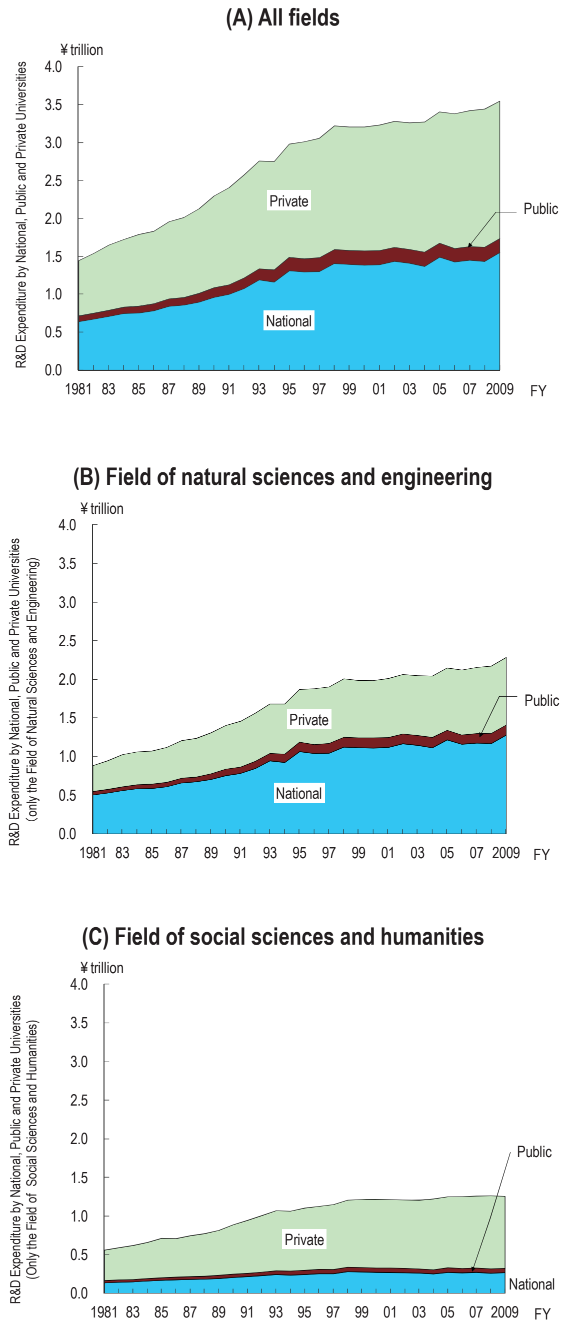
(5) R&D expenditure in the university and college sector in Japan

As stated above, it is necessary to be careful about the fact that the labor cost, which comprises a part of the R&D expenditure in the university and college sector in Japan, includes the cost for duties other than research. However, in this section, the R&D expenditure in the university and college sector by type, national, public or private, is examined in accordance with the data associated with R&D expenditure in universities and colleges. Published in the "Report on the Survey of Research and Development" (Chart 1-3-19).

R&D expenditure for the entire university and college sector in Japan in FY 2009 was approximately 3,549.8 billion yen, which was composed of approximately 2,289.3 billion yen for the field of natural sciences and engineering and approximately 1,260.5 billion yen for the field of social sciences and humanities, respectively. The shares of R&D expenditure by type of university versus the total in FY 2009 were 43.7% for national, 5.2% for public and 51.1% for private universities. Looking only at the field of natural sciences and engineering, the figures were 55.9% for national, 5.8% for public and 38.3% for private universities. For the field of social sciences and humanities, the shares were 21.5% in national, 4.2% for public and 74. 3% for private universities.

In summary, it was found that national universities accounted for large proportion of R&D expenditure in the field of natural sciences and engineering (natural sciences, engineering, agricultural sciences, medical sciences). On the other hand, private universities accounted for large proportion of R&D expenditure in the field of social sciences and humanities.

Chart 1-3-19: R&D expenditure by national, public and private universities

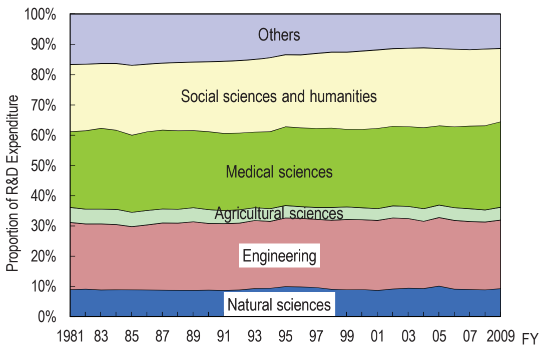


Note: "Social sciences and humanities" includes "Other."
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

Subsequently, the trend in the proportion of R&D expenditure in each field of study in universities and colleges, etc. is examined. The field of study represents the content of research conducted in faculties and research facilities. In a case where more than one field of study is included in an organization, the field which is considered central is used to represent the field of study of research.

Chart 1-3-20 shows that R&D expenditure of each field changes only slightly. It is difficult to understand actually what kinds of R&D are performed from this chart because the fields of study shown are classified only in accordance with the kinds of faculties, as mentioned above.

Chart 1-3-20: Trend of the proportion of R&D expenditure by field of study in universities and colleges



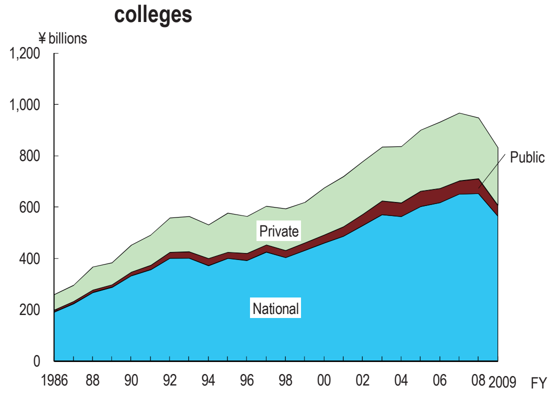
Note: Classification into the field of study represents a classification into the element of the organization, such as the faculty.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

In recent years, approaches trying to utilize the potential of universities are being enhanced in each country all over the world. It is true that universities are irreplaceable organizations for creating knowledge which is a source of innovation; however, transferring the knowledge generated by universities is not easy. The time is ripe to strongly enhance the cooperation between industry and academia, given the background mentioned above.

As an index to indicate the status of the cooperation between industry and academia, R&D expenditure which the university and college sector received from the business enterprise sector is examined (Chart 1-3-21). R&D expenditures received by universities and colleges from the business enterprise sector showed a sharp increase since FY 1999, but they decreased in FY 2008 and FY 2009. In FY 2009, they were 83.3 billion yen (down 12.2% from the previous year). During FY 2009, they accounted for only 2.3% of the total intramural R&D expenditure of universities (approximately 3,549.8 billion yen).

Among national, public and private universities, the proportion of R&D expenditure provided by the business enterprise sector in national universities was the highest at 70%, and this proportion has remained nearly unchanged.

Chart 1-3-21: Trend of the ratio of R&D expenditure from the business enterprise sector against the total intramural R&D expenditure in universities and colleges



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

(6) R&D expenditure by item of expense in the university and college sector for Japan

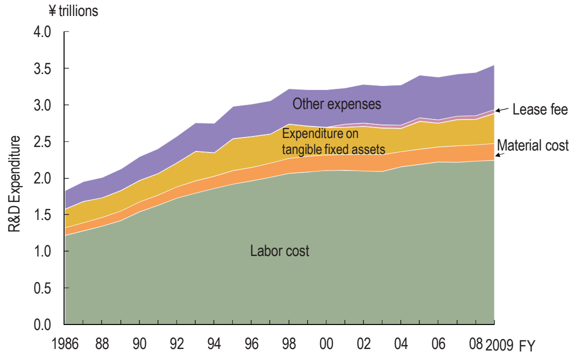
With regard to the breakdown of intramural R&D expenditure in universities and colleges by item of expense, the proportion of "labor cost" is large. The "labor cost" in FY 2009 was approximately 2,245.9 billion yen at 63.3% of the total (Chart 1-3-22).

Comparing national and private universities, labor costs accounted for about 50% of the total at national universities, where their share has been decreasing over the long term. In the field of natural science and engineering at national universities, labor costs once accounted for about 60% of the total, but their share has shrunk to around 50%.

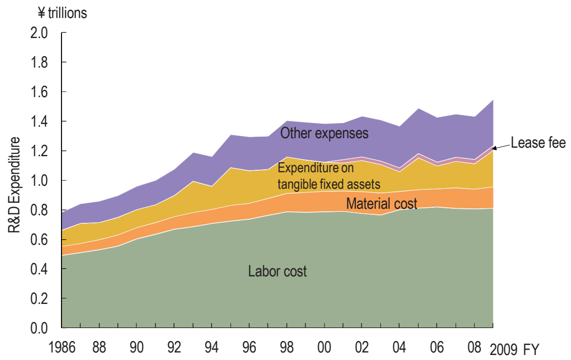
Labor costs at private universities were large at about 70%. However, since the field of social sciences and humanities comprises the largest part of private universities, if only the field of natural sciences and engineering is focused upon, total R&D expenditure is reduced by half, with labor costs accounting for about 60% of the reduced total.

Chart 1-3-22: R&D expenditure by item of expense in universities and colleges

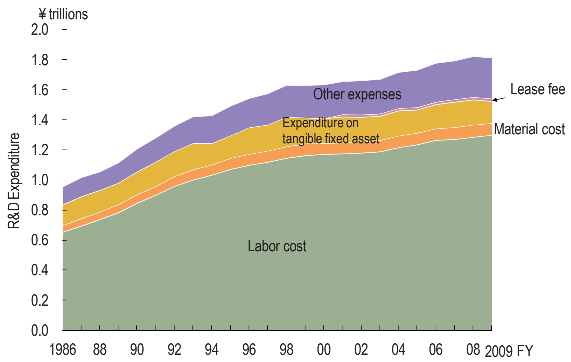
(A) Total



(B) National universities



(C) Private universities



Note: "Lease fee" was added to items for survey since FY 2001.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

1.4 R&D expenditure by type of R&D

Key points

○The expression R&D expenditure by type of R&D is a classification of R&D expenditure into that for basic research, applied research, and development. In Japan, however, this classification has been made only for the field of natural sciences and engineering.

○Out of R&D expenditure in FY 2009 for Japan, the proportion of that for basic research was 15.0%, and a large proportion, or 51.3%, of the total was used in the university and college sector.

○Among the countries studied, in France, the proportion of R&D expenditure for basic research in the latest available year was the largest at 25.4%. In contrast, the proportion of R&D expenditure for the basic research was smallest in China at 4.7%. Breaking down basic research expenditures, the university and college sector accounted for the largest share in France, the U.S. and Japan, the public organization sector accounted for the largest share in China, and the business enterprise sector accounted for the largest share in South Korea.

1.4.1 R&D expenditure by type of R&D

The expression R&D expenditure by type of R&D represents the intramural R&D expenditure roughly classified into that for basic research, applied research and development. This classification is in accordance with the definition in the “Frascati Manual” by the OECD which each country has adopted. Therefore, the influence caused by responders’ subjective estimates should be taken into account. The summary of the definition of characters of work in the “Frascati Manual” is as follows.

Basic research is exploratory and theoretical work mainly in order to obtain new knowledge on the causes behind phenomena and observable facts without considering any specific application or use.

Applied research is also an original exploration in order to obtain new knowledge. It is, however, mainly for certain actual purposes or objectives.

(Experimental) development is systematic work in which existing knowledge obtained by research or actual experiments is applied, for the purpose of producing new materials, products and devices, introducing new procedures, systems and services, or practically revising what has already been produced or introduced.

Each country seems to measure the data in accordance with the definition above, but the expressions used are somewhat different depending on country. For example, “experimental development” is expressed as “development” in the U.S. but as “development experimental” in France, explicitly including experimental work.

Germany has not publicly announced precise data for R&D expenditure by type of R&D, and does not have any such data for the university and college sector. But measured data for R&D expenditure by type of R&D in the business enterprise sector has been published since 2001 (through the data of OECD). Also, the U.K. does not have data for R&D expenditure by type of R&D in the university and college sector. Therefore, it is impossible to measure the total R&D expenditure by type of R&D.

Japan's R&D expenditures by type of R&D(8) measures only the field of natural science and engineering, not total R&D expenditures. The same was true of South Korea through 2006, but since 2007, all fields have been covered.

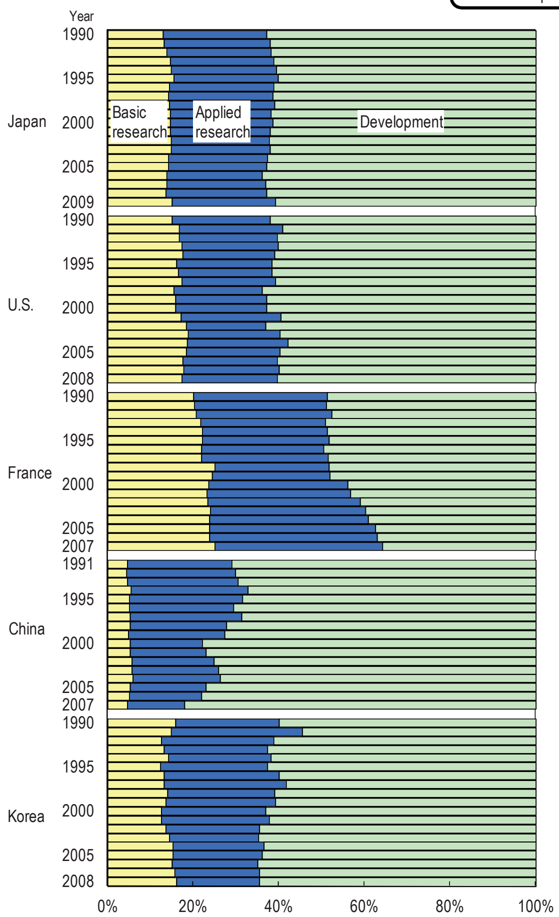
8 The definition of R&D expenditure by type of R&D in Japan’s survey of R&D expenditure, the “Survey of Research and Development” is as follows, and only the field of science and engineering is covered.
Basic research: theoretical or experimental research in order to create hypotheses and theories or to obtain new knowledge on phenomena or observable facts, without considering a certain application or use.
Applied research: research to determine the potential of the practical use of knowledge which was discovered by basic research in order to achieve certain objectives; research to explore additional application methods with regard to methods which are already in practical use.
Development: research to introduce new materials, devices, products, systems, procedures, etc. and to revise those which already exist, by using basic research, applied research and knowledge obtained by actual experience.

Chart 1-4-1 shows the proportion of development by type of R&D. Basic research accounted for 15.0% of all R&D expenditures by type in Japan during FY 2009. Over the long term, there has been little change. In the U.S. as well, there has been little change over the long term.

Looking at R&D expenditures by type for the most recent year available in each country, France is the country where basic research accounts for the largest share, at 25.4% of the whole. Basic research's share is smallest in China, at 4.7% of the total. Development accounts for a significant share in every country, most notably in China. Over the long term, development's share has been increasing in South Korea.

Chart 1-4-1: Trend of the proportion of R&D expenditure by type of R&D in selected countries

Attention to international comparison



Note: 1) In Japan (and Korea until 2006), R&D expenditure covers only the field of natural and engineering. But R&D expenditure in other countries is the total of that for the field natural sciences and engineering and for social sciences and humanities. Therefore it necessary to be careful when an international comparison is being made.
2) Figures for Germany are for basic research only.
3) Purchasing power parity equivalent is the same as that for Reference statistics E.
<Japan> Fiscal year is used as a year scale.
<U.S.> Values in 2007 is of preliminary.

Source: <Japan>The Ministry of Internal affairs and communications, "Report on the Survey of Research and Development".
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<France, China>OECD, "Research & Development Statistics 2010"
<Korea>Korea National Statistical Office, Statistical DB (web site)

1.4.2 Basic research in each country

Next, we examine which sector is in charge of basic research in each country.

According to the trend of the proportion of basic research expenditure by performing sector (Chart 1-4-2), the university and college sector accounts for a large proportion in almost all the selected countries. Especially in France, approximately 66.2% of the total is used by the university and college sector.

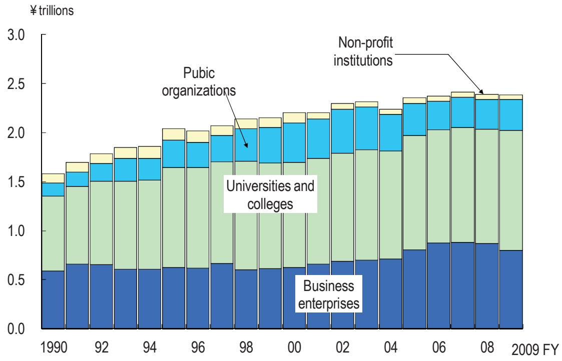
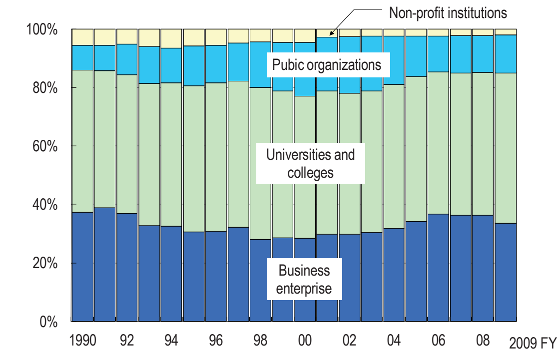
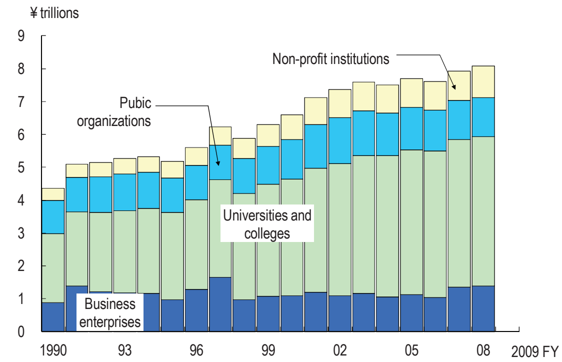
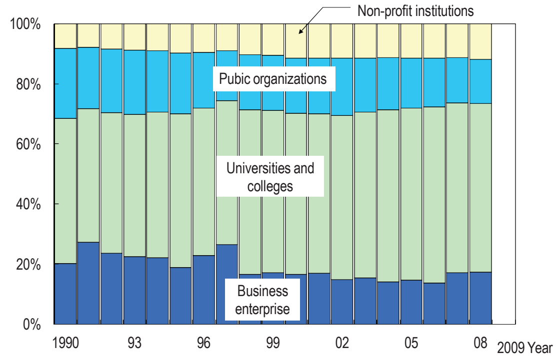
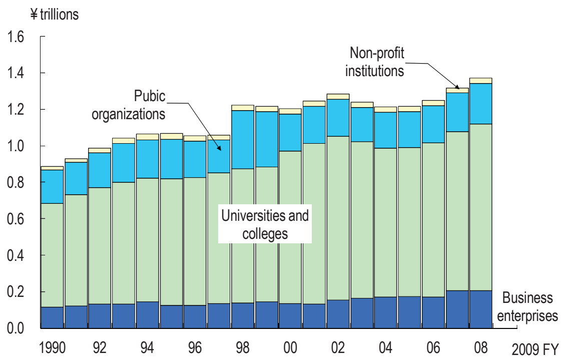
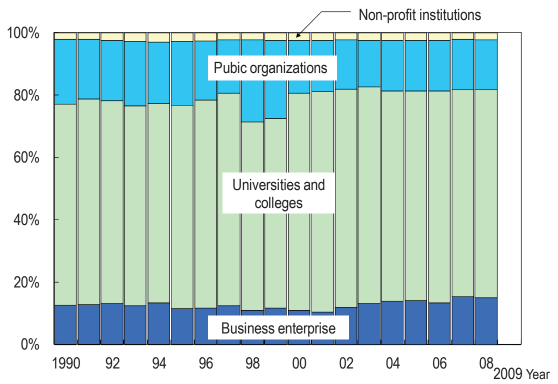
In Japan, the university and college sector accounts for a large share, at 51.3%. The business enterprise sector also accounts for a relatively large share. This proportion is even higher in Korea, where the business enterprise sector has rapidly grown to become the center of basic research since 2000.

The country in which the public organization sector accounts for the largest proportion of basic research expenditure is China. With regard to France, discrepancies were found in the data of the public organization sector in 1998 and 1999. This was caused by a change in the method for estimating and a change in survey response slips, and so it is better to consider that the continuity of data during this period was interrupted.

In the U.S., the proportion of R&D expenditure in the business enterprise sector against the total basic research expenditure has been reducing in recent years, while that in the university and college sector is on the rise instead. Compared to other countries, the amount in the non-profit institution sector is also increasing.

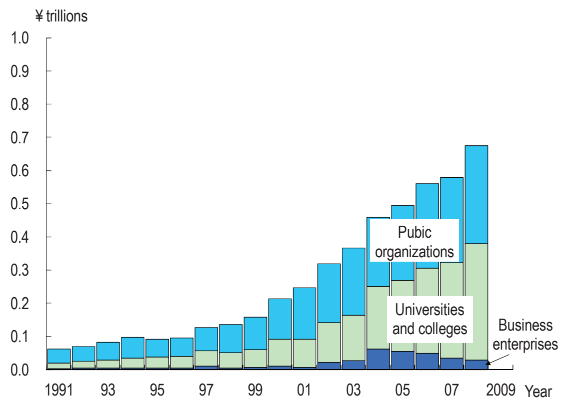
Chart 1-4-2: Basic research expenditure by sector in selected countries

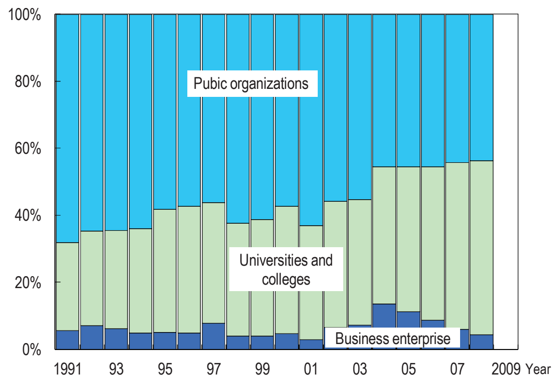
Attention to international comparison

	Expenditure (Yen PPP)	Proportion of expenditure by sector
(A) Japan		
(B) U.S.		
(C) France		

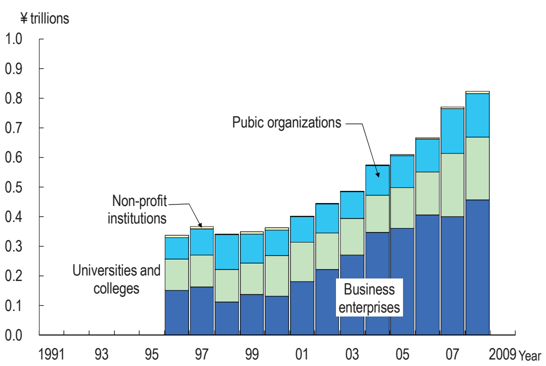
Expenditure (Yen PPP) / Proportion of expenditure by sector

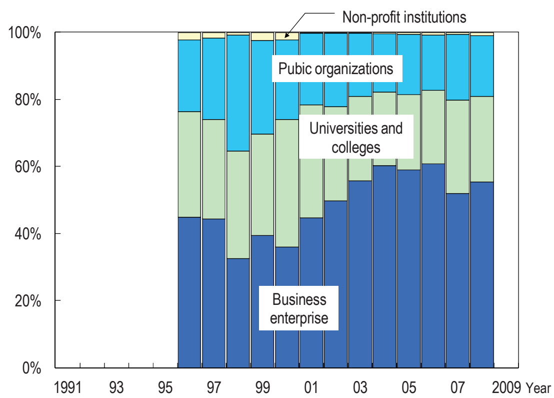
(D) China





(E) Korea





Note: 1) In Japan (and Korea until 2006), R&D expenditure covers only the field of natural sciences and engineering. But R&D expenditure in other countries is the total of the field of natural sciences and engineering and of social sciences and humanities. Therefore it is necessary to be careful when international comparisons are made.
2) Purchasing power parity equivalent is the same as for Reference statistics E.
<U.S.> Values in 2007 are preliminary .

Source: <Japan> The Ministry of Internal Affairs and Communications. "Report on the Survey of Research and Development"
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<France, China and Korea>OECD, "Research & Development Statistics 2010"

Chapter 2 : R&D personnel

Human resources, which are the basis for supporting scientific and technological activities, will be discussed here. In this chapter, R&D personnel, and more specifically, the status of researchers and research assistants in Japan and in selected countries will be explained. Concerning the present available data on the number of researchers, there are differences in definition of a researcher, and the methods of measurement applied are not unified across each country. Therefore, it could be said that this data is not suitable for strict international comparison. But even so, this data can be used to understand the condition of R&D personnel in each country if it is born in mind that there are differences in the scopes and levels of researchers in each country.

2.1 International comparison of the number of researchers in each country

Key points

- ○The definition and measurement of researchers in each country are conducted in line with the Frascati Manual. However, the actual methods used for the investigations are often different in each country. In particular, the university and college sector are excluded from the coverage of R&D statistical surveys in some countries. Also some countries set special conditions regarding the scope of the range of the surveys. Also there are countries which apply the full-time equivalent (FTE) method in surveying the number of researchers. And there are other countries which apply actual head counting (HC) for this purpose. Therefore, it could be said that there are many contributing factors which reduce potential international comparability. In addition, in the U.S., the number of researchers belonging to some sectors is not reported to the OECD. This forces the OECD to utilize estimated figures as a substitute. For the reasons given above, it is necessary to be careful in making international comparisons and trend comparisons of the number of researchers.
- ○In 2010, the number of researchers in Japan was a total of about 660,000, if the number of researchers working at universities and colleges is calculated by using the FTE method. The number is about 890,000 in the head count method. In recent years, the number of researchers in China has greatly increased. But the number of researchers per capita still lags behind compared to the other selected countries.
- ○Comparing the number of researchers by sector, the business enterprise sector has the largest share in each country. In terms of female researchers by sector, on the other hand, the business enterprise sector accounts for only a small share in each country.
- ○Looking at researcher mobility by sector in Japan, there are more new-graduate hires than mid-career recruits in "Companies, etc.". There had been little change in the figures in recent years, but in 2010 new-graduate hires decreased. In "Universities and colleges, etc.", mid-career recruits have passed new-graduate hires. The figures have been flat in recent years. In every sector, intra-sector mid-career recruits have been increasing.

2.1.1 Methods for measuring the number of researchers in each country

According to the Frascati Manual issued by the OECD, “researchers” are defined as “professionals engaged in the conception or creation of new knowledge, products, processes, methods, and systems and engaged also in the management of the projects concerned [(1)]”.

(1) In Japan the definition of a “researcher” is based on the terms written on the “Report on the Survey of Research and Development” issued by the Ministry of Internal Affairs and Communications. In the statistics of this Ministry, the field of “research” is classified into “basic research”, “applied research”, and “development” and the “regular researchers” conducting such research are considered to be quite close to the “R&D scientists and engineers” mentioned in the Frascati Manual.

To measure the number of researchers, similar to the method adapted to measure R&D expenditure, a questionnaire survey is used in general, but for some sectors in some countries data obtained from other survey is used.

In addition, there are two kinds of methods used to measure the number of researchers. One method is to measure the research work by converting it into "full-time equivalents" (FTE)(2). In this case, R&D activities are separated from other activities and the number of hours engaged in actual R&D activity is used as the basis for measuring the number of researchers. This method is widely accepted internationally, in which by giving consideration to the activities of the researchers, the measurement of the number of researchers is performed by deducting the time consumed for other activities besides R&D activity(3).

(2) For example, for researchers working at higher educational institutes such as universities and colleges, there are many cases when they are engaged in education together with their research work. The way to measure the manpower of the portion of activities engaged in actual research work rather than treating above mentioned kinds of researchers (called "part-time researchers") as the same level as "full-time researchers" is called the "full-time equivalent". Specifically, for example, if a researcher dedicates 60% of his/or her working time to R&D activities on annual basis, the value for this person as a researcher would be "0.6 people".

(3) In 1975, the OECD issued a recommendation that the full-time equivalent method should be applied to measure the manpower of researchers who are hired. The majority of OECD member countries have adopted the FTE method. The necessity of the FTE method and its principles are provided in the Frascati Manual issued by the OECD, which also provides international standards on the surveying methods for R&D statistics. The 2002 edition advises using both the HC and FTE methods.

The other method is to classify all activities as R&D activities, even when the research content of work is combined with other activities, and to measure the number of researchers according to the actual number found by head counting (HC).

Chart 2-1-1 shows the definition and measurement method of researchers for 4 sectors which are the same as the performing sectors of R&D expenditure in each country (The data for each country was measured by FTE conversion. And indication is given in the exceptional cases where the HC value was utilized.). All the countries conduct their measurements of researchers according to the questionnaire survey as indicated in the Frascati Manual issued by the OECD and based on its definition of researchers. But in some sectors, questionnaire surveys were not performed or the FTE value measurements were not carried out, which caused the differences by country and by sector. In particular, differences can be seen according to the country regarding the measurements of researchers working in the university and college sector.

Chart 2-1-1: Definition and measurement method of researchers by sector in each country

Country	Business Enterprise Sector	University and College Sector	Public Organization Sector	Non-profit Institution Sector
Japan	People who completed any undergraduate course (except for junior college cources)	(1) Teachers (HC) (2) Doctoral course students (HC) (3) Medical staff and others (HC)	People who completed any undergraduate course (except for junior college courses)	
	People who meet the above mentioned conditions or possess the equivalent or higher specialized knowledge, and conducting research on a special theme			
U.S.	Scientists and engineers mainly engaged in research	* Measured by independent surveys (HC) (1) Scientists and engineers with doctoral degree. (2) 50% of Doctoral course students who are given economic assistance	* Measured in accordance with existing personnel data (HC) Scientists and engineers who are mainly engaged in research.	Scientists and engineers possessing doctoral degrees (HC).
Germany	Staff who conceptualize or create new knowledge, products, manufacturing procedures, methods and systems. Persons in charge of the department of administration are included. Generally equivalent to scientists and engineers who graduated any university (comprehensive universities, technical universities and technical colleges)	* Measured in accordance with the statistics of education (HC) (1) Teachers × FTE coefficient of field of study × FTE coefficient of research time (2) Doctoral course students receiving economic assistance	Researchers	
France	(1) Researchers (2) Research technologists (3) Recipients of scholarship for preparing any doctoral thesis who are given reward for the work of research			
U.K.	Researchers	* Measured in accordance with existing personnel data	Researchers	Researchers
China	Scientists and enginees who are mainly engaged in research.			
Korea	Recipients of at least a doctoral degree who are engaged in R&D activities.	(1) Teachers with the position of full time lecturer or higher (2) doctoral course students (3) Recipients of at least a doctoral degree who are conducting surveys at any university research institute.	Recipients of at least a doctoral degree who are engaged in R&D activities.	
	People engaged in reseach activities who meet above mentioned conditions or possess the equivalent or higher specialized knowledge as those.			

Notes: 1) The data is in accordance with statistical surveys of R&D except for data marked with * which is obtained from a source other than statistical surveys of R&D.
2) Measurements are conducted on the basis of FTE in statistical surveys of R&D in each country. The cases in any sector in which FTE is not adopted are marked with (HC).
3) (2)Expression "doctoral course student" in the university and college sector in Japan represents those in the later term (the 3rd to 5th year).
4) With regard to the university and college sector in the U.S., the FTE of researchers is obtained by adding (1)50% of doctoral course students who are financially assisted.
5) In Germany, the public organization sector and the non-profit institution sector are combined. With regard to the university and college sector, the FTE of researchers is obtained by multiplying the HC of teachers by FTE coefficients.
6) Expression solely used "researchers" represents that any definition and measurement method of researchers was not obtained in the sector.
7) For the U.S., the 1999 method of counting researchers is used.
Source: NISTEP, "Metadata of R&D-related statistics in selected countries: Comparative study on the measurement methodology"(2007 October);
Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

In Japan, the number of researchers has been measured in R&D statistics (Survey of Research and Development) by the Ministry of internal affairs and communications. But it was not until 2002 that the FTE method was introduced to measure researchers.

Chart 2-1-2(A) shows the measurement method used until 2001, which was neither FTE nor HC, but a method of counting the number of the people as that of researchers in the column of researchers only if the corresponding cell of Column (1) was checked.

The measurement methods for 2002–2007 are shown in Chart 2-1-2(B). The number of researchers is obtained by counting the number of the people in the column for researchers by means of FTE if the corresponding cell in Column (2) is checked and by HC if the corresponding cell in Column (3) is checked, respectively.

Thus, three methods have been used to report the number of researchers in Japan. Since 2008, the FTE coefficient obtained through new FTE surveys is used (Chart 2-1-2 (C)).

Chart 2-1-2: Methods for measuring researchers in Japan

(A) Until 2001

Sector	Researchers	(1)
Companies etc	Researchers (regular)	○
	Researchers (external non-regular)	
Research Institutes (National and Public Institutes, Institutes run by Special corporations and by independent adminstrative corporations)	Researchers (regular)	○
	Researchers (external non-regular)	
Research Institutes (Private)	Researchers (regular)	○
	Researchers (external non-regular)	
Universities and Colleges	Researchers: (1) Teachers (2) Doctor's course students in graduate schools (3) Medical staff and others	○
	Researchers (external non-regular)	

(B) 2002–2007

Sector	Researchers		(2) (FTE)	(3) (HC)
Business Enterprises	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Public Organizations (Natinonal and Public Organizations, Special coporations and Independent Administrative Corporations)	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Non-profit Institutions	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Universities and colleges	Teachers	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.465)	
	Doctor's course students	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.709)	
	Medical staff and others	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.465)	
	Engaged in research under external and non-regular conditions	Number of people		○

(C) After 2008

Sector	Researchers		(2) (FTE)	(3) (HC)
Business Enterprises	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Public Organizations (Natinonal and Public Organizations, Special coporations and Independent Administrative Corporations)	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Non-profit Institutions	Mainly engated in research (number of people)		○	○
	Engaged in research under non-regular conditions	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○	
Universities and colleges	Teachers	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.362)	
	Doctor's course students	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.659)	
	Medical staff and others	Number of people		○
		Number of people obtained by multiplying the ratio of research related work against the total work.	○(0.387)	
	Engaged in research under external and non-regular conditions	Number of people		○

Notes: 1) (1) "People mainly engaged in research" not converted on R&D basis until 2001. (2) "People mainly engaged in research" and “people who are engaged in research under external and non-regular conditions and converted to FTE (FTE)" since 2002. (3) "People mainly engaged in research" and "people engaged in research under external and non-regular conditions (HC)" since 2002.

2) Values for the university and college sector are FTE coefficients.

(1) 2002–2007: An FTE is obtained by multiplying the corresponding number of people by a FTE coefficient. As FTE coefficient, the result of MEXT, “Survey on the data for full-time equivalents in universities and colleges” conducted by the Ministry of education, culture, sports, science and technology in 2002. For "medical staff and others", the FTE coefficient same as for "teachers" is used.

(2) 2008–: The results of the “Survey on the data for full-time equivalents in universities and colleges” conducted by MEXT in 2008 are used.

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

2.1.2 Trends in the numbers of researchers in each country

The number of Japan's researchers in 2010 was 660,000 (people) and its HC value was 890,000 (people) respectively. In 2008, Japan converted to using FTE to calculate the number of researchers. Data continuity between 2007 and 2008 is therefore impaired.

The number of researchers in the U.S. was publicly announced only up to 1999 for the university and college sector, and up to 2002 for the public organization sector and the non-profit institution sector. Therefore, the values estimated by the OECD have been used for the total number of researchers since 2000.

In Germany, statistical surveys for R&D are conducted in the business enterprise sector, the public organization sector and the non-profit institution sector. With regard to the university and college sector, however, the measurement is in accordance with the statistics on education, and the FTE value of researchers is estimated using full time equivalent coefficients by academic field of study. There is no significant change except for an increase in the number of researchers in 1991 because of the unification of East and West Germany in 1990.

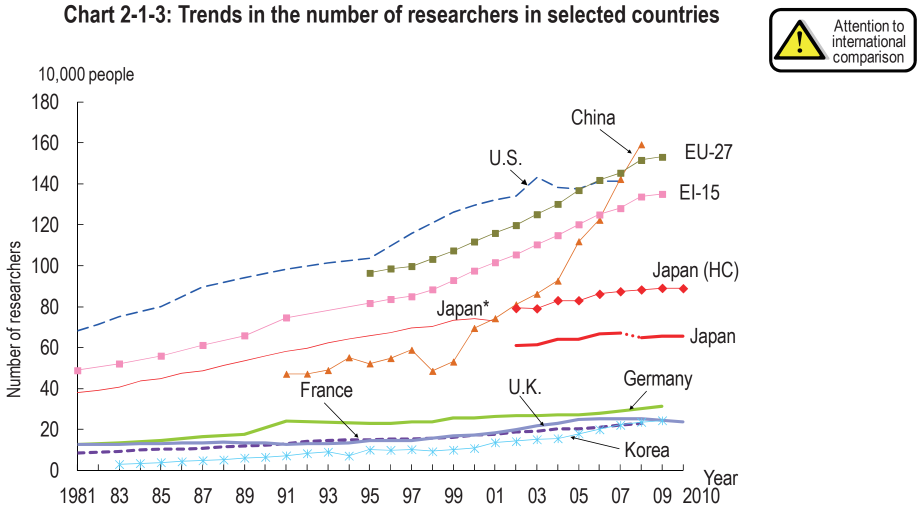
In France, the number of researchers is measured in accordance with statistical surveys for R&D which are conducted in all the sectors.

In the U.K., because no statistical survey for R&D is conducted in the university and college sector, the total number of researchers since 1999 was calculated using the estimates by the OECD. Recently, however, the U.K. has begun publishing the number of researchers. Figures have been available since 2005.

China publishes R&D statistics, but details of its statistical surveys are unknown. The number of researchers has surged since 1998 because of the rise in the number of researchers in the business enterprise sector, which surpassed that of Japan in 2002 and has remained more than that of Japan since then.

Korea conducts statistical surveys for R&D by sector. Through 2006, however, the target was limited to the "field of natural science and engineering". Since 2007, all fields have been covered. Therefore this condition should be born in mind. In recent years, the number of researchers passed that of France.

Chart 2-1-3: Trends in the number of researchers in selected countries



Notes: 1) The number of researchers in a country represents the total value of researchers in every sector, and the definition and measurement method for researchers in each sector is occasionally different depending on the country. Therefore it is necessary to be careful when international comparisons are being made.
2) Values for each country are FTE, except Japan, which showed both FTE and HC values.
3) The values include the number of researchers in the field of social sciences and humanities (until 2006, only that of the field of natural science and engineering for Korea).
<Japan>(1)Values until 2001 represent the numbers of researchers measured on Apr.1 and since 2002 represent the numbers of researchers measured on Mar.31 in the corresponding year, respectively.
(2) "Japan ∗ "represents the values in Chart 2-1-2(A)(1).
(The number of "people mainly engaged in research" without being converted on FTE basis. External non-regular researchers are not measured.)
(3) "Japan (HC)" represents the values in Chart2-1-2(B)(2).
(The total of "people mainly engaged in research" and "people engaged in research under non-regular conditions". The number of researchers in the university and college sector includes the above mentioned "external non-regular researchers").
(4) The FTE values of "Japan" through 2007 represent the values in Chart2-1-2(B).
(The measurement for the university and college sector is made with the conversion in accordance with the results of the "Survey on the data for full-time equivalents in universities and colleges" in 2002. With regard to the business enterprise sector, the public organization sector and the non-profit institution sector, "people mainly engaged in research" and "people engaged in research under non-regular condition whose values are converted on FTE basis" are measured.)
(5) FTE values for "Japan" from 2008 on are those shown in Chart 2-1-2 (C).
(The value for the ""universities and colleges" calculated using the 2008 "Survey on the data for full-time equivalents in universities and colleges," and

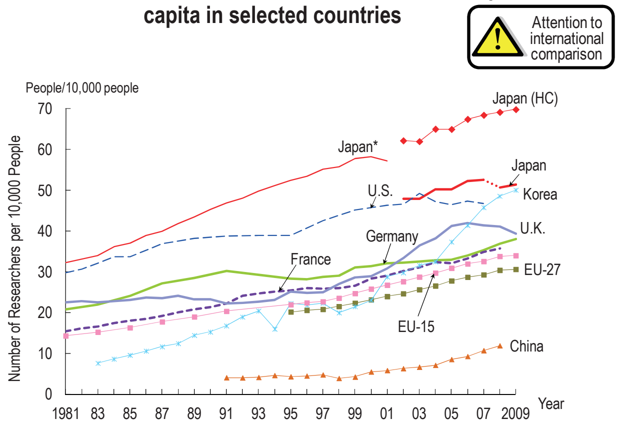
for "“business enterprises” and "public organizations and non-profit organizations” count "“people mainly engaged in research” and “people engaged in research under non-regular condition whose values are converted on FTE basis.”)
<U.S.> OECD secretariat estimate or projection based on national sources has been used since 2000.
<Germany>Former West Germany until 1990 and unified Germany since 1991 respectively.
<U.K.> OECD secretariat estimate or projection based on national sources has been used since 1999.
Source: <Japan>Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development ”;
MEXT, “Survey on the data for full-time equivalents in universities and colleges” (2002 and 2008)
<U.S.> NSF, “National Patterns of R&D Resources 1995, 1998, 2002 Data Update”; OECD, “Main Science and Technology Indicators 2010/2” for the data since 2000
<Germany> Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 1996, 2000, 2004”, "Forschung und Innovation in Deutschland 2007”, “Bundesbericht Forschung und Innovation 2008, 2010”; OECD, “Main Science and Technology Indicators 2010/2” for the data since 2008
<France, U.K., China, EU> OECD, “Main Science and Technology Indicators 2009/2”
<Korea>KISTEP, Statistical DB (website)

Next, an international comparison is conducted in which the influence of the size of each country is reduced by using the relative value of the number of researchers, in other words, the number of researchers per capita (Chart 2-1-4). As far as the period since 2002 is concerned, Japan’s values have been higher than those of the U.S., and approximately 2 times those in European countries. However, the FTE coefficient used for Japan was changed from 2007 to 2008, so data continuity is impaired.

The growth rate has been highest of all in Korea. It has been especially remarkable since 2004. European countries have shown a gradual increase over the long term.

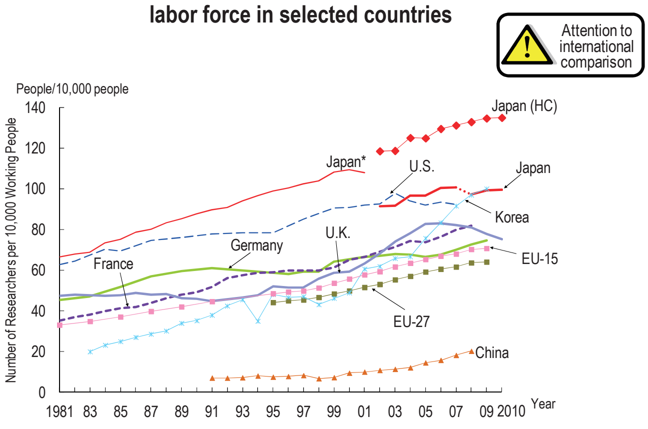
Also Japan’s values are high in terms of the number of researchers per labor force (Chart 2-1-5). The trend shows only a limited difference between the cases of the number of researchers per labor force and per capita, but in France the growth in the former case is on the rise recently.

Chart 2-1-4: Trends in the number of researchers per capita in selected countries



Notes: Refer to Chart 2-1-3 for the note on making international comparisons and the number of researchers. The population is the same as for Reference statistics A.
Source: Refer to Chart 2-1-3 for the note on making international comparisons and the number of researchers. The population is the same as for Reference statistics A.

Chart 2-1-5: Trends in the number of researchers per labor force in selected countries



Notes: Refer to Chart 2-1-3 for the note on making international comparisons and the number of researchers. The labor force is the same as for Reference statistics B.
Source : Refer to Chart 2-1-3 for the note on making international comparisons and the number of researchers. The labor force is the same as for Reference statistics B

2.1.3 Trends in the proportion of the number of researchers by sector in each selected country

The situation and trend over time with regard to the number of researchers are examined by sector, which are same as those in the classification of R&D expenditure, the "business enterprise sector", the "university and college sector", the "public organization sector" and the "non-profit institution sector".

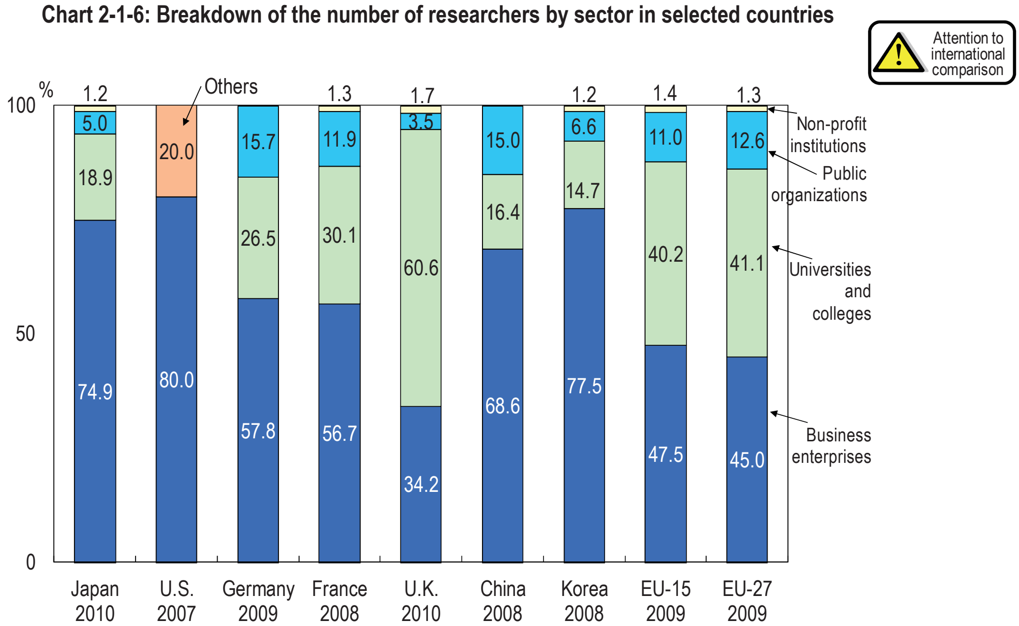
Although an international comparison of the number of researchers faces difficulties as mentioned in 2.1.1, in this section each country's characteristics are examined using the data which is available at the present time.

In each country except the U.K., the number of researchers in the business enterprise sector accounts for the largest proportion of the total, followed by that in the university and college sector, the public organization sector and the non-profit institution sector.

The proportion of researchers in the university and college sector is generally large in European countries and relatively small in South Korea and China (Chart 2-1-6).

In classifying the number of researchers by sector in order to break down the number of researchers (Chart 2-1-7), the number of researchers in the business enterprise sector was found to account for a large proportion in most countries. The increase in the number of researchers is largely due to the influence of the business enterprise sector. The rise in the number of researchers in the business enterprise sector is especially outstanding in newly developing industrial countries such as China and Korea. On the other hand, in the U.K., the increase in the business enterprise sector is not significant when compared to other countries. In addition, the number of researchers in the public organization sector is also reducing, which seems to be due to the transfer of a part of the public organization sector into the business enterprise sector.

Chart 2-1-6: Breakdown of the number of researchers by sector in selected countries

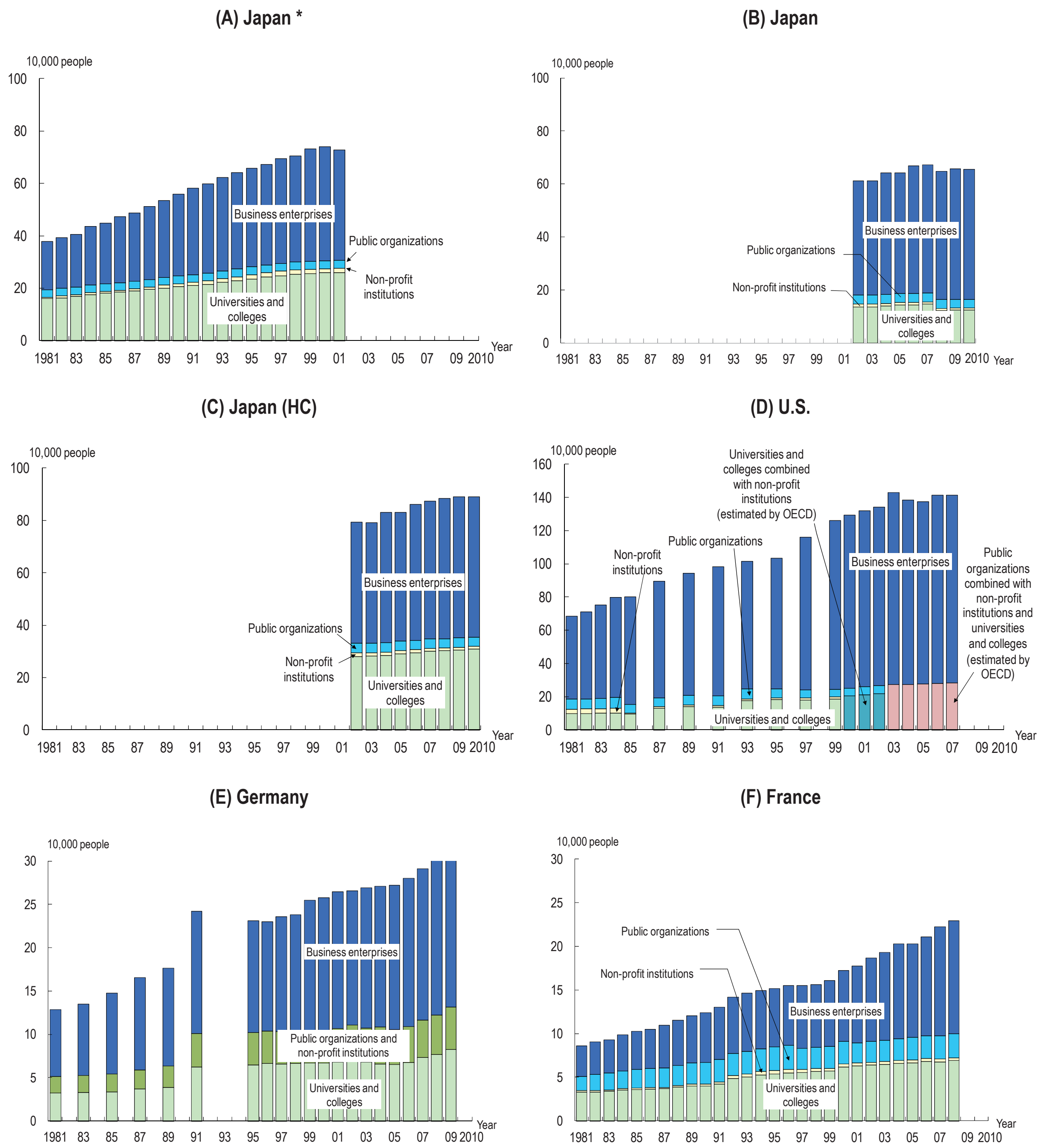


Notes: 1) Values for each country are FTE, except Japan, which is HC.
2) Data of the field of social sciences and humanities were also included.
3) The values in the non-profit institution sector for each country (other than Japan) were obtained by subtracting the number of researchers in the business enterprise sector, the university and college sector and the public organization sector from the total.

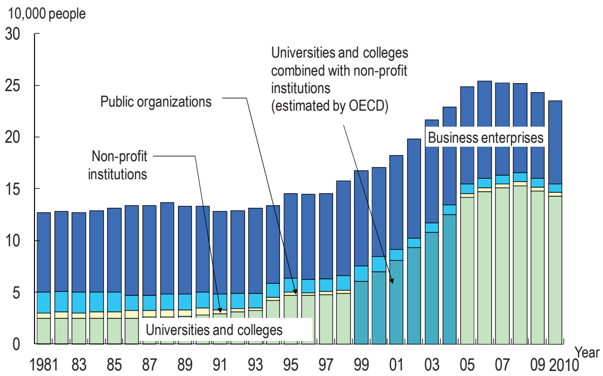
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; MEXT, "Survey on the data for full-time equivalents in universities and colleges" (2002 and 2008)
<U.S., Germany, France, U.K., China, Korea and EU> OECD, "Main Science and Technology Indicators 2010/2"

Chart 2-1-7: Trends in the number of researchers by sector

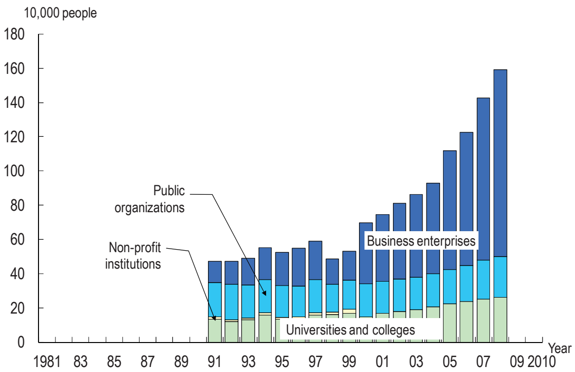
Attention to international comparison



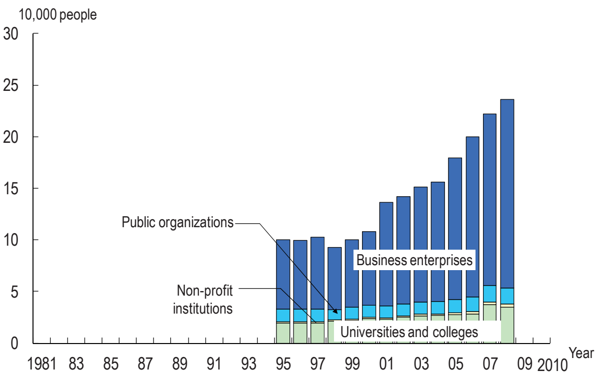
(G) U.K.



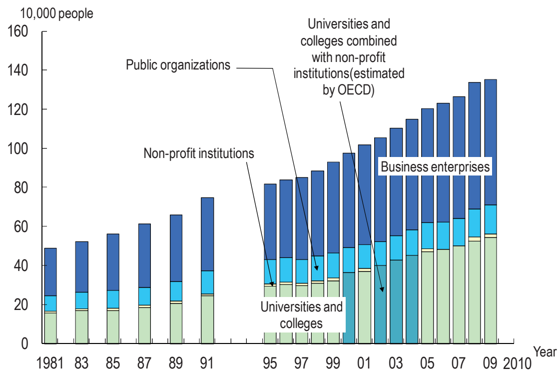
(H) China



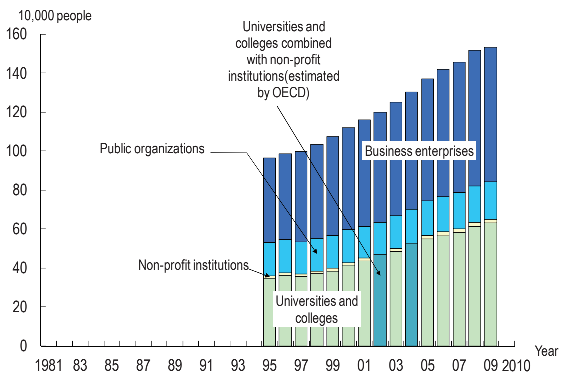
(I) Korea



(J) EU-15



(K) EU-27



Notes: 1) Refer to Chart 2-1-3 for the note on making international comparisons
2) Values for each country are FTE, except Japan, which is HC.
3) The values include the number of researchers in the field of social sciences and humanities (until 2006, only that of the field of natural science and engineering for Korea).
4) Refer to Chart 2-1-3 for the number of researchers in Japan.
5) The number of researchers in the university and college sector combined with the non-profit institution sector in the U.S. since 2000 was obtained by subtracting the number of researchers in both the business enterprise sector and the public organization sector from the total.
6) Germany represents the former West Germany until 1990 and unified Germany since 1991 respectively.
7) The number of researchers in the university and college sector in France, the U.K., China, Korea and EU since 1999 was obtained by subtracting the number of researchers in the business enterprise sector; public organization sector and the non-profit institution sector form the total.
8) Others of China represents the number of researchers was obtained by subtracting the number of researchers in the business enterprise sector, the university and college sector, the public organization factor and the non-profit institution factor from the total.
9) Others of EU represents the number of researchers was obtained by subtracting the number of researchers in the business enterprise sector, the university and college sector and the public organization sector from the total.

Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”; MEXT, “Survey on the data for full-time equivalents in universities and colleges” (2002 and 2008).
<U.S.> NSF, “National Patterns of R&D Resources: 1995, 1998, 2002 Data Update”; OECD, “Main Science and Technology Indicators (2009/2)” since 2000.
<Germany>Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 1996, 2000, 2004”; “Forschung und Innovation in Deutschland 2007” “Bundesbericht Forschung und Innovation, 2008, 2010”; OECD, “Main Science and Technology Indicators 2010/2)” since 2008.
<France, U.K., China, Korea, and EU> OECD, “Main Science and Technology Indicators 2010/2”

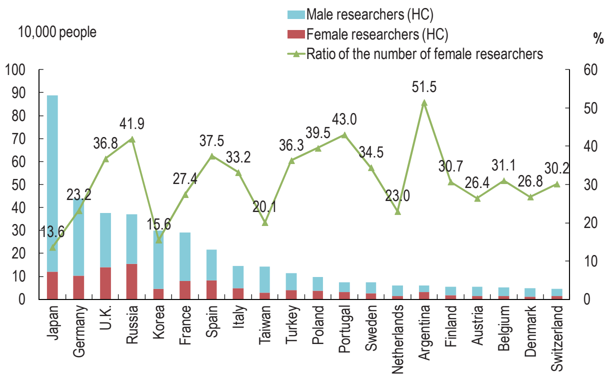
2.1.4 Female researchers in each country

In this section, the ratio of female researchers in each country is examined. The active role of female researchers is expected from the viewpoint of the diversity of researchers. Furthermore, promotion of the activities of female researchers is one of basic policies of the Science and Technology Basic Plans.

The ratio of the number of female researchers against the total was measured using HC values. No precise figures on the number of female researchers exist for the U.S. Figures for the U.K. are estimates by that country.

The ratio of the number of female researchers against the total in Japan was 13.6% in 2010. This ratio was the smallest among the surveyed countries, but the number place Japan third behind Russia and the U.K. (Chart 2-1-8).

Chart 2-1-8: Ratio of the number of female researchers against the total (comparison in HC values)



Notes: 1) Data are for 2010 in Japan, 2007 in Netherlands, Argentina, Austria, Belgium and Denmark, and 2008 in other countries and regions.
2) Values are on a head count basis.
3) Data for the U.S. and China are not included in materials below.
4) Continuity with values for previous years is impaired in the cases of South Korea, Spain, Portugal, Sweden and Denmark.
5) Value for the U.K. is as estimated by that government.
6) Value for Russia is underestimated or based on underestimated data.

Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”
<Others>OECD, “Main Science and Technology Indicators 2010/2”

What exactly is the difference in the proportion of the number of female researchers by sector in each country? The female ratio against the total by sector was examined for selected countries where the data was available (Chart 2-1-9).

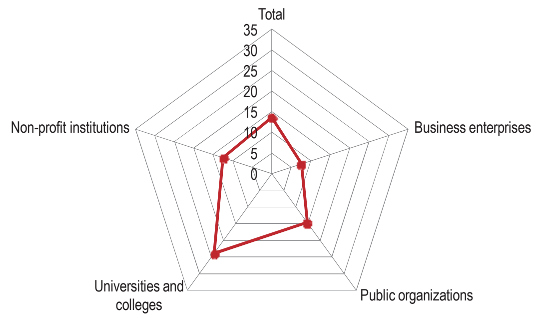
The data for the U.K. in the university and college sector is estimated. In Germany, the data of the public organization sector and that of the non-profit institution sector were combined.

In the business enterprise sector, the ratio of the number of female researchers was small in each country. On the other hand, the ratio in the university and college sector was relatively large, and that in the non-profit institution sector was remarkably large in size in the U.K. and Korea.

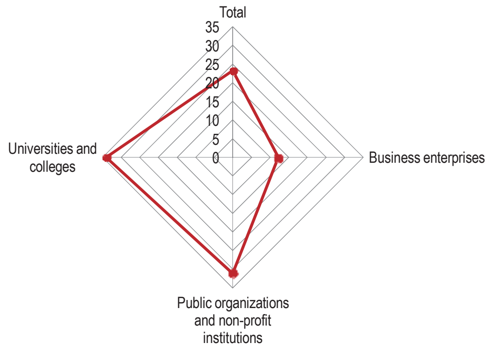
In Japan, the number of female researchers in the university and college sector accounted for the largest proportion of the total at 23.9% in 2010. This value was larger than that of Korea. The number of female researchers in the business enterprise sector was lowest, accounting for 7.6% of the total. In this connection, positive activities by female researchers in the business enterprise sector are required in the future.

Chart 2-1-9: The ratio of the number of female researchers by sector for selected countries

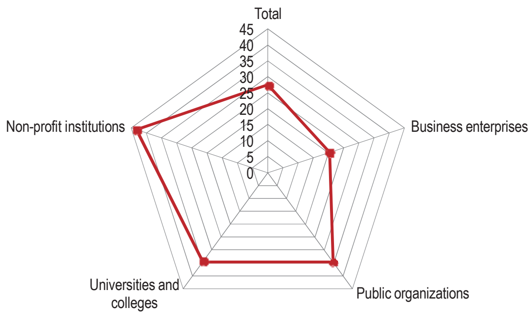
(A) Japan (2010)



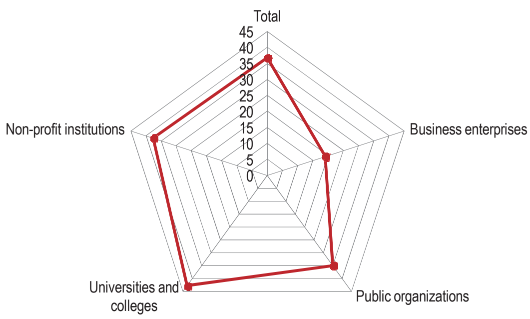
(B) Germany (2007)



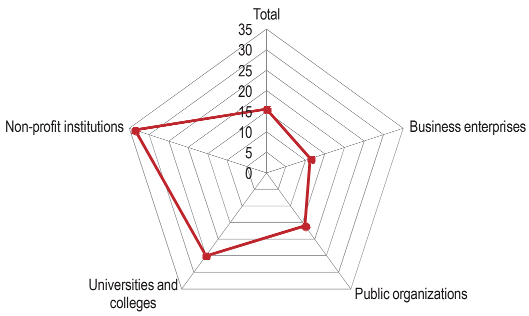
(C) France (2008)



(D) U.K. (2007)



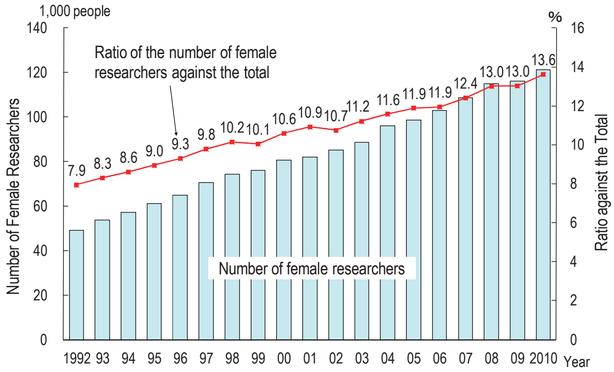
(E) Korea (2008)



Notes: Same as for Chart 2-1-7.
Source: Same as for Chart 2-1-7.

Next, the number of female researchers in Japan and their ratio to the total number of researchers was examined (Chart 2-1-10). The number of female researchers as of 2010 was 121,141. This is 2.5 times as many as there were in 1992. The past trend shows a tendency for the number and the ratio of female researchers to rise almost every year. It is true that the number is not high compared to other countries; however, it can be predicted that the role of female researchers in Japan will advance with the development of knowledge-based society.

Chart 2-1-10: The number of female researchers and their ratio against the total number of researchers



Notes: The ratios of the number of female researchers published in the "Report on the Survey of Research and Development" by the Ministry of Internal Affairs and Communications were used. The numbers of researchers until 2001 in this chart were obtained by measuring only regular researchers in the business enterprise sector and the non-profit institution sector, and those including external non-regular researchers in the university and college sector. The numbers of researchers by gender since 2002 were surveyed on head count basis.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

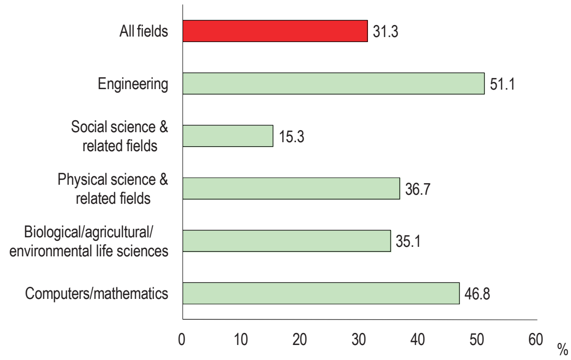
2.1.5 Doctoral degree holders

The existence of doctoral degree holders with advanced knowledge is a factor that can enhance a country's power. In this section, the country of origin and the specialized field of knowledge workers, each of whom possesses a doctoral degree in the field of sciences or engineering, in Japan and the U.S. are examined. Because no data on doctoral degree holders equivalent to the data in the U.S. is available in Japan, data on the employment status of post doctoral fellows in Japan is used as a substitute.

Out of the total doctoral degree holders in the U.S., 31.3% of them or 320,000 people were born in foreign countries (Chart 2-1-11). A breakdown finds that people who possess a doctoral degree in engineering fields account for 51.1%, about half of the total.

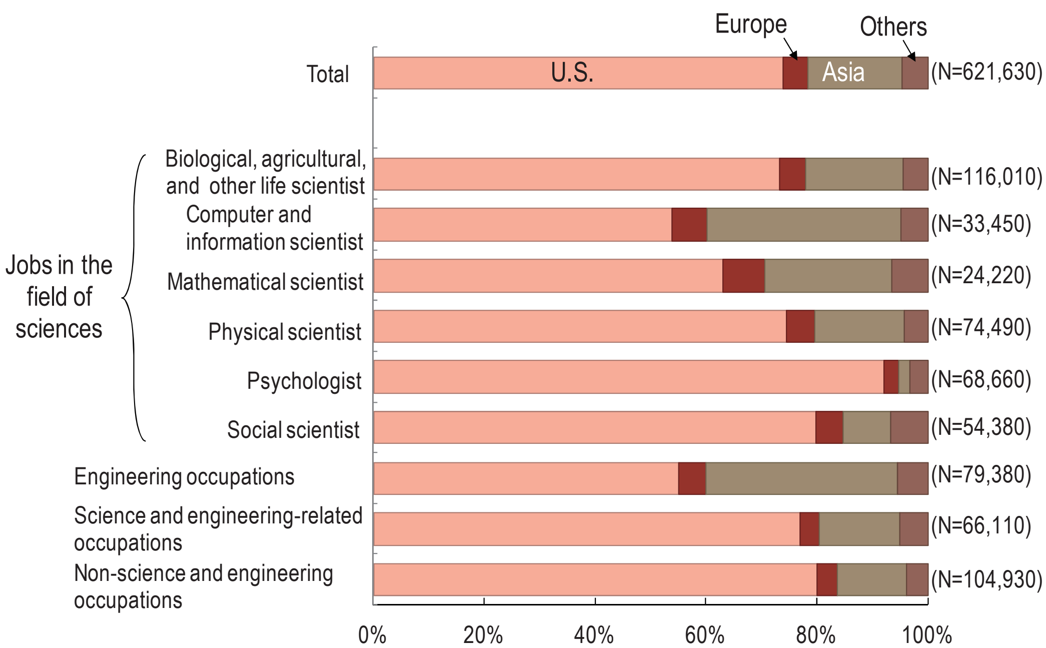
Next, which country and region doctoral degree holders came from and which specialized occupational fields they were employed in is examined. Understandably, the U.S. born researchers account for more than half the proportion of each total in almost every specialized occupational field, and account for 74.0% of the entire total of all the fields. By examining the proportion of doctoral degree holders from the Asian region, it was found that the proportion of people employed in the fields of computer science and information science was large at 35.0% followed by those in the field of engineering at 34.7% (Chart 2-1-12).

Chart 2-1-11: Ratios of foreign-born doctoral degree recipients by specialized field of study (2006)



Source: NSF, "SESTAT PUBLIC 2006" website

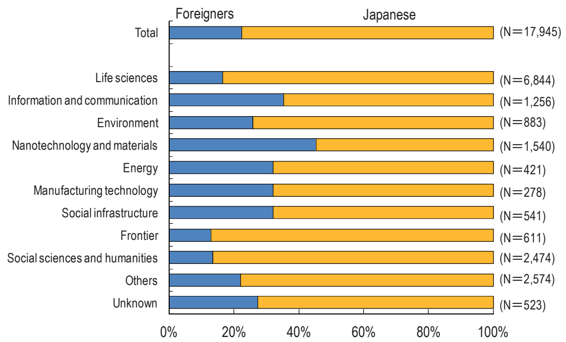
Chart 2-1-12: Status of employment for doctoral degree holders by country or region of origin in each occupational field (2006)



Source: NSF, "Characteristics of Doctoral Scientists and Engineers in the United States: 2006"

Chart 2-1-13 shows the ratio of the number of foreign employees against the total number of positions for post doctoral fellows in the university and college sector combined with the public organization sector in Japan. 22.4% of the total of such positions were held by foreigners. Examined by field, the ratio in nanotechnology and materials was highest at 45.3%, followed by the ratio in the field of information and telecommunication at 35.3%.

Chart 2-1-13: Employment status for post doctoral fellows in the university and college sector and public organization by the field of research in Japan (2008)



Notes: Positions for post doctoral fellows are for the employees under a fixed term contract, and composed of (1) employees engaged in research at university institutes, but not at the position of professor , associate/assistant professor, nor assistant, and (2)employees regularly engaged in research at research institutes run by independent administrative corporations etc, but not at the position of the leader of a research group nor senior research fellow, etc. (including those who obtained the required number of credits and then conditionally withdrew from school, i.e., so-called ABDs).

Source: NISTEP "Survey on Postdoctoral Fellows and Research Assistants (FY2007 and FY2008 Data)"

2.1.6 Mobility of researchers

Enhancing the mobility of researchers is considered to advance the use of the abilities of researchers, who are in charge of knowledge production, and simultaneously to develop a research environment with vitality in each workplace.

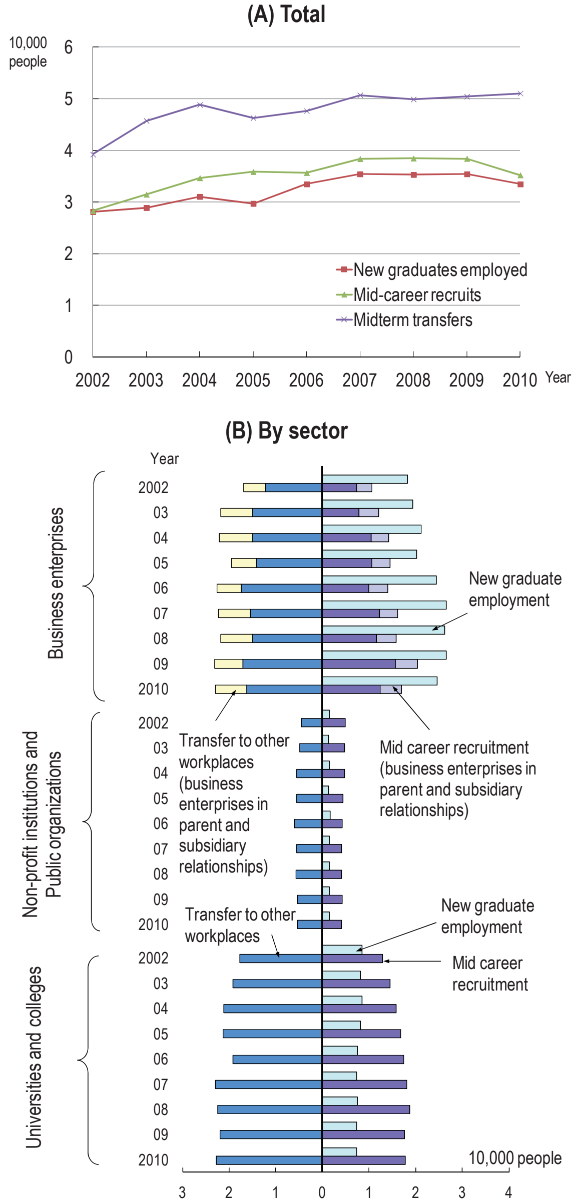
The status of new graduate employment(4) and transfer, both to(5) and from the latest work place, of the researchers in Japan was examined (Chart 2-1-14(A)). The number of researchers employed within the borders in 2010 was 68,681 people. Of these, the number of new graduates employed was 33,469 and the number of mid career recruits was 35,212, respectively. The number of researchers transferring out of their workplaces was 51,055. Compared with 2002, there has been a relatively upward trend. In 2010, however, there was a decrease in new graduates employed and mid-career recruits.

Compared by sector, in the business enterprise sector the numbers for new graduate employment have consistently been higher than those for mid-career recruits. The number of new graduates employed had been flat in recent years; in 2010, it declined. The number of researchers transferring out of their workplaces has increased since 2002.

In the university and college sector, the number of mid career recruits has been higher than that of new graduates employed. Over time, the number of new graduates employed has been flat, as has the number of mid-career recruits in recent years.

In the non-profit institution sector combined with the public organization sector, the number of mid career recruits has been higher than that of new graduates employed. In the business enterprise sector and the university and college sector, the number of new graduates employed and mid career recruits was higher than the number transferring to other sectors. On the other hand, in the non-profit institution/public organization sector, the number of new graduates employed and the number of mid-career recruits gradually declined.

Chart 2-1-14: Numbers of new graduates employed and midterm recruits/transfers with regard to researchers



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

(4) The new graduate employment represents so called new university graduates. Casual and part time workers as well as temporary workers at universities or research institutes are included.
(5) People transferred from the latest workplace include retired people.

In this connection, the sectors of the people who were employed as mid career recruits are examined by former affiliated sector by comparing the data from 2002 and that for the latest year for each sector where they were affiliated in 2010 (Chart 2-1-15).

In 2010, the number of researchers transferred from the business enterprise sector accounted for a significantly large proportion, 93.8%, of the total number of researchers transferred to the same sector. Compared with 2002, the percentage of researchers transferring in from business enterprises increased. Of this, transfers from parent and subsidiary companies increased by 5.1 percentage points.

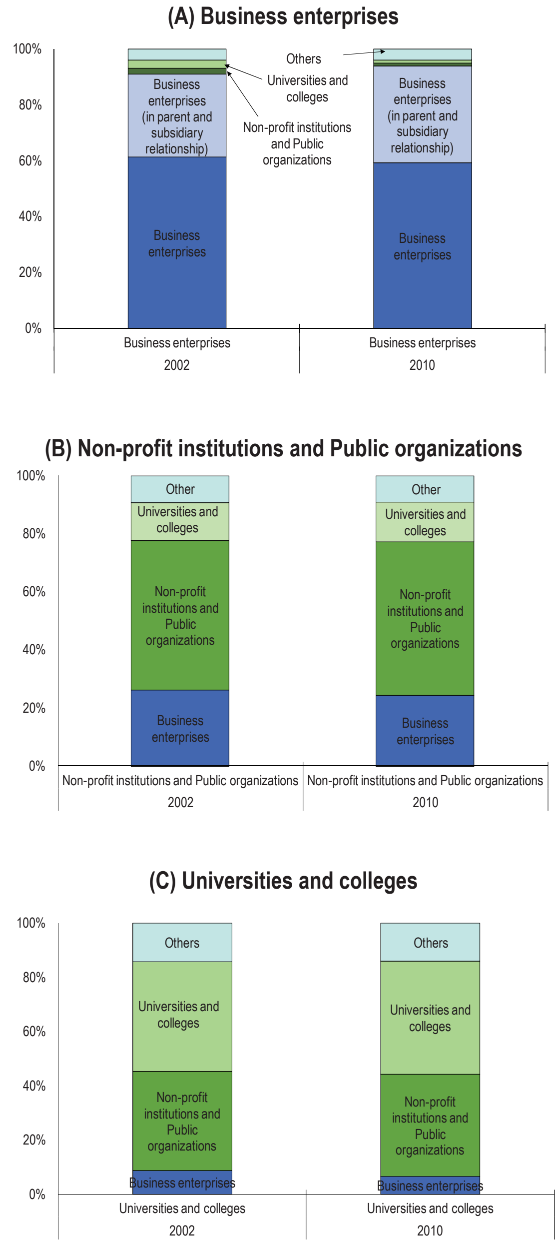
In the non-profit organization and public organization sector, transferred researchers from within those sectors accounted for the largest percentage, 52.9% of all transferred researchers. With an increase of only 1.4 percentage points, there has been little change since 2002.

In the university and college sector, 41.7% of transfers came from within that sector, but there were also many transfers from other sectors. The percentage coming from the non-profit organization and public organization sector was 37.8%.

With regard to transfers from other sectors, researchers from the non-profit institution and public organization sector accounted for the largest percentage in the university and college sector. Those from the business enterprise sector accounted for the largest percentage in the non-profit institution and public organization sectors.

In every sector, there was an increase in researchers transferring within the sector, but almost no increase in researchers transferring in from other sectors. It would thus be difficult to claim that mobility among sectors is increasing.

Chart 2-1-15: Breakdown of transferred researchers from other sectors by their former affiliated sector



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

Column: International research personnel entering and leaving Japan following the 3/11 Great East Japan Earthquake

Since the large earthquake that occurred in the sea off northeastern Japan (Great East Japan Earthquake) and the nuclear accident that followed, concern has been expressed regarding their impact on the mobility of foreign researchers engaged in research activities in Japan. These concerns include the effects on Japanese research sites, and whether foreign researchers have returned to their home countries or stopped coming to Japan. Have international research personnel in fact left Japan or stopped coming to Japan under these circumstances? In order to pursue this question, movement of international research personnel was analyzed by using the Ministry of Justice's monthly immigration control statistics to examine by status of residence the number of foreign nationals entering and leaving the country.

The international research personnel analyzed comprise those persons holding a status of residence of "professor" or "researcher," which are among 27 current types of resident status. Activities approved for "professor" status are research, research guidance and education at Japanese universities, equivalent institutions and technical colleges. Activities approved for "researcher" status are engagement in work performing research based on a contract with a Japanese public or private institution. Thus, persons holding one of those two statuses are likely to be engaged in research activities. There are 8,050 international research personnel in Japan engaged in the activities of a "professor," and 2,266 engaged in those of a "researcher," for a total of about 10,000 (Ministry of Justice, "Statistics on the Foreigners Registered in Japan 2010").

First, what is the state of international research personnel departing Japan? Chart 2-1-16 shows monthly fluctuations in the number of international research personnel leaving Japan from January 2009 through May 2011. As shown in (A), the number of research personnel leaving fluctuates on a monthly basis, and those fluctuations were stable when comparing 2009 and 2010. In light of this, there was a clear increase in the number of research personnel who left during March 2011. There was an increase of 1,621 (61%) compared with 2010, indicating the impact of the phenomena that occurred during March 2011. April and May 2011, however, settled back to numbers similar to the previous year's.

In addition, the total number of international research personnel departing Japan was broken down into those leaving Japan with re-entry permits (B) and without re-entry permits (C). Of the large increase in research personnel leaving in March 2011, most had re-entry permits. Re-entry permits ease the complexity of immigration procedures by allowing foreign nationals with residential status in Japan to leave the country temporarily on business and so on during their visa periods and then reenter without having to apply for a new visa.

What, then, is the state of international research personnel entering Japan? Chart 2-1-17 shows monthly fluctuations in the number of international research personnel entering Japan from January 2009 through May 2011. As with research personnel leaving Japan, the figures fluctuate on a monthly basis, and those fluctuations were stable when comparing 2009 and 2010. Looking at March 2011 in light of this, the number was similar to the previous year's. In April and May, however, the number of research personnel entering Japan increased by 843 (52%) and 424 (21%), respectively.

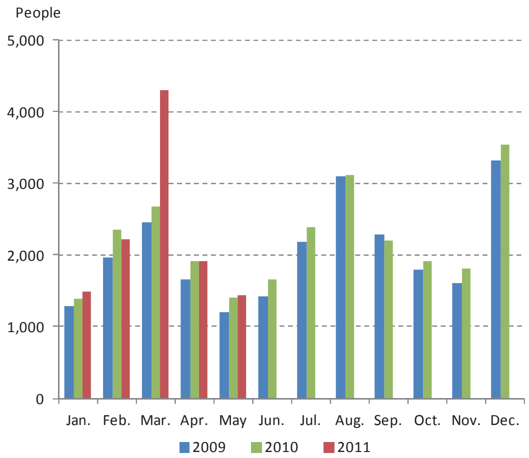
Changes in the total number of research personnel entering Japan were broken down into those entering with re-entry permits (B) and those entering with new visas (C). For (B), those entering with re-entry permits, there was a stable trend through March 2011. In April and May 2011, however, there were respective year-on-year increases of 992 (79%) and 396 (22%) research personnel entering the country with re-entry permits. As for (C), researchers entering with new visas decreased by 75 (21%) in March 2011 and by 149 (40%) in April from the previous year. In May 2011, the number increased by 28 (12%).

Thus, while it was confirmed that the Great East Japan Earthquake in March 2011 did affect the number of international research personnel entering and leaving Japan, the situation seems to have returned to normal within a relatively short time. However, since the number of research personnel entering Japan since March 2011 cannot be seen as adequate to the number departing, further confirmation of the number of international research personnel entering and leaving Japan will be carried out.

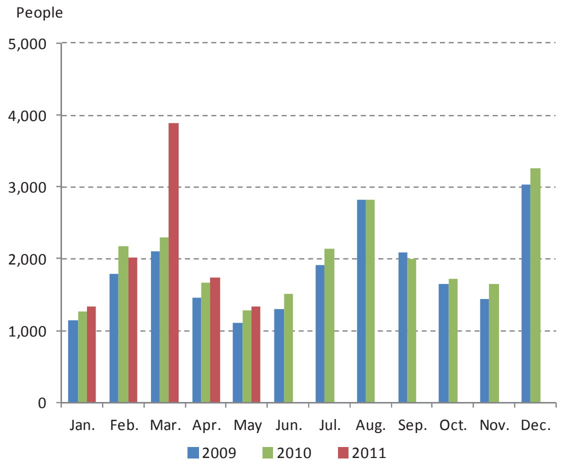
(Ayaka Saka)

Chart 2-1-16: Changes in the number of foreigners (with research-related statuses of residence) departing Japan

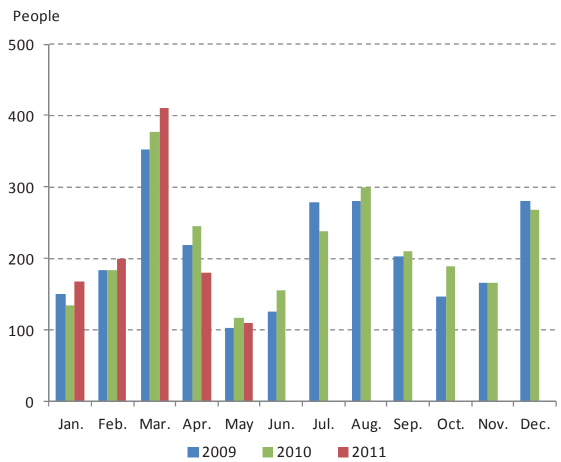
(A) Number departing Japan



(B) Of those departing, number with re-entry permits



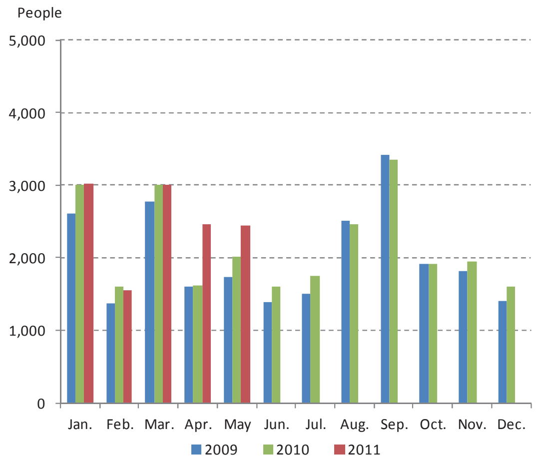
(C) Of those departing, number without re-entry permits



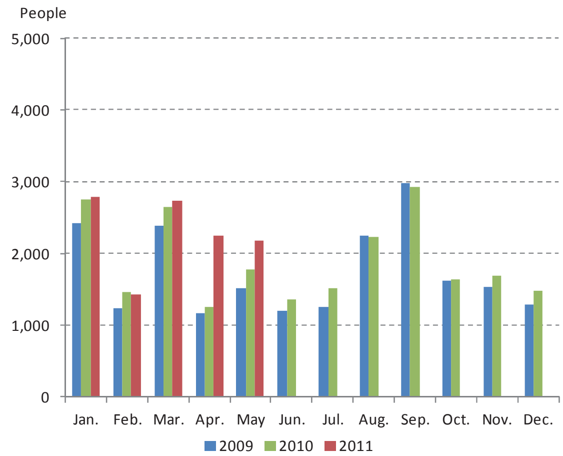
Notes: 1) Data as of July 25, 2011.
2) Persons with resident statuses of "professor" or "researcher" were analyzed.
Source: Compiled by the National Institute of Science and Technology Policy (NISTEP) based on Ministry of Justice, "Statistics on the Foreigners Registered in Japan."

Chart 2-1-17: Changes in the number of foreigners (with research-related statuses of residence) entering Japan

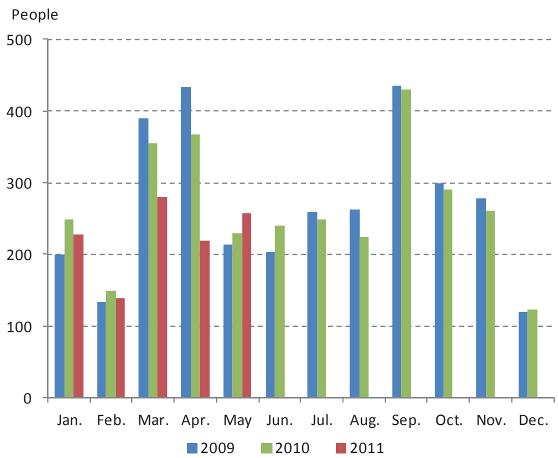
(A) Number entering Japan



(B) Of those entering, number with re-entry permits



(C) Of those entering, number without re-entry permits



Notes: Same as Chart 2-1-16
Source: Same as Chart 2-1-16.

2.2 Researchers by sector

Key points

○The number of researchers in the public organization sector per 10,000-person population in the latest available year was 6 in Germany, which was the highest value, followed by 4.3 in France. Japan's value was 2.5. However, the number of researchers in local governments (state governments, etc.) in Japan and Germany was included in the data above, while that for France was not included. The value for the U.S., whose data did not include the number of researchers in local governments, was 1.7.

○Looking at the number of researchers in the business enterprise sector, Japan and the U.S. showed a long-term rising trend, but in recent years have been flat. In 2010, Japan had 490,000 researchers. China has shown a sharp upward trend beginning in the 2000s. In Germany and France, there has been a long-term upward trend, while growth has been flat in over the long term in the U.K.

○With regard to the proportion of the number of researchers by industry, the ratio of those in the manufacturing industry to the non-manufacturing industry in Japan was approximately 90% to 10%, and in the U.S. was approximately 60% to 40%. The trends of both countries are different in this way.

○Breaking down the number of researchers in the university and college sector in Japan, teachers are most common at private universities, while doctoral course students in graduate schools are most common at national universities. Breaking down researchers at national universities by field, natural sciences is the most common field. This is also true of doctoral course students in graduate schools. At private universities, on the other hand, although natural sciences is the most common field, the humanities and social sciences field is also large, with little difference between the two.

2.2.1 Researchers in the public organization sector

(1) Researchers in public organizations in each country

Below is a summary of what "public organizations" in this section represent.

In Japan, "national" institutes (such as national testing and research institutes), "public" institutes (such as public testing and research institutes), and special and public administrative corporations (non-profit) are included.

In the U.S., research institutes run by the federal government are included.

In Germany, research institutes run by the federal government and local governments and other public research institutes, non-profit institutions (receiving 160,000 Euros or more as public funds) and the research institutes except for higher education institutions are included.

In France, types of research institutes such as scientific and technical research public establishment "Etablissement public a caractere scientifique et technologique" (EPST) (except for CNRS) and commercial and industrial research public establishment "Etablissement Public a Caractere Industriel et Commercial" (EPIC) are included.

In the U.K., research institutes run by the central government and decentralized governments and research councils are included.

In China, research institutes run by the central government are included. And in Korea, national and public research institutes, government supported research institutes and national and public hospitals are included.

It should be noted that the number of researchers in the public organization sector may fluctuate widely due to the privatization of public organizations and changes in what is subject to measurement with R&D statistics. The number of researchers in public organizations is examined in light of differences in each country.

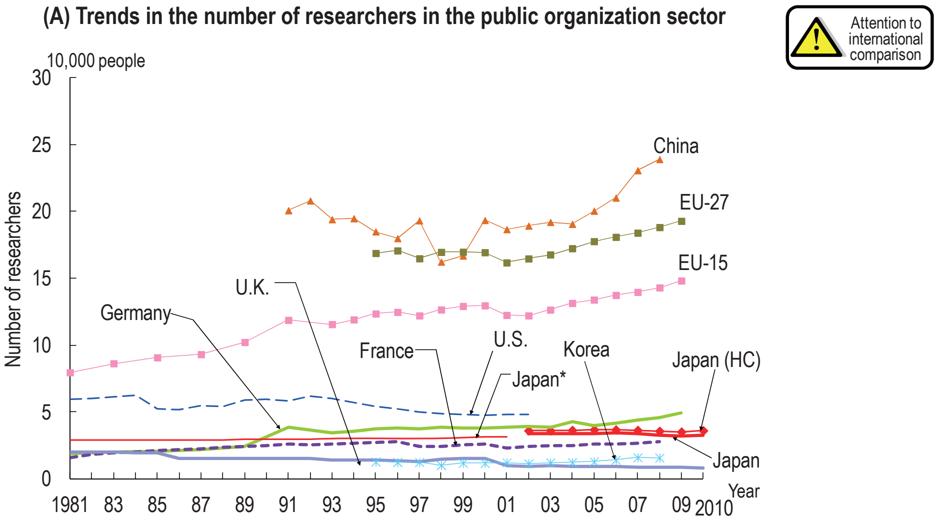
With regard to the trends in the number of researchers, Japan did not show a significant change in the public organization sector in the long term. The U.S., Germany, France and the U.K., however, have shown remarkable fluctuation. The main reasons are considered to be the transfer of some public organizations into the business enterprise sector, the change in surveying methods for measuring the number of researchers, etc. For example, in the U.K., the "UK Atomic Energy Authority" which belonged to the public organization sector in 1985 was transferred to the business enterprise sector, and DERA[(6)] ceased operations in 2000.

(6) The Defense Evaluation and Research Agency (DERA).

The number of researchers in the public organization sector in China is extremely large compared to that in other countries; however, at 1.8, the ratio of the former per 10,000-person population is not so remarkable (see chart 2-2-1(B)) In the U.K., both the number of researchers and the ratio of the number of researchers per 10,000-person population are small (Chart 2-2-1 (A, B)).

Chart 2-2-1: Researchers in the public organization sector in selected countries

(A) Trends in the number of researchers in the public organization sector



(B) Number of researchers in the public organization sector per 10,000-person population

(Unit: people)

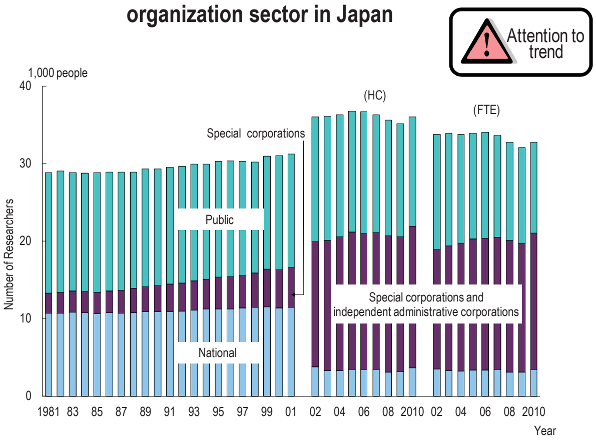
Country (Year)	
Japan（2009）	2.51
U.S.(2002)	1.66
Germany (2009)	5.98
France (2008)	4.27
U.K. (2009)	1.36
China (2008)	1.79
Korea (2008)	3.20

Notes: 1) The definition and measurement method of researchers in the public organization sector is different depending on country. Therefore it is necessary to be careful when international comparisons are being made. Refer to Chart 2-1-1 for the definition of researchers in each country.
2) Values for each country are FTE, except Japan (HC), which is HC.
3) Values include the number of researchers in social sciences and humanities (only in natural sciences and engineering in Korea through 2006).
<Japan>1) National and public research institutes, special corporations and independent administrative corporations.
2) Refer to Chart 2-1-3 for researchers.
<U.S. >1) The federal government only.
2) Out of "federal scientists and engineers", only researchers who are mainly in charge of "research" and "development" as their work have been measured since1998.
3) A part of the Department of Defense has been excluded since 2003.
<Germany>1) The federal government, non-profit institutions (organizations which receives 160,000 Euros or more as public funds), legally independent university research institutes and research institutes run by local governments (Equivalent of local governments).
2) Former West Germany and unified Germany until 1990 and since 1991 respectively.
<France>Scientific and technical research establishment "Etablissement public a caractere scientifique et technologique" (other than CNRS), commercial and industrial research public establishment "Etablissement public a caractere industriel et commercial", administrative research public establishment "Etablissement public a caractere administratif" (other than higher education institutions) and departments and agencies belonging to ministries.
<U.K. >The central government (U.K), decentralized governments (Scotland etc.) and research councils.
<China>Research institutes run by the government.
<Korea>National and public research institutes, government supported research institutes and national and public hospitals.
Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; MEXT, "Survey on the data for full-time equivalents in universities and colleges" (2002 and 2008)
<U.S.>NSF, "National Patterns of R&D Resources 1995, 1998, 2002 Data Update"; from 2000, OECD, "Main Science and Technology Indicators 2010/2"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 1996, 2000, 2004"; "Forschung und Innovation in Deutschland 2007" "Bundesbericht Forschung und Innovation, 2008, 2010"; OECD, "Main Science and Technology Indicators 2010/2)" since 2008.
<France, U.K., China, Korea, and EU> OECD, "Main Science and Technology Indicators 2010/2"

(2) Researchers in the public organization sector in Japan

It should be noted that in Japan's public organization sector, part of the "national" research institutes turned into independent administrative corporations in 2001 (furthermore, part of the "special" corporations also turned into independent administrative corporations in 2003). As a result, data since 2002 has had no continuity with the previous data. Given this background, the number of Japan's researchers in the public organization sector was 32,715 people in total in 2010. When examined by type of organization, the number of researchers in "special and independent administrative corporations" accounts for half of the total or 17,547 people, while that in "public" research institutes accounts for approximately 40% of the total or 11,724 people, and that in "national" research institutes accounts for slightly less than 10% of the total or 3,444 people. Since 2002, there has been a downward trend. The number of researchers in public institutions has particularly decreased (Chart 2-2-2).

Chart 2-2-2: Trend in the number of researchers in the public organization sector in Japan



Notes: 1) A part of national research institutes turned into independent administrative corporations in 2001. Therefore it is necessary to be careful when trends in time series are being examined.
2) Values for "special corporations and independent administrative corporations" until 2000 represent values for only "special corporations".
3) Because of the change in the contents and time of surveys, the numbers of regular researchers on Apr. 1 until 2000 and the numbers of researchers on Mar.31, since 2001 were used.
4) Because of the change in measurement methods in 2002, data are interrupted. Refer to Chart 2-1-2 about researchers and measurement methods.

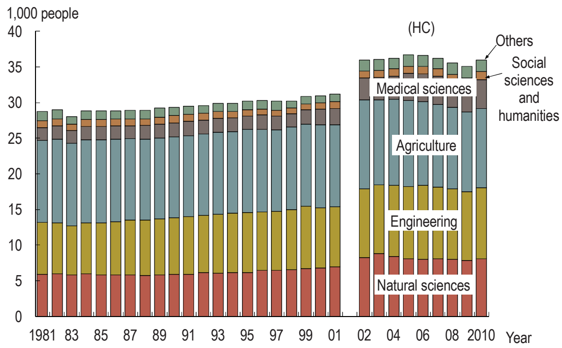
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

Next the number of researchers by specialty is examined. Specialty here represents a classification by specialized knowledge of individual researchers.

The number of researchers having specialized knowledge in "agriculture" has made up a large proportion consistently, although it is gradually decreasing. Among the types of organization to which they belong, "public research institutes" is at the top in terms of the number of researchers. The number of researchers in the field of "engineering" makes up the second largest proportion. For researchers in the field of "engineering" and "natural sciences", research institutes run by "special and independent administrative corporations" are the main workplaces. Many researchers in the field of "medical sciences" belong to "public" research institutes as well as "national" research institutes (Chart 2-2-3).

Chart 2-2-3: Breakdown of researchers in the public organization sector by specialty in Japan

(A) Trend in the number of researchers



(B) Affiliations of researchers by specialty (2010)

(Unit: People)

Field of research	Public Organizations			
	Total	National	Public	Special Corporations and Independent Administrative Corporations
Natural Sciences	7,842	498	1,945	5,399
Engineering	9,641	730	2,550	6,361
Agriculture	11,208	213	7,217	3,778
Medical Sciences	3,766	1,336	1,439	991
Social Sciences and Humanities	1,040	262	241	537
Others	1,587	106	1,195	286
Grand Total	35,084	3,145	14,587	17,352

Notes: Same as for Chart 2-2-2. HC values have been used since 2002.
Source: Same as for Chart 2-2-2.

2.2.2 Researchers in the business enterprise sector

(1) Researchers in the business enterprise sector in each country

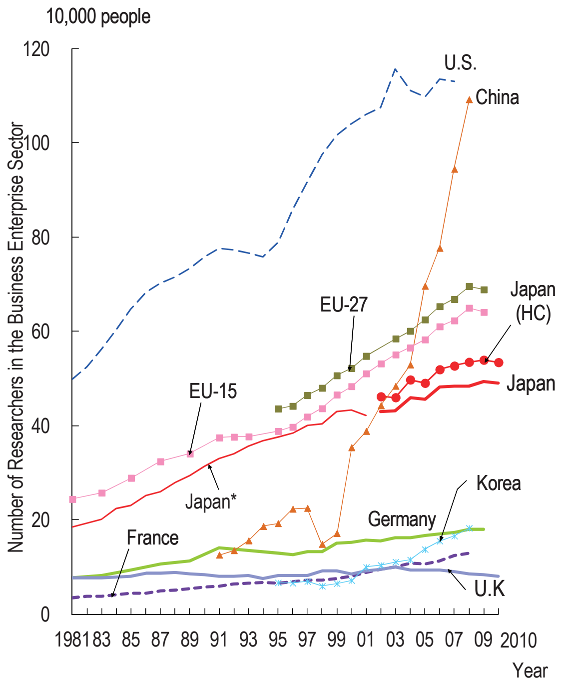
The number of researchers in the business enterprise sector is measured by statistical survey on R&D in every selected country. Therefore, the data for this sector is considered potentially more suitable for international comparison compared to that for other sectors. The same data, however, can show fluctuation over time. The fluctuation is influenced by the fact that, in each country, the methods and scopes of surveys change when they are adjusted to structural change in industries due to the sophistication of economic activities, and due to the revision of the standard classifications of industries.

The number of researchers in the business enterprise sector in Japan had been on a continually rising trend, but in recent years it has been flat. In 2010, there were 490,000 such researchers.

China has shown rapid growth during the 2000s. The U.S. experienced drastic growth from 1995 through 2003. This is thought to have been caused by a revision in the scope of statistical surveys of R&D in 1995, when a wider range of enterprises started being included than previously, and researchers in service industries started being measured.

In France and the U.K., some public organizations were privatized and transferred to the business enterprise sector, causing a corresponding increase in researchers (although the effect is not large enough to cause a significant change in the chart). Germany and France show long-term rising trends. The trend in the U.K. is flat (Chart 2-2-4).

Chart 2-2-4: Trends in the number of researchers in the business enterprise sector in selected countries



Notes: FTE values were used.

<Japan>1) Values until 2001 represent the numbers of researchers measured on Apr.1and since 2002 represent the numbers of researchers measured on Mar.31 in corresponding year respectively.
2) Refer to Chart 2-1-3 for what the researchers represent.
3) The industrial classification adopted in the Survey of Research and Development was used based on Japan standard industry classification.
4) As industrial classification was revised, the classification adopted in the Survey of Research and Development was changed in its 1996, 2002 and 2008 versions.

<U.S.>1) SIC were used until 1998 and NAICS has been used since 1999 as the industrial classification.
2) FFRDCs have been excluded since 2001.

<Germany>1) West Germany until 1990 and unified Germany since 1991, respectively.
2) German Industrial classification, "Classification of Economic Activities", was revised in 1993 and 2003.

<France>1) Classification under the scope of surveys was changed in 1991 and 1992 (France Télécom and GIAT Industries was moved from the government sector to the business enterprise sector).
2) The survey method on research personnel in the administration sector was changed in 1997.
3) French industrial classification, "Nomenclature d'activités française ", was revised in 2001 and 2005.

<U.K..>1) Classification under the scope of surveys was changed during 1985 and 1986, and in 2000 (“United Kingdom Atomic Energy Authority” was transferred from the government sector to the business enterprise sector during 1985 and 1986).
2) The Defence Evaluation and Research Agency (DERA) stopped operating in 2000. Three-quarters of it was turned into limited private companies and were transferred to the business enterprise sector.
3) Classification of research institutes was re-classified during 1991 and 1992.
4) British industrial classification, "UK Standard Industrial Classification of Economic Activities", was revised in 1980, 1992, 1997, 2003 and 2007.

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 1995, 1998, 2002 Data Update”; OECD, “Main Science and Technology Indicators 2010/2”
<Germany>Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 1996, 2000, 2004”; “Forschung und Innovation in Deutschland 2007” “Bundesbericht Forschung und Innovation, 2008, 2010”; OECD, “Main Science and Technology Indicators 2010/2)” since 2008.
<France, U.K., China, Korea, and EU> OECD, “Main Science and Technology Indicators 2010/2”

(2) Researchers by industry in each country

Chart 2-2-5 shows the number of researchers by industry in various countries. Industrial classification in this section represents what each country established for the statistical survey of R&D in the business enterprise sector referring to standard industrial classifications. Standard industrial classifications in each country are mostly established consistent with ISIC (International Standard Industry Classifications); however some discrepancies inevitably exist depending on the country. Therefore, with regard to the credibility for international comparison, the level of data using this classification is considered to be low.

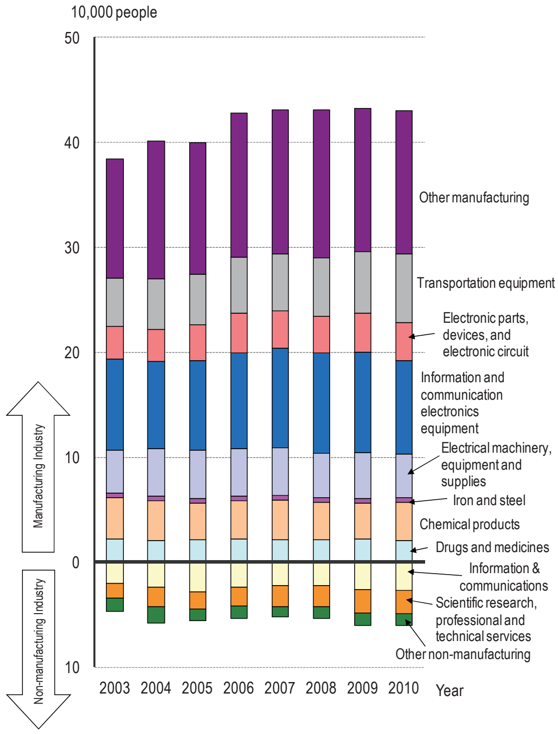
Given the background mentioned above, by examining the number of researchers by industry in Japan, the U.S., and Germany, it was found that the number of researchers in the manufacturing industry accounted for a considerably large ratio in Japan. This means that the increase in the number of total researchers was probably greatly influenced by the manufacturing industry. However, the trend has been flat since about 2006. In the non-manufacturing industry, no significant change was shown.

In the U.S., the number of researchers in non-manufacturing industry is large. "Specialized, scientific and technical services" account for a large share of this. In Germany, values are growing both in the manufacturing and non-manufacturing industries.

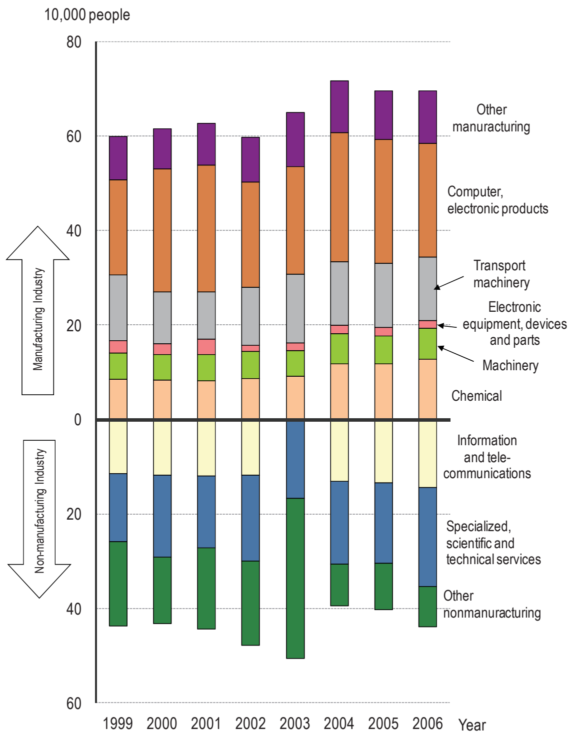
It should be noted that in Germany, the "software industry" and "R&D", etc. are classified into "real estate, lease and business activities". Variations in standard industrial classifications like this example should be taken in to account.

Chart 2-2-5: Number of researchers by industry in each country

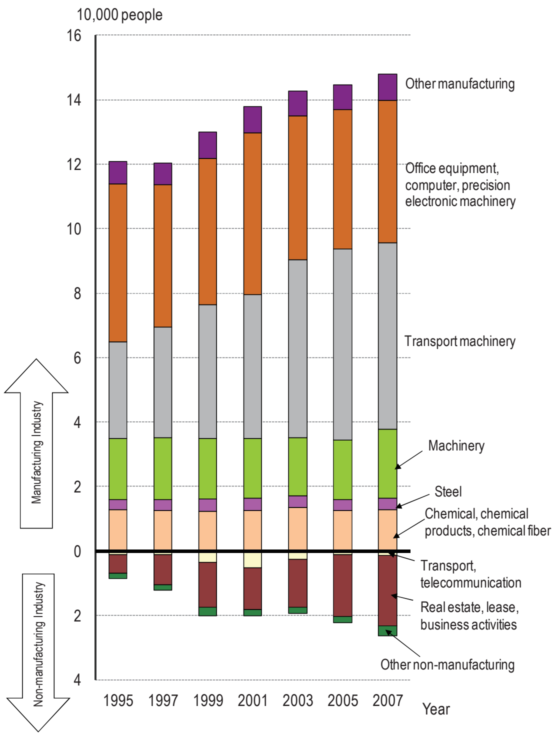
(A) Japan



(B) U.S.



(C) Germany



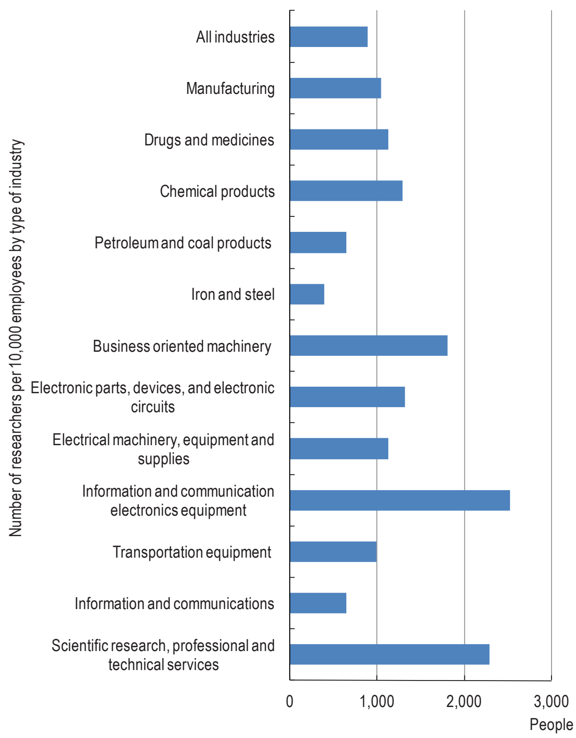
Notes: Same as for Chart 2-2-4.
Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.>NSF, "Industrial R&D for each year"
<Germany>BMBF, "Research and Innovation in Germany 2007", "Bundesbericht Forschung und Innovation 2008"

(3) Density of the number of researchers against the total number of employees by industry for Japan

The number of researchers per 10,000 employees (whether or not researchers) was examined in some types of industries picked up in order to understand which types of industries and enterprises employ researchers in Japan. The top position was for the industry of "information and telecommunication machinery and equipment" which has 2,523 researchers followed by the industry of "academic research, specialized and technical service" which has 2,286 researchers (Chart 2-2-6).

The manufacturing industry of "information and communication electronics equipment" includes the manufacturing industries of telecommunication machinery and equipment, audio and video equipment, electronic computer, etc. The industry of "scientific research, professional and technical services" includes categories such as natural science research institutes and other academic institutions.

Chart 2-2-6: Number of researchers per 10,000 employees by type of industry in Japan (2010)



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

2.2.3 Researchers in the university and college sector

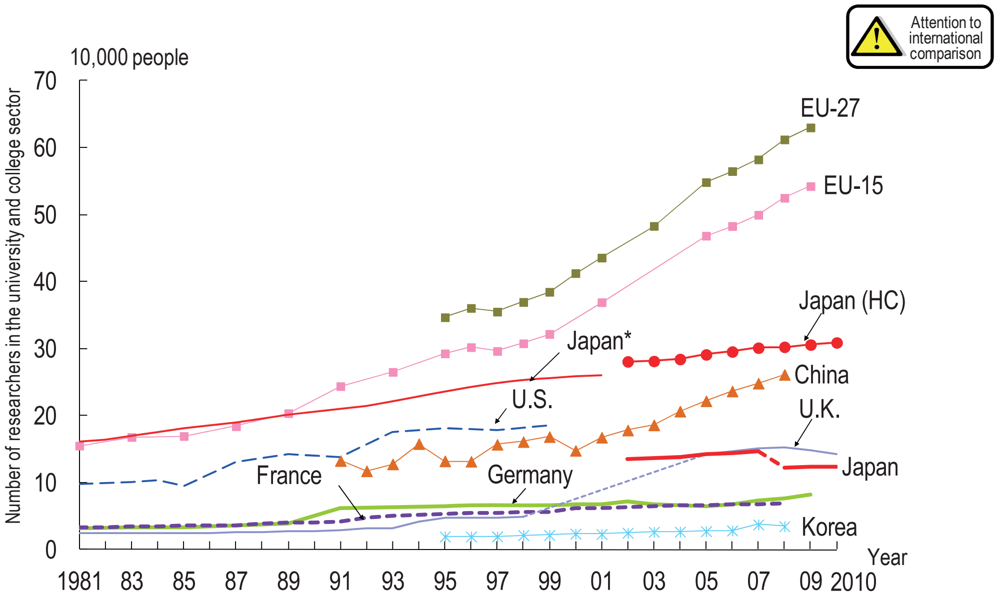
(1) Researchers in the university and college sector in each country

With regard to researchers in the university and college sector, international comparison is difficult. The details were described in 2.1.1., and the main points which should be noted are restated below.

(1) Differences in the method of survey: Some countries use existing data such as statistics on education (statistics measuring teaching staff and students) and on the status of occupations and academic degrees without conducting statistical surveys on R&D. (2) Differences in measurement methods: In cases where statistical surveys on R&D are conducted, it is possible to measure the number of researchers on an FTE basis based on questionnaires. However, in cases where the FTE values are measured in accordance with statistics on education etc., the values need to be obtained by multiplying full time equivalent coefficients. Japan is special because it conducts statistical surveys on R&D but does not obtain FTE values in these surveys. (3) Differences in the coverage of surveys: Doctoral degree holders included in researchers in the university and college sector are treated differently in surveys depending on country. For instance, whether or not they receive financial assistance and whether or not full time equivalent coefficients are multiplied depends on each country. As for S&T indicators, Japan's Ministry of Education, Culture, Sports, Science and Technology carried out surveys in 2002 and 2008 that measured an FTE coefficient to find the FTE number of researchers in Japan's university and college sector. The value obtained using that FTE coefficient is used as the FTE number of researchers (see Chart 2-1-2). Data continuity between 2007 and 2008 is therefore impaired.

Given the above, trends over time by country are examined. In Japan, the number of researchers in the university and college sector was approximately 124,000 people in 2010, a slight increase from 2008. In Germany, slight increases have continued, with no major change other than the influence of the 1991 reunification of East and West Germany. In the U.K., the number of researchers surged during 1993 and 1994. However, this is considered the result of a change in the coverage of surveys due to reform of higher education institutions (the integration of universities and former polytechnics). There are no data for the U.K. for 1999 through 2004, and values from 2005 on are estimated. In France, the number of researchers has been consistently on the rise. In China, the number of researchers has rapidly increased since 2000. The influence of the policy on science and technology (985 programs) is considered to be substantial to this increase. In Korea, the number of researchers is on the rise although the values themselves are small (Chart 2-2-7).

Chart 2-2-7: Trends in the number of researchers in the university and college sector for selected countries



Notes: 1) The definition and measurement method of researchers in the university and college sector is different depending on the country. Therefore it is necessary to be careful when international comparisons are being made. Refer to Chart 2-1-1 for the differences in researchers in each country.
2) Values for each country are FTE, except Japan (HC), which is HC.
3) Values are the total of that in the field of the natural sciences and engineering and the field of social sciences and humanities (only natural sciences and engineering were included in Korea through 2006).
<Japan >1) Faculties in universities (including graduate school courses), junior colleges, university research institutes. etc.
2) Refer to Chart 2-1-3 for researchers.
<U.S. >University & Colleges
<Germany>1) Universities ,Comprehensive universities, Colleges of education, Colleges of theology, Colleges of art, Universities of applied sciences, Colleges of public administration
2) Former West Germany until 1990 and united Germany since 1991. respectively.
<France> French National Centre for Scientific Research (CNRS), Grandes Ecoles (other than those under the jurisdiction of the Ministry of National Education (MEN)), higher education institutions.
<Korea> All university and college majors (extension campuses and local campuses are included), university research institutes, university hospitals (only for the case that a medical university and its accounting department are integrated).

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; MEXT, "Survey on the data for full-time equivalents in universities and colleges" (2002 and 2008)
<U.S.> NSF, "National Patterns of R&D Resources 1995, 1998, 2002 Data Update"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 1996, 2000, 2004"; "Forschung und Innovation in Deutschland 2007" "Bundesbericht Forschung und Innovation, 2008, 2010"; OECD, "Main Science and Technology Indicators 2010/2)" since 2008.
<France, U.K., China, Korea, and EU> OECD, "Main Science and Technology Indicators 2010/2"

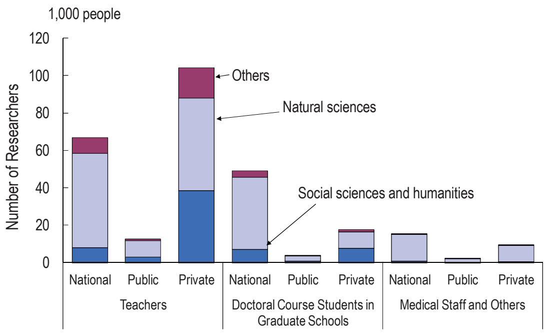
(2) Researchers in the university and college sector in Japan

Chart 2-2-8 shows the number of researchers in the university and college sector in Japan by type of researcher, by type of organization, and by academic field of study in Japan. The number of researchers in the university and college sector in this section represents the number of "regular researchers" as stated in the "Report on the Survey of Research and Development", which does not cover external non-regular researchers.

The value of the total was 281,740 people on March 31, 2010, and 65.3% of those or 184,092 people are teachers. The number of researchers in the university and college sector includes "doctoral course students in graduate schools (70,635 people)" and "medical staff and others (27,013 people)". In these statistics, almost all the teachers in universities are measured as researchers[7].

Overall, teachers are most common at private universities, while doctoral course students in graduate schools are most common at national universities. Breaking down researchers at national universities by field, natural sciences is the most common field. This is also true of doctoral course students in graduate schools. At private universities, on the other hand, although natural sciences is the most common field, the humanities and social sciences field is also large, with little difference between the two.

Chart 2-2-8: Breakdown of the number of researchers in the university and college sector in Japan (2010)



Notes: Values are for universities and graduate schools
Source: Ministry of Internal Affairs and Communications "Report on the Survey of Research and Development"

(7) According to the statistics on universities and colleges (MEXT, "Report on School Basic Survey" 2010 version), as of May 1, 2010, the number of regular teachers in faculties of universities combined with graduate schools was 174,403 and in junior colleges was 9,657, respectively, totaling 184,060.

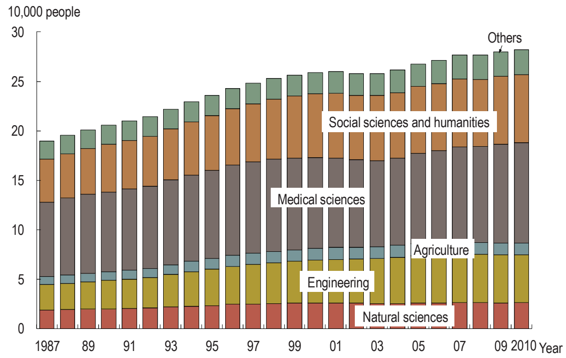
Next, the trend in the number of researchers by specialized field of study was shown (Chart 2-2-9(A)).

The expression "by specialized field of study" here represents "by personal specialized knowledge" and fields which are associated with each researcher's current work are prioritized.

The total number of researchers is increasing, and researchers in the field of "medical sciences" and the field of "social sciences and humanities" account for the main elements of the entire structure. But as far as the proportion of the number of researchers against the total is concerned, the increase in the field of engineering is larger than that in these two kinds of fields.

Chart 2-2-9: Researchers in the university and college sector in Japan

(A) Trend in the number of researchers by specialized field of study



Furthermore, the proportion of researchers by type of university in each specialized field is examined.

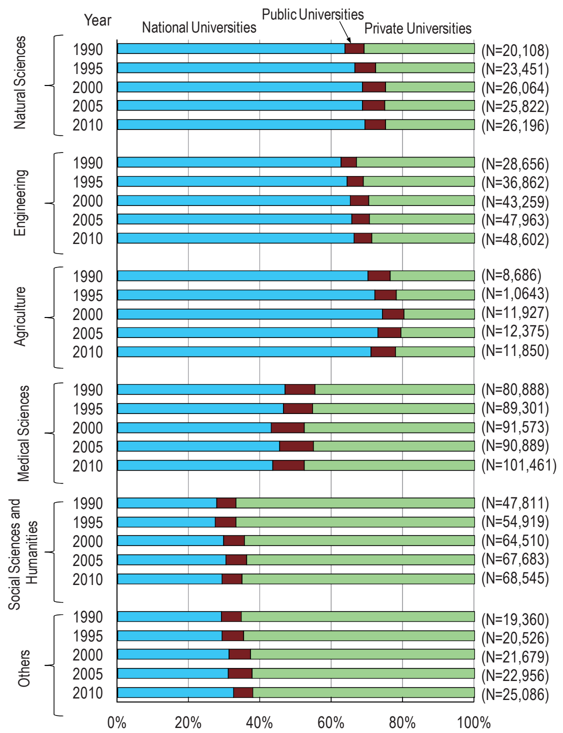
Chart 2-2-9(B) shows the proportion of the number of researchers by type of university, in other words, national, public and private universities, after classifying them by the field of their personal specialized knowledge.

The number of researchers in "national universities" accounts for large proportion, 60 to 70% of the number of researchers with knowledge in the field of "natural sciences", "engineering" and "agriculture". With regard to the field of "natural sciences" and "engineering", the proportion is increasing. The number of researchers in "private universities" accounts for a large proportion of the number of researchers with knowledge in the field of "social sciences and humanities" and "others". "Medical sciences" had been more common at national universities, but in 2010 it became more common at private universities.

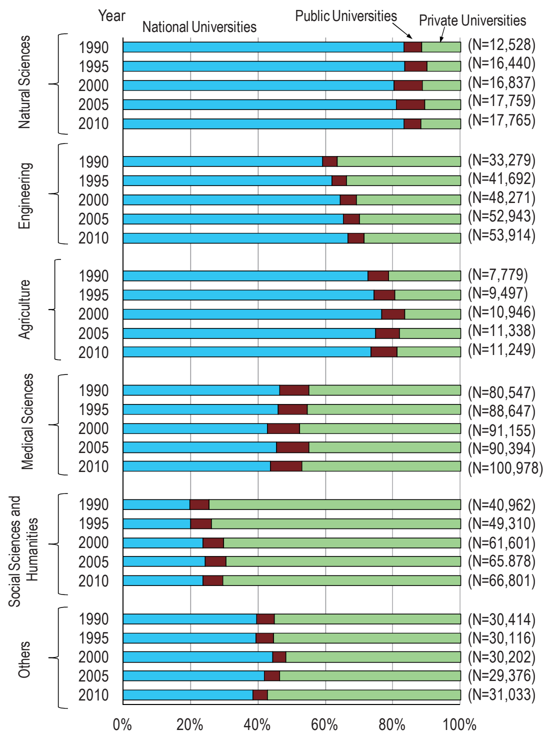
Next, the proportion of researchers by type of university in each field of affiliation (academic field) is examined (Chart 2-2-9(C)). This proportion is almost the same as in the case for each specialized field of study (Chart 2-2-9(B)). But the number of researchers in "national universities" accounts for a substantial 80% or more of those whose affiliation is in the field of "natural sciences", while the proportion in "private universities" accounts for only approximately 10% of the same.

The fact of the matter is that the number of researchers in "private universities" accounts for 20% to 30% of the number of researchers whose personal specialized field is "natural sciences". But only approximately 10% of researchers in "private universities" have affiliations related to "natural sciences". This means that researchers who have specialized knowledge in "natural sciences" in "private universities" do not necessarily have affiliations related to "natural sciences".

(B) Proportion of researchers by type of university (national, public and private) in each personal specialized field of study



(C) Proportion of the number of researchers by type of university (national, public and private) in each academic field of affiliation



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

(3) Greater diversity in alma maters of university teachers

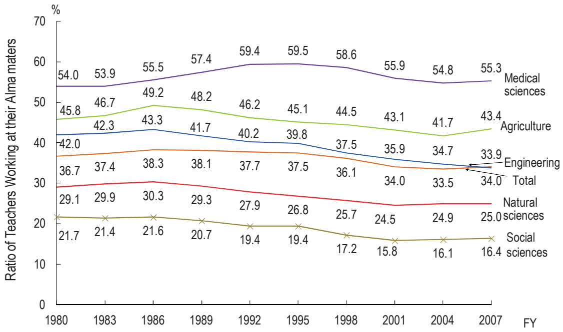
In Japan, traditionally many teachers currently working for a university graduated from the same university. Therefore the diversification of teachers' alma maters is a policy objective.

The average ratio of university teachers working at their alma mater in FY 2007 was 34.0% against the total, but is decreasing in the long term. Examined by field of study, the number of teachers working at their alma mater accounts for a large proportion or approximately 50% in the field of "medical sciences", and the trend is flat. The proportion has recently decreased in the field of "engineering", and remains flat or increasing in other fields (Chart 2-2-10(A)).

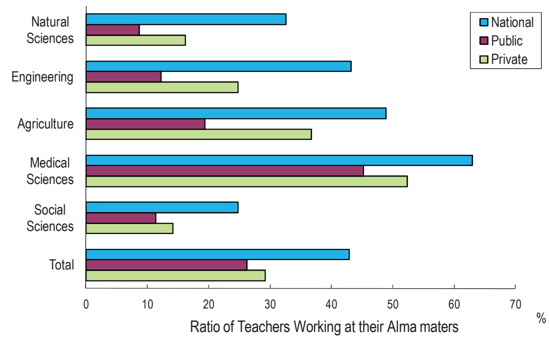
Examined by type of university, the ratio of university teachers working at their alma maters against the total was large in national universities and small in public universities in every specialized field of study. And when examined by field of study, the number of university teachers working at their alma maters accounts for especially large proportion in "medical sciences" in all types of, or national, public and private universities. But in "natural sciences" the number of teachers working at their alma maters was approximately a half in private universities and a quarter in public universities, respectively (Chart 2-2-10(B)).

Chart 2-2-10: Ratio of university teachers working at their alma maters

(A) Trend of ratio by specialized field of affiliated university



(B) Ratios by type of university (FY 2007)



Notes: The field of "Medical Sciences" includes Medicine.
Resource: MEXT, "Statistical Survey on School Teachers"

2.3 Research assistants

Key Points

○With regard to the number of research assistants per researcher by sector, in the business enterprise sector it varies by country. The figures for the most recent available years were 0.3 assistants per researcher in Japan and China, 0.8 in Germany and the U.K., 0.7 in France and 0.1 in South Korea. Over time, there has been a long-term downward trend, although the trend has been flat in the U.K. Figures in the university and college sector in the most recent available years were 0.2 in Japan, 0.4 in Germany, 0.5 in France, 0.1 in the U.K. and 0.7 in South Korea. Over time, growth has been flat in Japan, France and China, Germany and the U.K. have been on a downward trend, and South Korea has been rising in recent years.

○In Japanese universities and colleges, the number of research assistants per researcher has been flat, although the number of assistants has grown in absolute terms. With regard to the breakdown of research assistants, since entering the 2000s, "clerical and other supporting human resources" have shown an increase. In recent years, "Assistant research workers" have also shown an increase.

○Among national, public and private universities in Japan, the number of research assistants per researcher is largest in “national universities”. With regard to the trend by field of study, the number has tended to increase since 2000 in the field of “natural sciences” and “agriculture”.

2.3.1 Status of research assistants in each country

Research assistants tend to be recognized as being peripheral despite the fact that they are important participants in R&D. However, both researchers and research assistants play important roles in modern R&D as it becomes more complicated and larger in scale.

Each country has its own statistics on the number of research-related human resources including research assistants, but each of the statistics is different, as in the case of the number of researchers. But, “Technical and equivalent staff(8)” and “Other supporting staff(9)” according to the definition of “Frascati Manual” compiled by the OECD correspond to so called research assistants.

Chart 2-3-1 shows the names of elements which comprise “research assistants”. For Japan, France and Korea, the terms found in the questionnaire for the statistical survey of R&D was used. For Germany, the terms in R&D documents were used. For the U.K. and China, the terms in documents compiled by the OECD were used. There was no data for research assistants in the U.S.

Chart 2-3-2 shows the number of research assistants per researcher by sector. In the business enterprise sector, it varies by country. The figures for the most recent available years were 0.3 assistants per researcher in Japan and China, 0.8 in Germany and the U.K., 0.7 in France and 0.1 in South Korea. Over time, there has been a long-term downward trend, although the trend has been flat in the U.K. Figures in the university and college sector in the most recent available years were 0.2 in Japan, 0.4 in Germany, 0.5 in France, 0.1 in the U.K. and 0.7 in South Korea. Over time, growth has been flat in Japan, France and China, Germany has been on a downward trend, and South Korea has been rising in recent years. There are no data for universities in the U.K. from 1994 through 2004. The U.K. began publishing estimated figures in 2005. The continuity of data from before 1994 and after 2005 is therefore impaired.

(8) Technical staff and their equivalent are people who are required to have technical knowledge and experience in one or more fields of study from among engineering, physics and life sciences, social sciences and humanities. They participate in R&D by accomplishing scientific and technical duties related to the application of concepts and practical methods usually under the guidance of researchers. The equivalent staffs accomplish duties related to R&D under the guidance for research in the field of social sciences and humanities.

(9) Other supporting staffs include skilled and unskilled craftsmen, secretaries and clerical staff who participate in R&D projects or are related to those projects.

Chart 2-3-1: Research assistants by sector in each country

Country	Business Enterprises	Universities and Colleges	Public Organizations	Non-profit Institutions
Japan	(1) Assistant research workers (2) Technicians (3) Clerical and other supporting personnel	(1) Assistant research workers (HC) (2) Technicians (HC) (3) Clerical and other supporting personnel (HC)	(1) Assistant research workers (2) Technicians (3) Clerical and other supporting personnel	(1) Assistant research workers (2) Technicians (3) Clerical and other supporting personnel
U.S.	NA			
Germany	(1) technisches personal : Technicians (2) Sonstige: Others (specialized labor, assistant labor, clerical staff, etc. directly related to R&D fields)			
France	(1) Techniciens: Technicians (2) Ouvriers: labor (3) Administratifs: Clerical staff	Classification by EPST/EPA/other organizations (1) Ingénieur d'étude, assistant ingénieur, technicien: Design engineers, assistant engineers, technicians (2) Autre personnel: Other personnel Classification by EPIC (1) Personnel de soutien technique: Technical assistant personnel (2) Personnel de soutien administratif et de service: Clerical and service personnel		
U.K.	(1) Technicians: Technicians (2) Other support staff: other supporting staff			
China	(1) Technicians: Technicians (2) Other support staff: Other supporting staff			
Korea	Assistant research workers (1) Research assistant personnel and technical personnel (2) Research administration personnel and other assistant personnel	Assistant research workers (1) Master's degree students participating in research (2) Other assistant personnel (Research management and clerical	Assistant research workers (1) Research assistant personnel and technical personnel (2) Research administration personel and other assistant personnel	Assistant research workers (1) Research assistant personnel and technical personnel (2) Research administration personnel and other assistant personnel

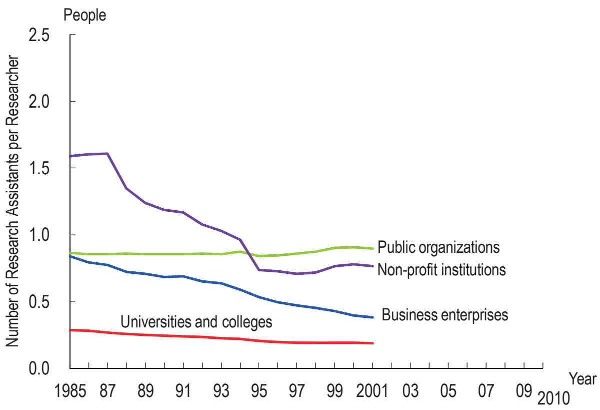
Notes: 1) For the U.S., Germany and France, terms in their national languages are shown (this version is in Japanese). For the U.K. and China, terms used in OECD materials are shown.
2) Values for each country are FTE, except where marked with (HC), which refers to actual values.
3) Nothing on the U.S.

Source: NISTEP, "Metadata of R&D-related statistics in selected countries: Comparative study on the measurement methodology"; Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; OECD, "R&D Statistics (last updated 2009.2)

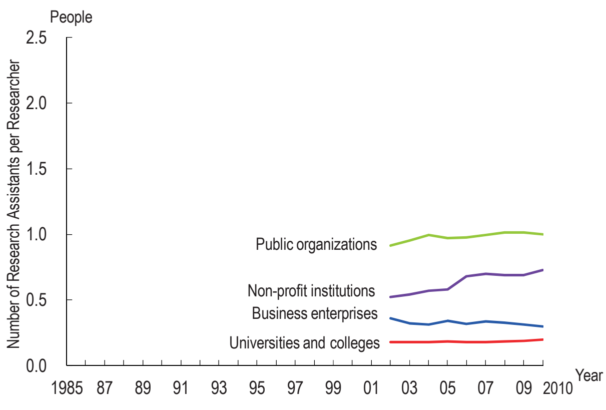
Chart 2-3-2: Trends in the number of research assistants per researcher by sector for selected countries

Attention to international comparison

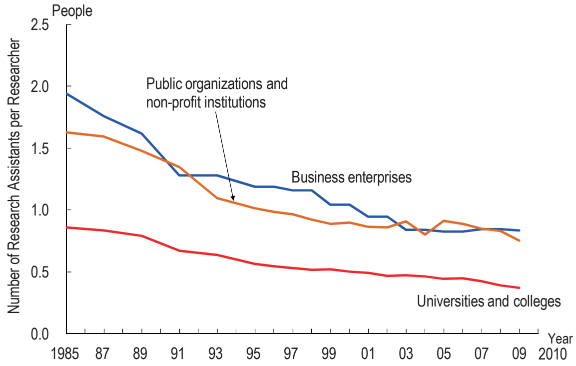
(A) Japan *



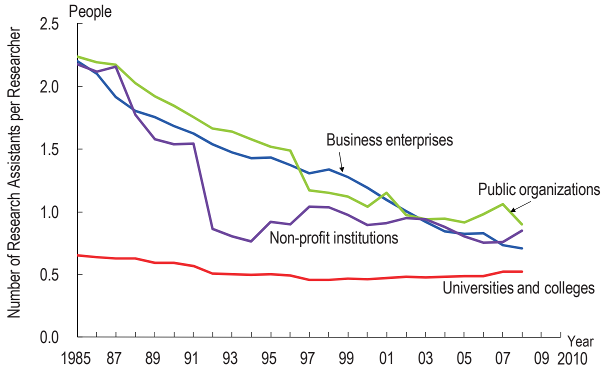
(B) Japan (HC)



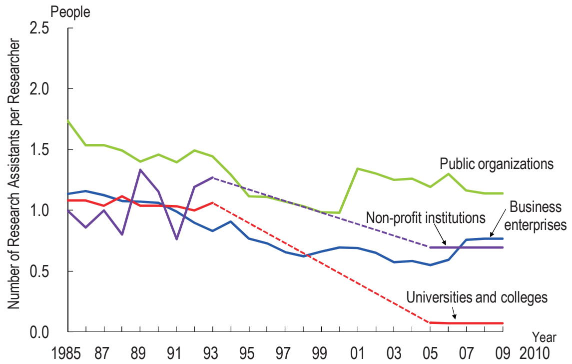
(C) Germany



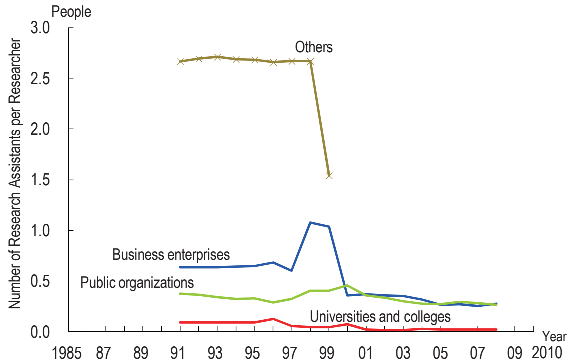
(D) France



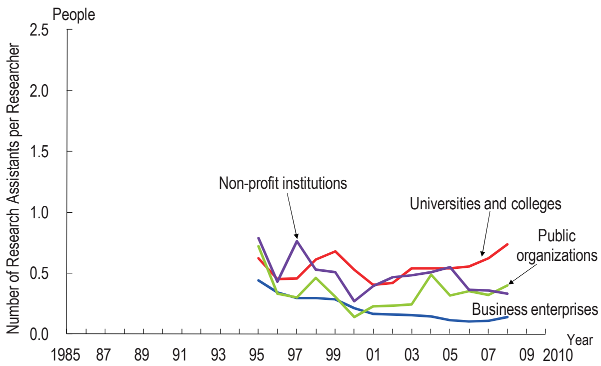
(E) U.K.



(F) China



(G) Korea



Notes:1) The definition and measurement methods of research assistants are different depending on the country or sector. Therefore it is necessary to be careful when international comparisons are being made. Refer to Chart 2-3-1 for the differences in research assistants.
2) The note for researchers is the same as for Chart 2-1-1.
3) FTE values were used in each country. But a part of Japan's data was HC values.
4) "Japan ∗" used the values in accordance with Chart 2-1-2(A) (Values represent the number of researchers mainly engaged in research, and were not measured on FTE basis. External non-regular researchers were not covered.)
5) "Japan (HC)" used values in accordance with Chart 2-1-2 (A)(3) (the total number of researchers "mainly engaged in research" and "engaged in research under non-regular conditions". The number of researchers in university and college sector includes the number of above mentioned "external non-regular researchers")
6) For France, the U.K. and Korea, the values for “non-profit institutions” were found by subtracting business enterprises, universities and public organizations from the total number of research assistants.

Source: <Japan>Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”,
<Germany> Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 1996, 2000, 2004”; “Forschung und Innovation in Deutschland 2007” “Bundesbericht Forschung und Innovation, 2008, 2010”; OECD, “Main Science and Technology Indicators 2010/2)” since 2008.
<Other countries>OECD “Main Science and Technology Indicators 2010/2”

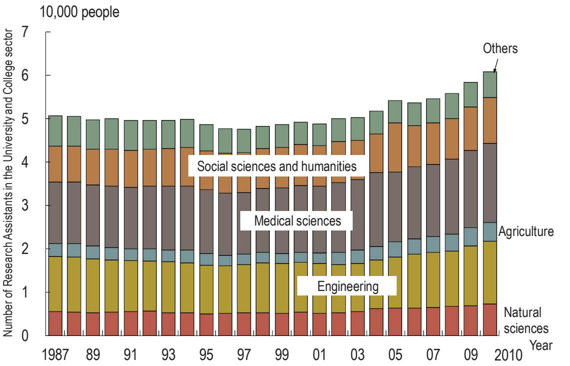
2.3.2 Status of research assistants in the university and college sector in Japan

(1) Breakdown of research assistants

As mentioned in Section 2.3.1., Japan's research assistants consist of "technicians", "assistant research workers" and "clerical and other supporting staff". In this section, details on research assistants in the university and college sector in Japan are examined.

Chart 2-3-3 shows the number of research assistants by the academic field of their affiliation. Their numbers have tended to be on the rise mainly in the field of natural sciences and the field of agriculture since around 2000, and the total for all fields was 61,000 people in 2010.

Chart 2-3-3: Numbers of research assistants by academic field of study in the university and college sector



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

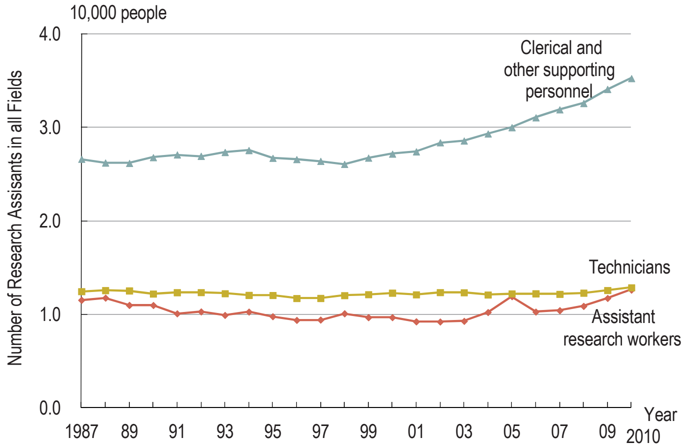
Next, looking at the breakdown of the number of research assistants, the number of "clerical and other supporting personnel", which account for the largest proportion of the total, has been increasing since 2000. It was and 35,000 people in 2010 (Chart 2-3-4(A)).

Above mentioned increase seems to have been caused by the revision of a cabinet order on the Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers in FY 1997, which added "research tasks related to sciences" to the list of temporary tasks permitted and as a result enabled temporary researchers to be employed. Another likely cause is a decision in FY 2001 to enable research institutes to employ research assistants who are necessary for the accomplishment of scientific research covered by grants in aid.

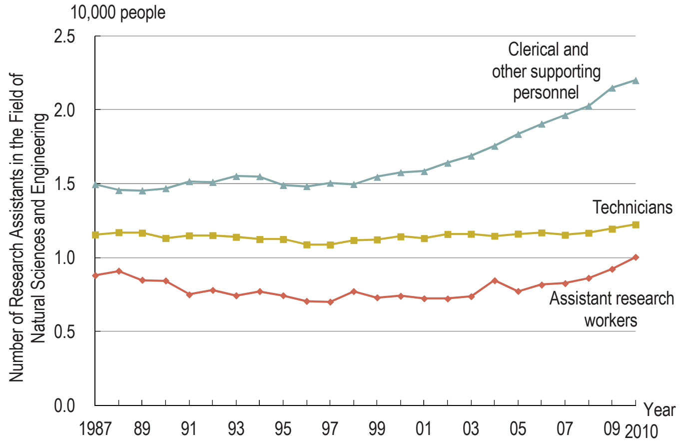
The breakdown of the number of research assistants by the academic field of their affiliation shows that the number of "clerical and other supporting personnel" is highest both in the field of "natural sciences" and the field of "social sciences and humanities" as it was in the breakdown of the total. But the number of "technicians" and "assistant research workers" is substantially larger in the field of "natural sciences" compared to that in the field of "social sciences and humanities" (Chart 2-3-4(B), (C)).

Chart 2-3-4: Breakdown of research assistants by academic field of study in the university and college sector

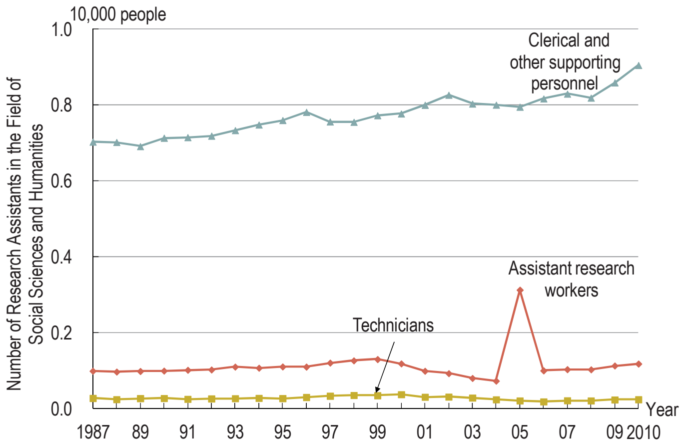
(A) Breakdown of the total



(B) Breakdown of the field of natural sciences and engineering



(C) Breakdown of the field of social sciences and humanities



Notes: 1) Expression "assistant research workers" represent s the people who assist "researchers" and work under the researchers' guidance.
2) Expression "technicians" represents the people who are not categorized as "researchers" nor "assistant research workers" and conduct research related auxiliary technical services under the guidance and supervision of "researchers" and "assistant research workers".
3) Expression "clerical and other supporting personnel" represents the people who are not categorized as "assistant research workers" nor "technicians", and work in general affairs, accounting and miscellaneous affairs.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

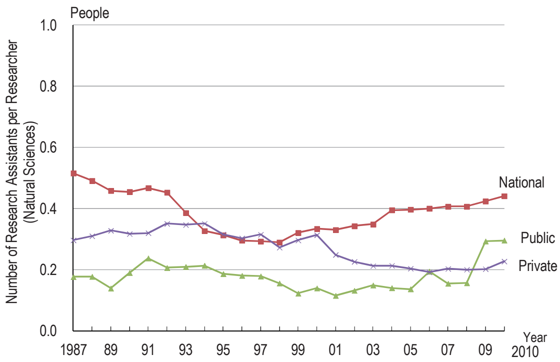
(2) Number of research assistants per researcher

In this section, the ratio of the number of research assistants per researcher (regular researchers: other than external non-regular researchers) by field of their affiliation is examined in order to determine whether or not the values differ depending on the type of university (national, public and private). (See Chart 2-3-5.)

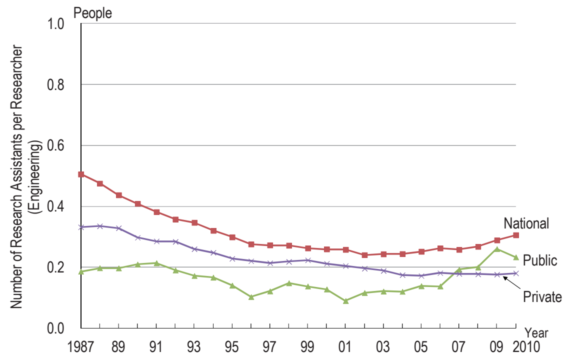
The number of research assistants per researcher is large in national universities in every field. In the field of "engineering", although the number had been decreasing in the long term in both national and private universities, a rising trend has been apparent in recent years. In the field of "medical sciences", the research assistants per researcher is small, and the difference with the research assistants per teacher in Chart 2-3-6 is significant. This difference, however, is due to the huge number of "medical staff and others" in this field compared to the other fields. In other words, the large number of researchers or the large denominator, rather than the small number of research assistants, influenced the result.

Chart 2-3-5: Trends in the number of research assistants per researcher by type of university in each academic field

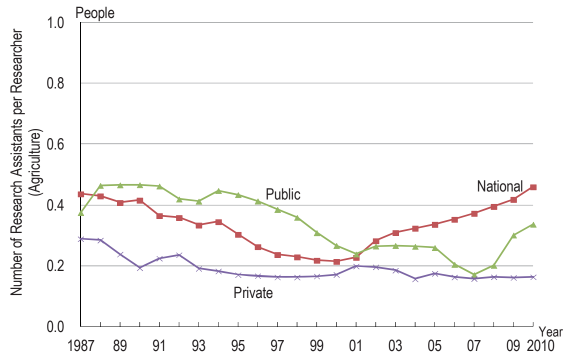
(A) Natural sciences



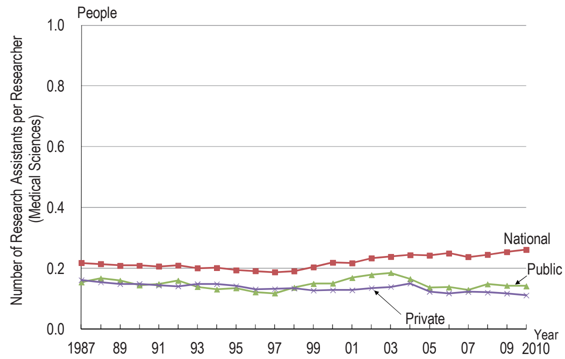
(B) Engineering



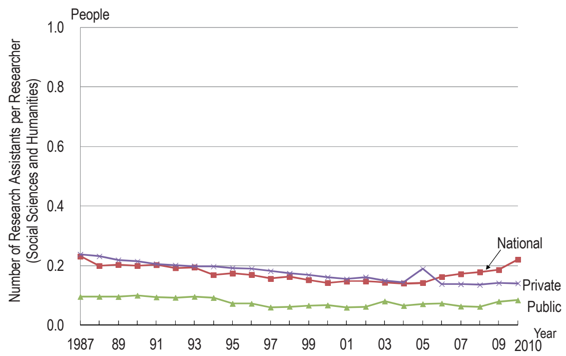
(C) Agriculture



(D) Medical sciences



(E) Social sciences and humanities



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

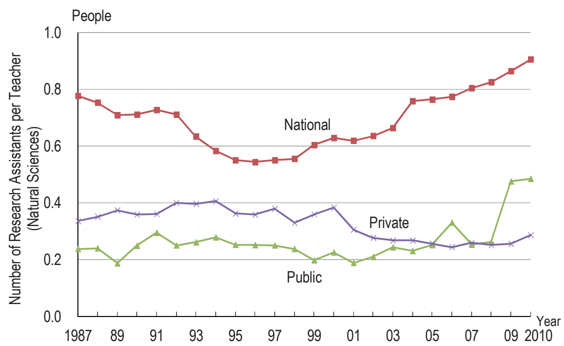
(3) Number of research assistants per teacher

Regular researchers are composed of (1) teachers, (2) doctoral course students and (3) medical staff and others, and the proportion of (2) and (3) differs depending on the field. Therefore, in this section, (2) and (3) were excluded from the coverage on the purpose of removing their influence. And the number of research assistants per teacher by field of their affiliation is examined in order to determine whether or not the values differ depending on the type of university (national, public and private).

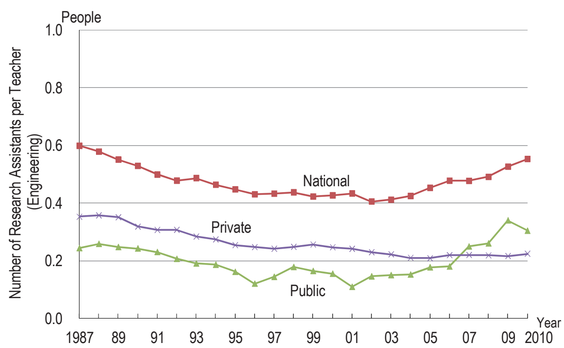
In every field, the number of research assistants is large in "national universities". In addition, the number of research assistants per teacher in the field of "natural sciences" and "agriculture" of "national universities" have a similar tendency of a decreasing trend until the 1990s which begins to rise in 2000 (Chart 2-3-6).

Chart 2-3-6: Trends in the number of research assistants per teacher by type of university in each academic field

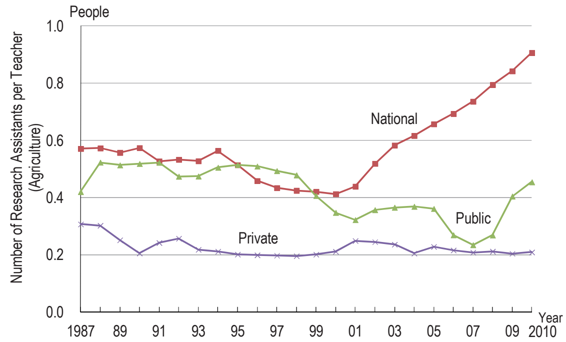
(A) Natural sciences



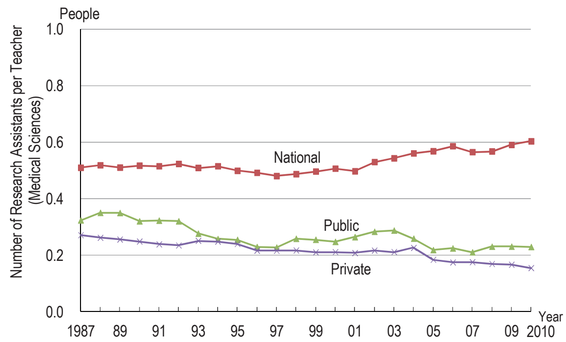
(B) Engineering



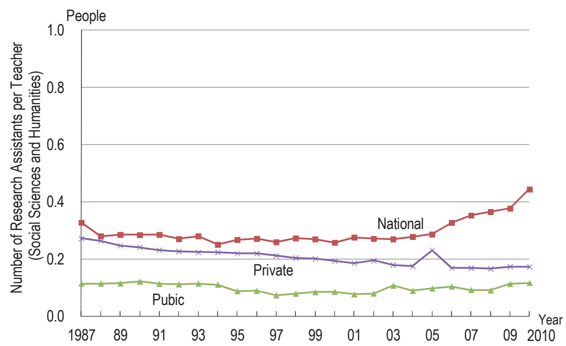
(C) Agriculture



(D) Medical sciences



(E) Social sciences and humanities



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

Chapter 3 : Higher Education

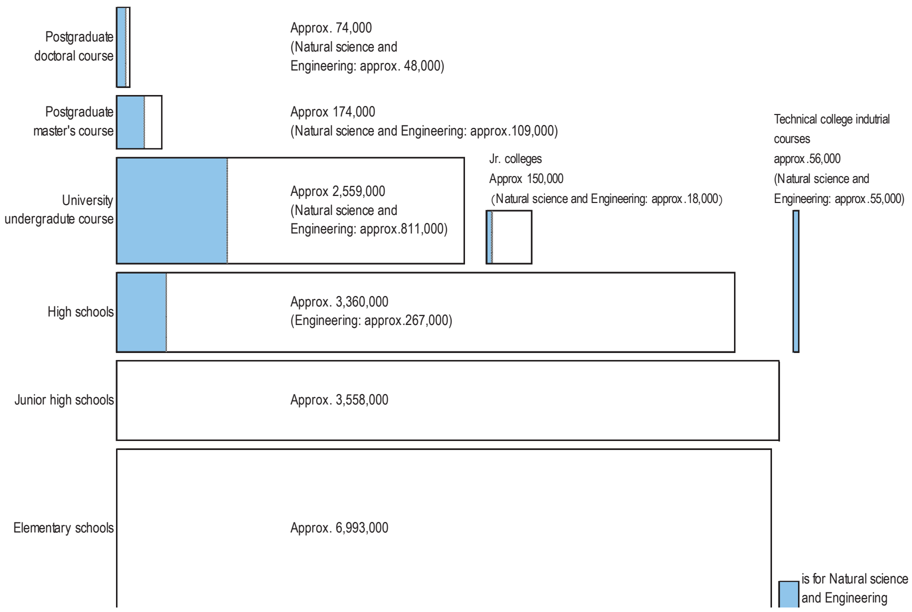
The cultivation of human resources relevant to science and technology is one of the most important basic infrastructures for promoting science and technology. This chapter describes the cultivation of human resources for science and technology in school education, mainly looking at conditions in universities and colleges as higher education institutions. Here, an international comparison of the enrollment status at each phase of higher education, career options after graduation or leaving school, the present situation of adult education, and of degree awarded is attempted.

3.1 The status of the number of students in Japan's education institutions

Chart 3-1 shows the total numbers of students and pupils in school education for the FY 2010, in order to gain an overall impression of the education system in Japan. The height of each bar in the graph represents the length of time in terms of course terms in each educational institution and the area of each bar of the graph indicates the number of the students and the pupils enrolled there.

The number of children in elementary schools is about 6,993,000, that of pupils in junior high schools are about 3,558,000, and that of high school students are about 3,360,000 (including only the regular courses). The number of undergraduate students is about 2,559,000 (including approx 811,000 in the field of "Natural science and engineering"), and that of college students is about 150,000 (including approx 18,000 in the field of "Natural science and engineering"). The number of master's program students in graduate schools is about 174,000 (including approx 109,000 in the field of "Natural science and engineering") and that of doctoral program students is about 74,000 (including approx 48,000 in the field of "Natural science and engineering")

Chart 3-1: The present status of the number of students and pupils, etc. in school education (for the FY 2010)



Note: 1) Conceptual representation indicating the breakdown of the number of students and pupils enrolling in the regular courses of each education institution and, of these, the number of students and pupils enrolled in Natural sciences and Engineering (regions shown in blue).
2) "Natural sciences and engineering" for universities and colleges or graduate schools is the total of Natural sciences, Engineering, Agricultural sciences, Medical science, and Dentistry and Pharmaceutical science.
3) "Natural sciences and Engineering" in junior colleges means the "Industrial department".
4) The height of each bar in the graph represents the length of time in terms of course terms for each educational institution and the area of each bar of the graph indicates the number of the students and the pupils enrolled.
5) The number of students in the postgraduate master's course and postgraduate doctoral course excludes the students in professional graduate school program.
Source: MEXT, "Report on School Basic Survey"

3.2 The status of students in Higher Education institutions

Key points

○The number of newly enrolled undergraduates in Japan had been roughly unchanged since about 2000, but in FY2010 it increased by 1.7% over the previous year, to about 619,000. The number newly enrolled in private universities and colleges was high, and constituted about 80% of the total. Classified by field, students majoring in "Natural science and engineering" comprised about 30% of the total.

○The number of students newly enrolled in master's programs had been roughly unchanged since about 2005, but in FY2010 it increased by 5.4% over the previous year, to 82,000. Those newly enrolled in national universities and colleges constituted about 60% of the total. Classified by field, students majoring in "Natural science and engineering" accounted for about 60% of the total.

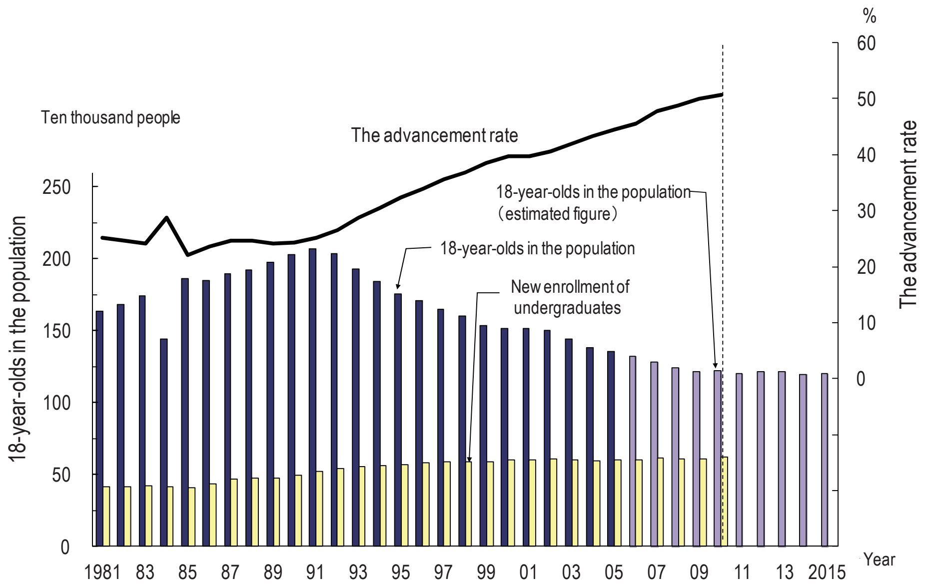
○The number of people newly enrolled in doctoral programs had been decreasing since peaking in 2003, but it increased by 3.6% over the previous year in FY2010, to 16,000. The number newly enrolled in national universities and colleges was high and constituted about 70% of the total. Classified by field, students majoring in "Natural science and engineering" accounted for about 70% of the total.

3.2.1 New enrollment of undergraduates

The number of 18-year-olds in the population has been decreasing from about 2,068,000 in 1991, which marked the peak. It is expected that this trend of decreasing will continue and estimated that the numbers will decline to about 1,202,000 in 2015, which 58% of the peak (see Chart 3-2-1).

Under circumstances of young people increasingly wanting to proceed to higher education and an increase in the number of student places, the numbers newly enrolled for undergraduate studies has increased from about 413,000 for the FY 1981 to about 619,000 for the FY 2010, which represents a growth of 1.5 times. As a result, the advancement rate for the FY 2010 (the ratio of the number newly enrolled to the total of 18-year-olds) is 50.7%, which is the highest rate ever.

Chart 3-2-1: 18-year-olds in the population and the transition of the numbers newly enrolled for undergraduate studies



Note: 1) 18-year-olds in the population is by medium estimation.
2) The numbers newly enrolled for undergraduate studies is the number of the students that enroll in universities and colleges (not including Junior colleges) in the above mentioned year, and are on the register as of 1st of May in the following year.
3) The advancement rate is the ratio of the numbers newly enrolled for undergraduate studies against 18-year-olds in the population.

Source: 1) 18-year-olds in the population: <until 2009>Ministry of International Affairs and Communications, Statistics Bureau, "Population Estimates" (as of October in every year).
<After 2010>National Institute of Population and Social Security research, "Population Projections for Japan: 2006-2055, December 2006"
2) The numbers newly enrolled for undergraduate studies: MEXT, "Report on School Basic Survey"

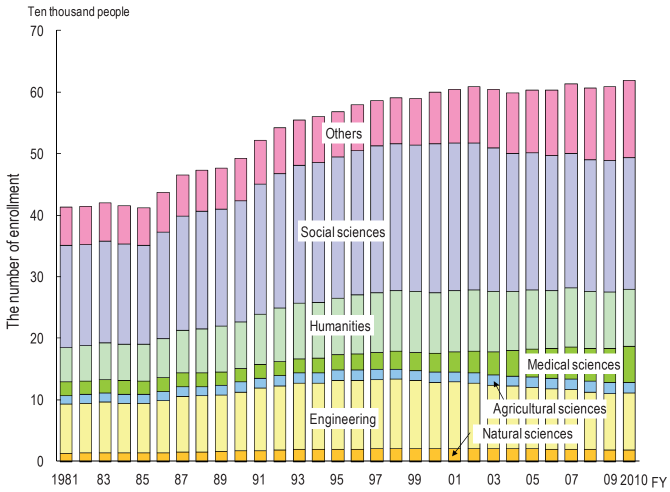
Chart 3-2-2 (A) shows changes in new enrollment of undergraduates by major fields. New enrollment of undergraduates in Japan had been largely unchanged since FY2000, but it increased by 1.7% over the previous year in FY2010, reaching 619,000.

Breaking down the new enrollment, the field of “Social sciences” had about 214,000 newly enrolled students, “Humanities” about 93,000, “Engineering” about 92,000, “Medical sciences” about 58,000, “Natural sciences” about 19,000 and Others (Home economics, Education, Art, others) about 125,000. The number of students newly enrolled in the field of “Medical sciences” was 2.7 times as high compared with FY1981, while “Others” was twice as high.

When the number newly enrolled is sorted by national, public and private universities and colleges (Chart 3-2-2(B)), the new enrollment in private universities and colleges constitutes 80% of the total. The increase in the new enrollment in private universities and colleges has had a profound effect to increase the new enrollment as a whole. By field, students majoring in "Natural sciences and engineering" accounted for about 30% of the total. A large share of the new enrollment in private universities and colleges was in the “Social sciences”. However, the composition ratio looking at private universities and colleges as a whole shows the trend that “Social sciences” has been decreasing. Meanwhile, the large number of the new enrollment in national universities and colleges is in “Engineering”. The increase in “Others” is largely a result of the increase in the new enrollment in “private universities and colleges”.

Chart 3-2-2: The numbers newly enrolled for undergraduate studies

(A) The transition of the numbers newly enrolled for undergraduate studies by major fields



(B) The transition of the number newly enrolled is sorted by national, public and private universities and colleges

(Unit person)

FY	Universities and colleges	Total	Humanities	Social science	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Mercantile marine	Home economics	Education	Art	Others
1990	Total	492,340	76,115	196,659	16,940	95,401	16,527	21,651	222	9,218	34,946	12,230	12,431
	National	100,991	6,360	15,757	6,419	29,117	7,549	6,047	222	306	22,137	600	6,477
	Public	14,182	2,842	5,346	709	1,739	422	1,233	-	746	342	633	170
	Private	377,167	66,913	175,556	9,812	64,545	8,556	14,371	-	8,166	12,467	10,997	5,784
2000	Total	599,655	98,407	241,275	20,795	107,566	16,147	31,573	174	11,473	32,086	17,395	22,764
	National	103,054	6,969	16,760	7,414	31,792	6,987	8,403	174	292	17,569	600	6,094
	Public	23,578	4,033	7,921	1,004	3,639	685	3,874	-	561	273	812	776
	Private	473,023	87,405	216,594	12,377	72,135	8,475	19,296	-	10,620	14,244	15,983	15,894
2010	Total	619,119	92,644	214,192	18,761	92,010	17,847	58,482	-	17,868	43,497	18,099	45,719
	National	101,310	6,810	15,443	7,079	29,886	7,022	11,023	-	294	16,077	846	6,830
	Public	29,107	4,824	8,006	581	3,305	1,038	5,947	-	703	467	1,154	3,082
	Private	488,702	81,010	190,743	11,101	58,819	9,787	41,512	-	16,871	26,953	16,099	35,807

Note: The “Others” in (A) are “Mercantile marine”, “Home economics”, “Education”, “Art” and “Others”
Source: MEXT, “Report on School Basic Survey”

3.2.2 New enrollment in master's programs in graduate schools

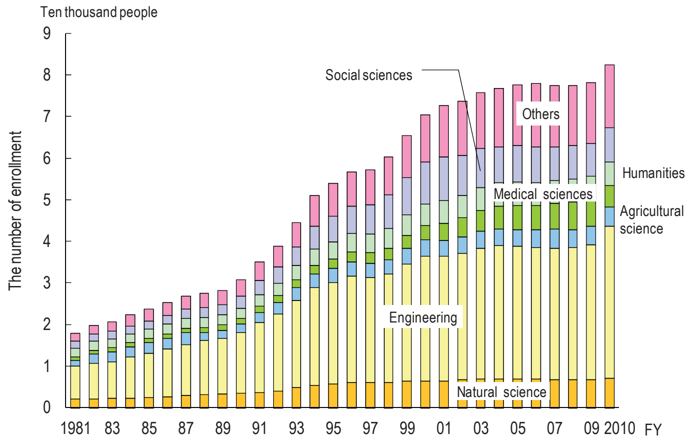
The number of new enrollments in graduate school master's programs in FY2010 totaled 82,000. It increased by 5.4% from the previous year. Broken down by major, "Engineering" accounted for the largest share, with 37,000 students (44.3%). It was followed by "Social sciences" with 8,000 students (10.1%), "Natural science" with 7,000 (8.5%) and "Medical sciences" with 5,000 (6.2%).

Since there has been greater of focus on graduate schools since the FY 1990, the number of new enrollments in master's programs in graduate schools greatly increased between the FY 1990 and the FY 2000. The rate of the increase was 2.3 times. Looking at this by major subject, the growth of the "Social sciences" was 3.4 times and that of "Medical sciences" was 2.5 times. During the 2000s, the overall rate of increase stagnated, but during the most recent available year, "Engineering" showed an increase of 12.4% compared with the previous year. This increased enrollment in "Engineering" programs contributed significantly to the overall rise in the number of new enrollments in graduate school master's programs in FY2010. On the other hand, enrollment in "Medical science" programs decreased by 23.4% from the previous year (Chart 3-2-3 (A)).

Looking at the trend of the number of new enrollments in master's programs by national, public and private universities and colleges, the trend was different from that for undergraduates. National universities and colleges accounted for about 60% of the total. By major, "Natural science and engineering" accounted for the largest share at national, public and private universities and colleges. Private universities and colleges had relatively high new enrollments in "Social sciences and humanities." (Chart 3-2-3 (B))

Chart 3-2-3: The number of new enrollments in graduate school (master's program)

(A) The transition of the number of new enrollments in graduate school (master's program) by major subjects



(B) The transition of new enrollments in graduate school (master's program) is sorted by national, public and private universities and colleges

(Unit: person)

FY	Universities and colleges	Total	Humanities	Social science	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Mercantile marine	Home economics	Education	Art	Others
1990	Total	30,733	2,400	2,927	3,291	14,697	2,104	1,376	55	206	2,684	713	280
	National	19,894	829	877	2,359	10,267	1,805	644	55	44	2,420	326	268
	Public	1,190	75	127	142	482	66	130	-	29	5	134	-
	Private	9,649	1,496	1,923	790	3,948	233	602	-	133	259	253	12
2000	Total	70,336	5,251	10,039	6,285	30,031	3,938	3,424	15	486	5,212	1,437	4,218
	National	41,278	1,814	2,929	4,464	19,336	3,297	1,661	15	114	4,564	366	2,718
	Public	3,307	233	389	391	1,178	185	326	-	126	17	246	216
	Private	25,751	3,204	6,721	1,430	9,517	456	1,437	-	246	631	825	1,284
2010	Total	82,310	5,633	8,341	6,974	36,501	4,746	5,132	30	519	4,865	2,136	7,433
	National	45,993	1,624	2,129	4,715	22,331	3,827	2,622	30	99	4,044	520	4,052
	Public	5,305	218	538	634	1,912	184	798	-	144	24	317	536
	Private	31,012	3,791	5,674	1,625	12,258	735	1,712	-	276	797	1,299	2,845

Note: The "Others" in (A) are "Mercantile marine", "Home economics", "Education", "Art" and "Others"
Source: MEXT, "Report on School Basic Survey"

3.2.3 New enrollment in doctoral programs in graduate schools

The number of new enrollments in graduate school doctoral programs had been declining since peaking in FY2003, but in FY2010 it increased by 3.6% from the previous year, reaching 16,000. By major, "Medical sciences" had a new enrollment of 6,000, accounting for 35.5%, of the total and "Engineering" had 3,000 (18.6%), while "Natural sciences," "Humanities" and "Social sciences" each had new enrollments of about 1,000 (Chart 3-2-4(A)). Compared with the previous year, "Engineering" showed the largest increase, 6.3%. "Medical science" also had a large increase at 5.6%.

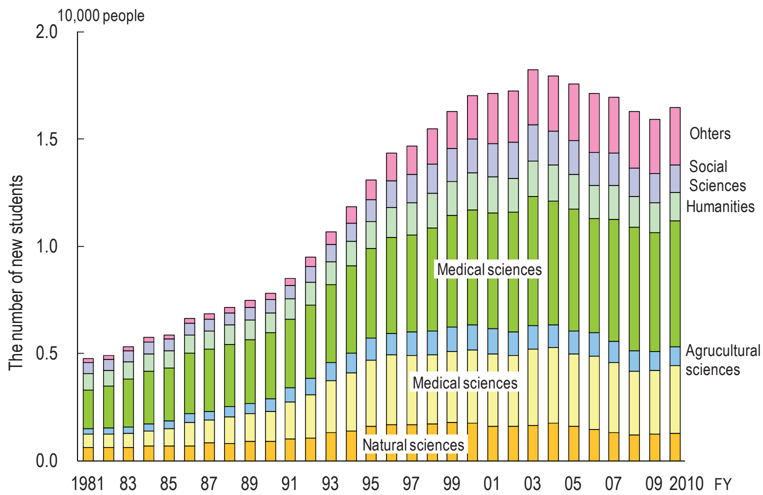
The number of new enrollments in graduate school doctoral programs has largely increased since the beginning of the 1990s. This resembles the increase in the number of new enrollments in graduate school master’s programs. The number of new enrollments in master's programs had been unchanged since the mid-2000s, while that of enrollments in doctoral programs had begun decreasing since its peak in 2003. During the most recent available year, however, new enrollments in both master's and doctoral programs increased.

By major, "natural science and engineering" accounted for 70% of the whole.

Looking at national, public and private universities and colleges, national universities and colleges account for 70% of the total. By major, "Natural sciences," "Engineering" and "Agricultural sciences" account for 80–90% of the total at national universities and colleges, with "Medical sciences" accounting for 60%. Thus, national universities and colleges have a high percentage of students majoring in "Natural sciences and engineering" (Chart 3-2-4(B)).

Chart 3-2-4: The numbers of new enrollments in graduate school (doctoral program)

(A) The transition of the numbers of new enrollments in graduate school (doctoral program) by major subjects



(B) The transition of new enrollments in graduate school (doctoral program) is sorted by national, public and private Universities and Colleges

(Unit: person)

FY	Universities and colleges	Total	Humanities	Social science	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Mercantile marine	Home economics	Education	Art	Others
1990	Total	7,813	917	606	929	1,399	580	3,076	-	21	165	24	96
	National	5,170	368	244	776	1,182	522	1,830	-	12	116	24	96
	Public	417	53	31	36	31	16	239	-	6	5	-	-
	Private	2,226	496	331	117	186	42	1,007	-	3	44	-	-
2000	Total	17,023	1,710	1,581	1,764	3,402	1,192	5,339	-	61	373	117	1,484
	National	11,931	761	638	1,461	2,732	1,070	3,710	-	0	246	47	1,266
	Public	941	71	95	126	172	36	364	-	23	9	17	28
	Private	4,151	878	848	177	498	86	1,265	-	38	118	53	190
2010	Total	16,471	1,318	1,303	1,285	3,139	902	5,850	-	79	488	199	1,908
	National	11,021	597	542	1,043	2,529	785	3,740	-	8	335	86	1,356
	Public	1,050	51	87	94	135	25	492	-	24	-	36	106
	Private	4,400	670	674	148	475	92	1,618	-	47	153	77	446

Note: The “Others” in (A) are “Mercantile marine”, “Home economics”, “Education”, “Art” and “Others”
Source: MEXT, “Report on School Basic Survey”

3.2.4 The ratio of female students

New enrollment of female students for undergraduate studies in the FY 2010 was 268,000, which accounted for 43.3% of the total and a percentage increase of 20.1 point than that for the FY 1981, which was only 23.2% (Chart 3-2-5).

Looking at the situation by department, the majority took "Humanities". Over the long term, however, the highest rate of increase in new enrollment was in "Engineering". Although the new enrollment was small, it was approximately 6 times that for the FY 1981 (Chart 3-2-5 (A)).

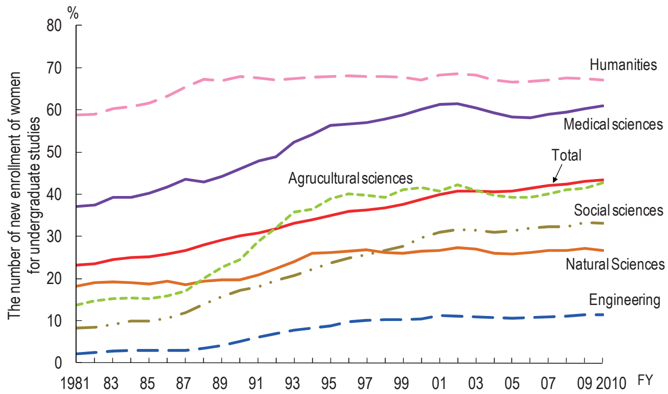
Next, when looking at the percentage of new enrollment by women in master's programs, many take "Humanities" which is the same as in the case of new enrollments for undergraduates. However, the percentage of female students in "Medical sciences" is also high. Although the percentage for the FY 1990 was 22.9%, it became 52.3% in FY 2010, which was more than the percentage of men.

The percentage of new enrollment of female students in doctoral programs for the FY 2010 was 31.8%, which was 3.4 points higher than the percentage of new enrollment of female students in master's programs in the same year.

Until the early 1990s, the percentage of new enrollment of women in "Natural sciences and Engineering" had a rising trend. While the trend has slowed down recently, the percentage of women who are entering higher education at the doctoral program level, has been increasing in "Natural sciences and engineering" (Chart 3-2-5 (B)).

Chart 3-2-5: The ratio of new enrollment of female students for undergraduate studies

(A) The transition of the ratio of new enrollment of female students for graduate studies



(B) The transition of the ratio of new enrollment of female students in graduate studies by departments・master's program・doctoral program, major fields and major subjects

	FY	Total	Humanities	Social sciences	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Others
Undrgraduate students	1990	30.2	67.9	17.3	19.7	5.1	24.5	46.0	59.1
	2000	38.8	67.1	29.6	26.5	10.5	41.5	60.1	62.6
	2010	43.3	67.0	33.2	26.7	11.4	42.7	61.0	60.9
Master's grpgrams	1990	16.1	46.3	25.2	12.5	3.4	11.8	22.9	41.4
	2000	26.3	55.0	30.8	21.6	9.0	33.9	52.0	46.9
	2010	28.4	61.5	39.4	21.7	10.1	34.7	52.3	47.2
Doctoral programs	1990	15.5	34.0	22.4	7.0	4.6	12.1	14.7	36.6
	2000	26.8	52.5	30.1	15.6	9.9	25.8	27.6	39.3
	2010	31.8	52.1	36.8	17.5	14.9	30.8	33.4	42.6

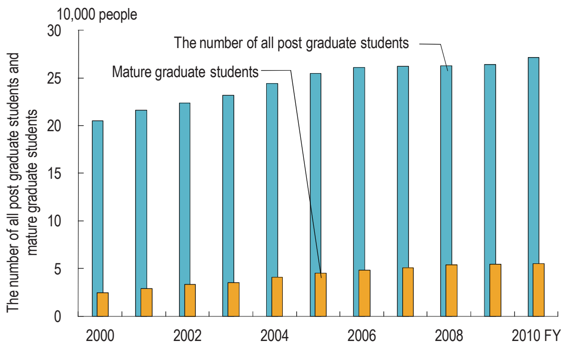
Source: MEXT, "Report on School Basic Survey"

3.2.5 Mature students in higher education institutions

Utilization of higher education institutions to give opportunities for the reeducation of people in the working world who are highly motivated to study is helpful to advance the cultivation of excellent human resources and use them. Moreover, it contributes to energizing society as a whole.

Of all postgraduate students in Japan for the FY 2010, the number of working people was 55,345, which accounts for 20.4%. Compared with 12.1% in the FY 2000 when statistical data on mature students was first gathered, this is about double (Chart 3-2-6).

Chart 3-2-6: The transition of the number of mature graduate students in Japan

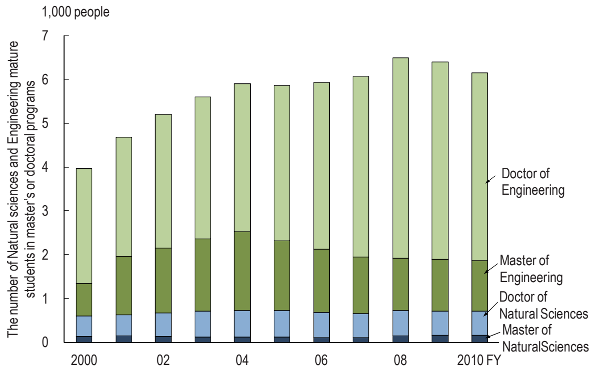


Note: 1) "Mature" is the persons who enter into employment for taking current income such as pay or wage as of May 1st in each year, and include retired employees and house wives.
2) Postgraduate students here are persons who are registered in a master's program and the preliminary term of a doctoral program, or in a doctoral program and the latter term of doctoral program, and in professional graduate schools.
Source: MEXT, "Report on School Basic Survey"

Looking at the number of mature graduate students in "Natural sciences" and "Engineering" by degree, 4,280 were enrolled in doctoral programs in "Engineering" in FY2010, a decrease from FY2008. The number of mature graduate students in master's programs in "Engineering" has been on a downward trend since FY2004. At 1,115 in FY2010, there was about one-fourth as many mature students in master's programs as there were in doctoral programs.

Mature students enrolled in doctoral courses in "Natural sciences" during FY2010 numbered 554. Those in master's courses in "Natural sciences" numbered 169. This was only about 1.2 times the number enrolled during FY2000, a slower growth rate than for "Engineering" (Chart 3-2-7).

Chart 3-2-7: The transition of Natural sciences and Engineering mature graduate students



Source: MEXT, "Report on School Basic Survey"

3.3 Career options for students in Natural sciences and Engineering

Key Points

○Looking at the career paths of students in "Natural sciences and engineering" after graduation, until recently, about 60% of students receiving bachelor's degrees obtained employment, while 40% proceeded with further education. In 2010, however, only 45.8% of those receiving bachelor's degrees obtained employment. This is different from the situation that had prevailed in recent years.

○As for the career paths of those obtaining master's degrees in "Natural sciences and engineering," about 80% have been obtaining employment. This percentage has been increasing since entering the 2000s. In 2010, 83.3% obtained employment, with a decline of 3.8 percentage points compared with the previous year.

○Looking by industrial classification at graduates in "Natural sciences and engineering" who obtain employment, since 2000, "manufacturing industry," "Service type industries" and "Others" had each accounted for about one-third of those receiving bachelor's degrees. In 2010, however, the percentage obtaining employment in "Manufacturing industry" fell to 27.4%.

○In the case of those receiving master's degrees in "Natural sciences and engineering," since the mid-1990s, the percentage of students obtaining employment in "Manufacturing industry" had been over 60%, with around 20% entering employment in "Service type industries". In 2010, however, the percentage obtaining employment in "Manufacturing industry" declined to 55.5%.

○Looking by industrial classification at graduates of undergraduate, master's, and doctoral courses in "Natural sciences and engineering" who obtain employment, over 80% become "professional and technical workers". Of these, a large number of bachelor's and master's graduates become "Engineers" (Although the number of bachelor's degree recipients becoming "Engineers" decreased in 2010 compared with the previous year.). In the case of doctoral graduates, they are more likely to obtain academic occupations. A balance had been maintained, with about 30% becoming "Scientific researchers," 40% "Engineers" and 20% "Teachers," in recent years. In 2010, however, the percentage becoming "Scientific researchers" increased to 38.7%.

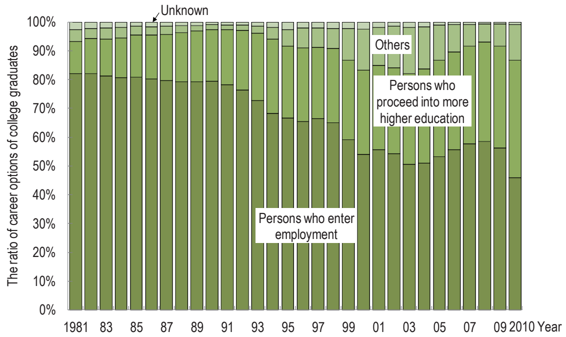
3.3.1 The status of employment and continuing education among students of Natural sciences and Engineering

This section describes career options particularly for students of “Natural sciences” and “Engineering”. “Persons who enter employment” as used herein represents those who get jobs with routine income. Persons who get temporary or part time jobs are included in “Others”. This data was based on a survey of the employment status of students for whom universities and colleges could provide information at the time of the survey being conducted (as of May 1st of respective years).

(1) Career options of college graduates

Looking at the career options of “Natural sciences and Engineering” college graduates for the FY 2010, the percentage of “persons who entered employment” was 45.8%, which is the biggest share, and that of “persons who proceeded with more higher education” was 41.0% in the second place. The percentage of “persons who entered employment” was approximately 80% in the 1980s, however, it largely declined in the 1990s. In recent years, it had been increasing, but in 2010 it declined sharply, while the number of graduates pursuing further education increased. Partly due to the influence of upgrading and expanding graduate schools since the late 1990s, the percentage of "persons who proceed to higher education" has been consistently increasing. In 2010, both the percentage and the number increased (Chart 3-3-1).

Chart 3-3-1: Career options of “Natural sciences and Engineering” college graduates

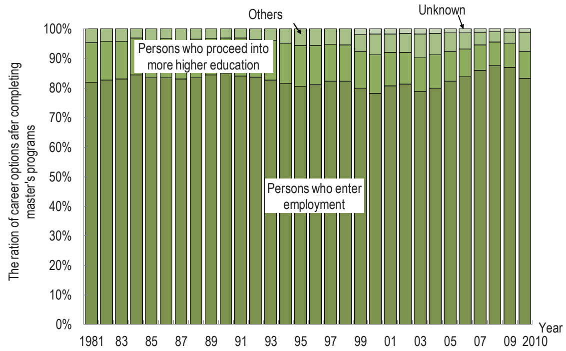


Note: 1) This chart includes both “persons who entered employment” and “persons who proceeded with more higher education” in the “number of persons who entered employment”.
2) Persons who entered employment are persons who work for current income
3) Persons who proceeded with more higher education are persons who proceeded to undergraduate schools, etc. Persons who enrolled in special training schools and schools overseas are excluded.
4) Unclear: Deceased/Unknown
5) The others: Do not fall under above mentioned
Source: MEXT, “Report on School Basic Survey”

(2) Career options of persons who complete master’s programs

Looking at career options of persons who complete master’s programs in “Natural sciences and Engineering” over the long term, the composition ratio did not show a big change until the early 2000s and the percentage of “persons who entered employment” accounted for about 80% of the total. Since the beginning of the 2000s, the percentage had been increasing, but in 2010 it decreased 3.8 percentage points, to 83.3% from the previous year. The percentage of "persons who proceeded to higher education" had been declining through the 2000s, but it rose 1 percentage point to and it was 9.2% in 2010 (Chart 3-3-2).

Chart 3-3-2: Career options of persons who complete master’s programs in “Natural sciences and Engineering”



Note: Same as Chart 3-3-1
Source: MEXT, “Report on School Basic Survey”

Column: Postdoctoral career options in Natural sciences and Engineering

There are statistics on postdoctoral career options collected in the School Basic Survey, however, it is necessary for this data to be interpreted with care.

Chart 3-3-3 shows "postdoctoral career options for Natural sciences and Engineering". The percentage of "The others" is indicated as higher than that of college graduates and people who complete master's degree programs. "The others" used herein means the sum of "residents", "persons who enrolled in special course schools and schools abroad", "persons who have temporary jobs" and "the other persons who were not applicable to these categories". The following two points are considered as reasons why the percentage of "not otherwise classified" is high.

(1) Influence of the classification of the career options on doctoral graduates

After graduation from a doctoral program, persons who work for universities and colleges or public organizations as doctoral graduates have been increasing. However, it is not clear whether doctoral graduates are included in "persons who enter employment", "persons who got temporary jobs" or "other persons who were not applicable in these categories" in the classification of the career options in School Basic Survey. As the employment patterns of doctoral graduates are diverse, there are some cases in which they are employed on the basis of a few months at a time. Therefore, there is a possibility that some doctoral graduates can be categorized into "persons who got temporary jobs" or "other persons who were not applicable in these categories".

(2) Influence of graduates of doctoral programs whose career path was not decided at the time of the survey being carried out

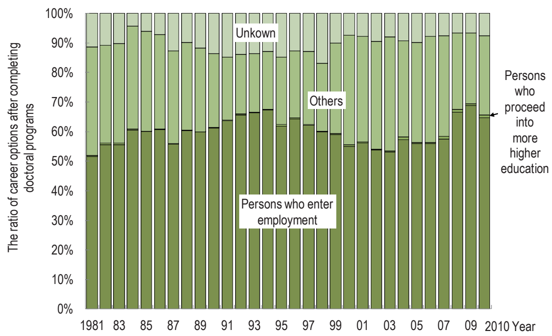
Different from college graduates and persons who complete master's degree programs, there are many doctoral graduates who aim at academic careers. As for getting into a company, the recruiting time is more or less set. However, academic recruitment occurs throughout the year. Therefore, there are many people, who seek academic careers, who have not still set their career in concrete as of May 1st of the year following graduation, which is scope of target for School Basic Survey. Regarding career options for these people who are not employed or proceed to higher education, they are sorted into "other persons who were not applicable in these categories". Actually, the percentage of "other persons who were not applicable in these categories" in "not otherwise classified" (1,317 persons) for the FY 2010 was about 70%, which was the largest.

Moreover, since career options have not been determined at the time of the survey being carried out, there might be some persons who did not reply to the survey (such cases become unknown).

Thus, over the past 20 years, the percentage of doctoral graduates in Natural sciences and Engineering who have entered employment is about 60%, and it can be said that the reason for the percentage of "not otherwise classified" being high is that the career path pattern of doctoral graduates is different from that of college graduates and master's graduates. Based on this data, one should not conclude, for example, that the reason why the percentage of doctoral graduates who enter employment has remained around 60% is because there is mismatch between the ability of doctoral graduates and social needs. Regarding whether there is mismatch between supply and demand, it would be necessary to analyze occupations and industries, in which doctoral degree awarded work, by implementing continuous follow-up surveys on human resources with doctoral degrees as is carried out in the U.S.

(Masatsura Igami)

Chart 3-3-3: Postdoctoral career options in Natural sciences and Engineering



Note: Same as Chart 3-3-1
Source: MEXT, "Report on School Basic Survey"

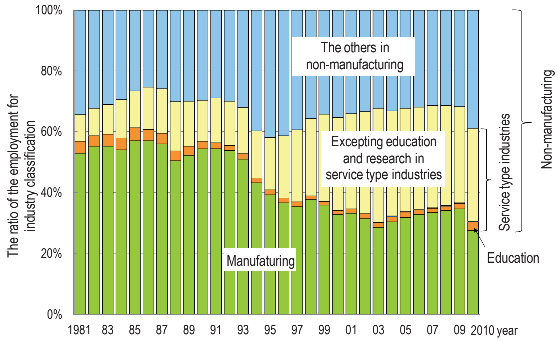
3.3.2 The employment status of students of Natural sciences and Engineering by industry classification

This section shows the place of employment by industry classification of the students described in section 3.3.1, "The status of employment and continuing education among students of Natural sciences and Engineering". The industry classification used herein is the "Japan Standard Industry Classification: JSIC" which determines an industry by the main services of its business enterprises (The revision of JSIC was conducted in 1993, 2002 and 2007 and all were applied from the next year). "Education" as used in the JSIC refers to "school education," which includes elementary schools, junior high schools, high schools, universities and colleges. And "Research" means "Academic and R&D institutes", which refers to business premises doing academic, experimental and R&D research.

(1) College graduates entering employment

Looking by industry classification at changes in the percentage of bachelor's degree recipients in "Natural science and engineering" who enter employment, the percentage of employment in "Manufacturing" was in the 50s during the 1980s. In recent years, however, the percentage fell to the 30s, and in 2010 it dropped to 27.4%. As will be discussed below, this is even lower than the percentage of doctoral recipients who enter employment in "Manufacturing" (30.2%). Meanwhile, the percentage of employment in "Service-type industry" within "Non-manufacturing" has increased from the 10s to the 30s (Chart 3-3-4). Within this, "Education" had decreased from the 4% level to the 1% level, but it rebounded to the 3% level in the most recent available year. Additionally, the percentage in "Others in non-manufacturing" became large in 2010.

Chart 3-3-4: College graduates in Natural sciences and Engineering entering employment



Note: 1) Includes both "persons who entered employment" and "persons who proceeded with more higher education" in the "number of persons who entered employment".

2) 1981 - 2001

Service-type industry other than Education/research: Service industry in Japan Standard Industry Classification (revised in 1993)

Education: "Education" within "service industry" in the same Classification

Research: No applicable classification

2002 – 2006

Service-type industry not including Education/Research: In Japan Standard Industry Classifications (revised in 2002), "Information and communication industry", "Catering establishment, Service industry", "Medical services, Welfare", "Education, Study-support service" excludes "School education": "Combined services", "unclassified other services" excepting "Academic field/R&D"

Education: "School education" within "Education/Study-support services" in the same Classifications

Research: "Academic field/R&D" within "unclassified other services" in the same Classifications

2007 -

Service-type industry not including Education/Research: In Japan Standard Industry Classifications (revised in 2007), refers to "Academic research, Specialty services" excluding "Academic field/R & D institutions": "Lodging industry, Catering establishment", "Living-related services" and "Education, Study-support services" without "School education": "Medical services, Welfare", "Combined services", "unclassified other services" and "Information and communication services"

Education: "School education" within "Education/Study-support services" in the same Classifications

Research: "Academic field/R&D institutions" within "Academic research/Specialty services" in the same Classifications

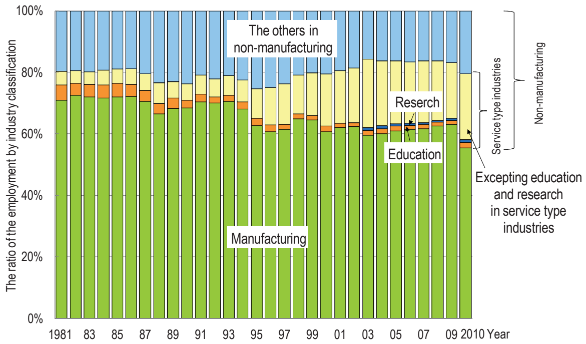
Source: MEXT, "Report on School Basic Survey"

(2) Master's degree program graduates entering employment

Looking by industry classification at the change in the percentage of graduates from master's degree programs in "Natural sciences and Engineering" entering employment, the percentage finding employment in "Manufacturing" was in the 70s during the 1980s. In recent years, however, the percentage had fallen into the 60s, and it 2010 it dropped to 55.5%. The percentage of employment in the "Service-type industry" of "Non-manufacturing" has increased from the 10s to the 20s. "Education" within "Service-type industry" has dropped from the 4% level to the 1% level. And "Research" is under 1%.

During the 2000s, employment of new graduates from master's degree programs in "Natural sciences and Engineering" in "Manufacturing" was 60%, with 40% in "Non-manufacturing". During the most recent available year, both categories approached 50%. (Chart 3-3-5).

Chart 3-3-5: Graduates from master's degree programs in Natural sciences and Engineering entering employment



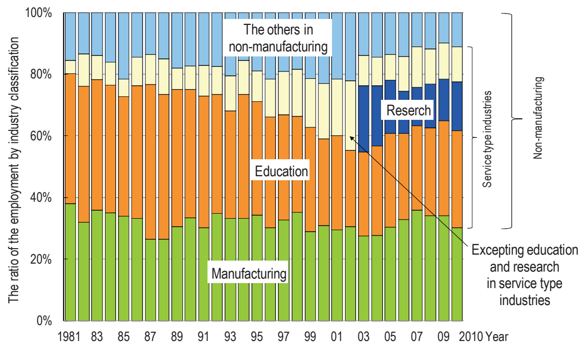
Note: The same as Chart 3-3-4
Source: MEXT, "Report on School Basic Survey"

(3) Doctoral graduates entering employment

Looking by industry classification at changes in the percentage of doctoral graduates in "Natural sciences and Engineering" entering employment, the percentage obtaining employment in "Manufacturing" has generally been around 30%. In 2010, it was 30.2%. The percentage obtaining employment in "Non-manufacturing" was higher than this. Within "Non-manufacturing," the percentage in "Service-type industry" has been around 50%. Although "Education" in "Service-type industry" went from 40% to 50% in the 1980s, it has declined to less than 30% in the 2000s. The percentage of doctoral graduates finding employment in "Research," which has been measured since 2003, has been large compared with those of graduates receiving bachelor's and master's degrees.

Recent employment of doctoral graduates in Natural sciences and Engineering by industry classification was about 30% in "Manufacturing", around 30% in "Education" and approximately 10% in "Research" (Chart 3-3-6).

Chart 3-3-6: Doctoral graduates in Natural sciences and Engineering entering employment



Note: The same as Chart 3-3-4
Source: MEXT, "Report on School Basic Survey"

3.3.3 The employment status of Natural sciences and Engineering students

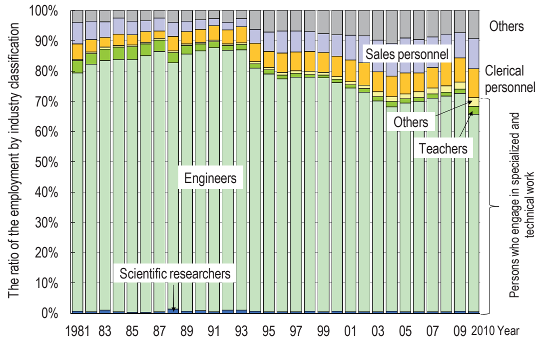
This section shows the place of employment by occupation classification of the students described in section 3.3.1, "The status of employment and education continuance on Natural sciences and Engineering students". Occupation classification referred to herein means the "Japan Standard Occupational Classification" and it classifies individual occupations. Therefore, it is without regard for the business activities of Business enterprises which individuals belong to.

"Scientific researchers" as used herein means "persons who engage in research which requires specialized and scientific knowledge for research and testing in facilities such as laboratories and test stations," and so-called researchers are included in it. "Engineers" mean "persons who engage in scientific and technical work which applies specialized, scientific knowledge and means for production such as project, management, supervision and research". "Teachers" are "persons who engage in education and advocacy for students in facilities which provide education such as schools and kindred class of school education". Teachers at universities and colleges are included in this category.

(1) College graduates entering employment

Looking by occupation classification at the employment percentage of "Natural sciences and engineering" college graduates, "Persons who engage in specialized and technical work" was at 80–90% during the 1990s and dropped to the 70s during the 2000s. Breaking this down further, there have been a large number of "Engineers", with percentages tracking those for "Persons who engage in specialized and technical work". In 2010, they accounted for 65.2%, a decline of 6.7 percentage points from the previous year. Additionally, bachelor's degree recipients who work as "Scientific researchers" account for about 0.5% of the total (Chart 3-3-7).

Chart 3-3-7: The status of Natural sciences and Engineering college graduates by occupation

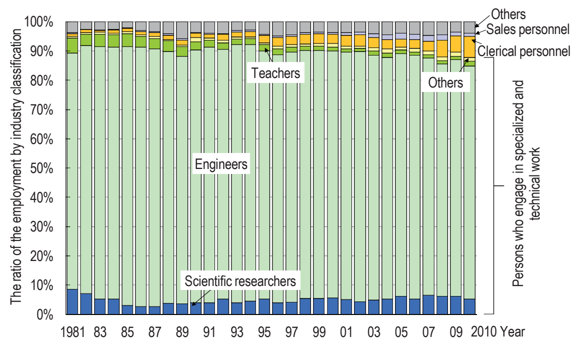


Source: MEXT, "Report on School Basic Survey"

(2) Master's degree program graduates entering employment

Looking at the employment percentage of persons who completed master's program in Natural sciences and Engineering by occupation classification, "persons who engage in specialized and technical work" is approximately 90% of the total and consistently accounts for the large portion. The breakdown shows that "Engineers" is in the 80% range and "Scientific researcher" is in a 5~6% range in recent years. The percentage of "Teachers" has been decreasing in the long term, hovering at the 1% level during recent years. On the other hand, "persons who engage in clerical work" has continued to increase slightly (Chart 3-3-8).

Chart 3-3-8: The status of the employment of persons who completed master's program in Natural sciences and Engineering by occupation

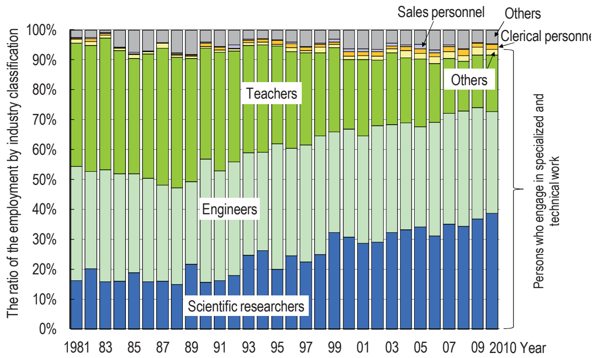


Source: MEXT, "Report on School Basic Survey"

(3) Doctoral graduates entering employment

Looking at the employment percentage of doctoral graduates in Natural sciences and Engineering by occupation classification, “persons who engage in specialized and technical work” comprise a high level of over 90%.　A breakdown shows that the percentage of "Engineers" was consistently at 30–40%, while that of "Scientific researchers" was under 20%. Beginning around 2000, however, it began to increase, rising to 38.7% in 2010.　On the contrary, although the percentage of “Teachers” used to be 40%, now it has declined to less than 20% (Chart 3-3-9).

Chart 3-3-9: The status of the employment of doctoral graduates in Natural sciences and Engineering by occupation



Source: MEXT, “Report on School Basic Survey”

3.4 International comparison of degree awarded

Key Points

○Looking at the number of persons who have degrees per one million of the population, bachelor's degrees awarded in Japan are about 4,246. This is less than Korea, the U.S. and the U.K., however, it greatly surpasses Germany and France. Meanwhile, the number of doctoral degree awarded is about 135, which is half as many as that in the U.K. and Germany and falls below that of the U.S., Korea and France.

○When the rate of increase in the number of doctoral degree recipients per one million population is obtained by comparing 1995 with the most recent available year, the U.K. has grown the most, becoming 1.61 times as large. It is followed in order by the U.S. at 1.26 times as large, Japan (1.25), France and South Korea (both 1.22) and Germany (1.12).

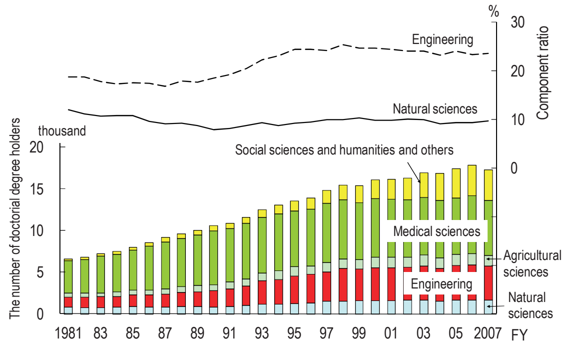
3.4.1 Doctoral degree awarded in Japan

The number of doctoral degree awarded is considered to be as one of important indicators for evaluating the quality of human resources in science and technology.

Chart 3-4-1 shows the change in the number of doctoral degrees conferred by major field. Conferral of doctoral degrees as used herein is the number of degrees given in the year which is based on degree rules (the so-called new Ph.D. system). This was 6,599 in FY1981, and subsequently increased. Recently growth slowed, however, reaching 17,291 in FY 2007, which was decrease of 3.2% from the previous year.

The breakdown by main subjects of special study of the number of degrees conferred in the FY 2007 shows that "Medical sciences" (science of medicine, dentistry, pharmaceutical sciences and health science) were 6,603, which accounts for 38.2% of the total. "Natural sciences" were 1,686 (9.8%) and "Engineering" was 4,073 (23.6%).

Chart 3-4-1: The transition of the number of doctorates awarded



Note: 1) "Medical sciences" is for "Science of medicine", "Dentistry", "Pharmaceutical sciences" and "Health sciences".
2) "Education", "Art" and "Home economics" are included in "Education".
Source: Until the FY 1986, surveyed by Education Research Center, Hiroshima University "Higher Education Statistical Data (1989)"
After the FY 1987, surveyed by MEXT, for FY2007, "Statistical Handbook on Education, Culture, Sports, Science and Technology

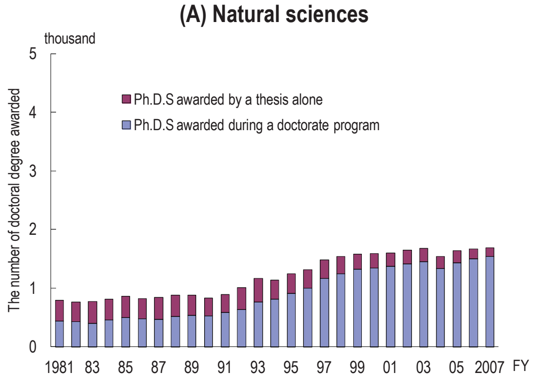
Chart 3-4-2 shows the change in the number of degrees awarded by the breakdown of the number of Ph.D.s awarded during a doctoral program and Ph.D.s awarded by a thesis alone.

The number of degrees awarded in "Natural sciences" had been increasing since FY 1991, but has been flat since entering the 2000s. Looking at the breakdown of Ph.D.s awarded during a doctoral program and Ph.D.s awarded by a thesis alone, the number of Ph.D.s awarded during a doctoral program exceeds the number of Ph.D.s conferred by a thesis alone throughout the years. Additionally, the recent increase in the number of degrees conferred has been brought about almost entirely by Ph.D.s awarded through doctoral programs. The percentage grew to 91.5% in FY2007.

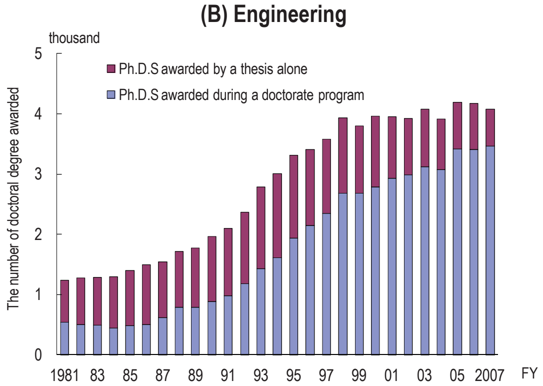
There had been a sharp increase in the number of degrees conferred in "Engineering" since the late 1980s, but, as with "Natural sciences," growth flattened during the 2000s. To break this down further, the number of Ph.D.s awarded by a thesis alone exceeded the number of Ph.D.s awarded during a doctoral program until the early 1990s. Since then, however, the number of Ph.D.s awarded during a doctoral program has increased remarkably, accounting almost entirely for the rise in the number of Ph.D.s awarded. In FY2007, they accounted for 85.2% of the total.

Chart 3-4-2: The Change of the number of doctorates awarded (the number of Ph.D.s conferred by a thesis alone/the number of Ph.D.s awarded during a doctoral program)

(A) Natural sciences



(B) Engineering



Notes: Same as Chart 3-4-1.
Source: The same as Chart 3-4-1

3.4.2 International comparison of the number of bachelor's degrees, master's degrees and doctorates degrees awarded

Regarding the number of bachelor's degrees, master's degrees and doctoral degrees awarded per one million of the population by country, persons covered here are those who are considered to be awarded bachelor's degrees, master's degrees and doctoral degrees by Japanese standards, although there are differences in the contents of academic degrees according to the country (refer to notes for details).

In recent years, Germany has begun adopting the common European standards for undergraduate (bachelor's) and graduate (master's) degrees in addition to its traditional first university degree, the Diplom. Traditionally, only those passing a national examination (the Diplom exam) after graduating had been counted as degree holders. In the most recent year, however, those passing the national exam, those completing specialized college, and those receiving first university degrees were all counted.

In addition, data on master's degrees is now calculated.

(1) Bachelor's degrees awarded per one million of the population

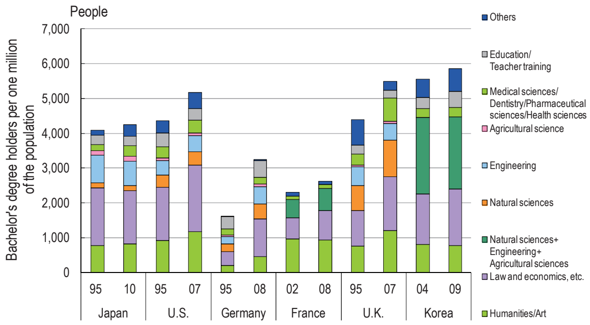
When looking at bachelor's degrees awarded per one million of the population, Japan had about 4,246 in 2010. Countries awarding more than 5,000 in the most recent available year were South Korea with 5,855 (in FY2009), the U.K. with 5,491 (FY2007) and the U.S. with 5,181 (FY2007). Germany and France awarded relatively fewer, at 3,251 and 2,625, respectively (both in FY2008).

Regarding the rate of increase when comparing the figures for 1995 (2002 for France) with those for the latest available year in each country, the U.K. had the highest growth rate, becoming 1.25 times as large. It was followed by the U.S. at 1.19 times as large, France (1.14), South Korea (1.05) and Japan (1.04).

When the composition ratio is divided according to subjects of special study, such as "Natural science and engineering" ("Natural sciences," "Engineering," "Agricultural sciences" and "Medical sciences," etc.) and "Social sciences and humanities" ("Social science," "Art," "Law," etc.), each country had a large percentage in "Social sciences and humanities". The percentage in France was particularly high, accounting for 70%. In Japan and the U.S., it accounted for about 60%. In contrast, it accounted for around 40% in South Korea, about the same as "Natural science and engineering". In the U.K., "Natural science and engineering" accounts for about 50%.

Chart 3-4-3: The international comparison of the number of bachelor's degrees awarded per one million of the population

(A) Bachelor's degrees awarded



Note: <Japan> Accounted for college graduates as of March in the year noted. "Others" are "General education course", "International relations" and "Mercantile marine".

<U.S.> Accounted for bachelor's degrees awarded in the year starting from September of the year represented. "Science of medicine, Dentistry, Pharmaceutical sciences and Health sciences" include "Veterinary medicine". "Others" includes "Military science" and "Interdisciplinary science".

<Germany> The number of successful applicants for the Diplom Examination in the winter term of the year indicated and the summer term of the following year, the number of successful applicants for Teacher Testing (national exam), the number completing specialized college, and the number receiving bachelor's degrees (standard three-year course).

<France> The number of college graduates in the year represented (calendar year). Bachelor's degree of national universities and colleges (3 years) and first degree in Science of medicine/Dentistry/Pharmaceutical sciences. The number of conferred "Diplome de docteur" (5 – 8.5 years).

<U.K.> Accounted for the number of first degrees awarded from universities and higher education colleges

<Korea> The number of college graduates of March in the year represented. "Humanities/Art" is for "Humanities" alone, and "Art" is included in "Others".

Source: MEXT, "International Comparison of Education Indicators".
The population of each country is the same as Reference Statistics A.

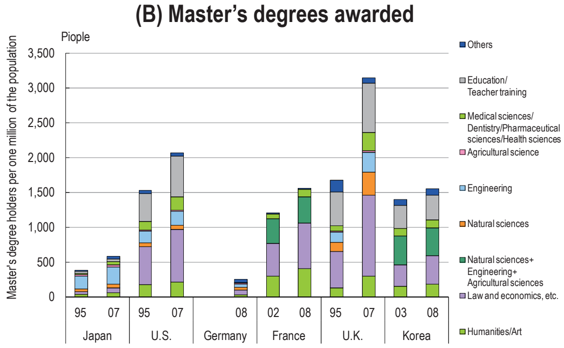
(2) Master's degrees awarded per one million of the population

When looking at the number of master's degrees awarded in each country per one million of the population, Japan marked about 586 (in FY 2007), which was less than the other countries. With about 3,140 in FY 2007, the U.K. marked the largest figure by far, and the U.S. was also large, with around 2,072 in FY 2007.

When growth rates were compared using 1995 and the most recent available year, the U.K. had the highest rate of increase, becoming 1.88 times as large. Japan grew to become 1.55 times as large. Germany has just adopted a new master's degree system, so only the most recent year is shown.

Regarding the percentage of the composition by the subject of special study, Japan had about 70% in the field of "Natural science and engineering", which was the opposite of the ratio for bachelor's degrees awarded. In the other countries, the ratio was roughly the same as that of bachelor's degrees awarded. They did not show the degree of change that Japan did.

(B) Master's degrees awarded



Note: <Japan> Accounted for the number of master's degrees awarded from April of the year represented to March of the following year.

<U.S.> Accounted for the number of master's degrees awarded in the year starting from September of the year represented.

<Germany> Accounted for the number of master's degrees (standard one- or two-year course) awarded in the winter term of the year indicated or the summer term of the following year

<France> The number of master's degrees awarded (5 years) in the year represented (calendar year). Accounted for "Natural sciences", "Engineering" and "Agricultural sciences" together.

<U.K.> Accounted for the number of advanced academic degrees awarded from universities and higher education colleges in the year represented (calendar year).

<Korea> The number of master's degrees awarded from March of the year represented to February of the following year. Accounted for "Natural sciences", "Engineering" and "Agricultural sciences" together.

Source: The same as Chart 3-4-3

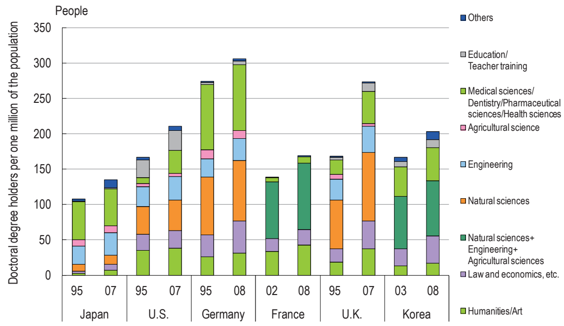
(3) Doctoral degrees awarded per one million of the population

When looking at the number of doctoral degrees awarded in each country per one million heads of the population, Japan had about 135 (in FY 2007), which is less than in other countries. The number for Germany was 307 (in FY 2008), which was the largest of the countries. And that of the U.K. was also high, at 272 (in FY 2007).

When growth rates were compared using 1995 and the most recent available year, the U.K. had the highest rate of increase, becoming 1.61 times as large. It was followed by the U.S. (becoming 1.26 times as large), Japan (1.25), France and South Korea (both 1.22) and Germany (1.12)

Looking at the percentage of the composition by the subject of special study, in case of doctoral degrees awarded, the ratio of "Natural sciences and Engineering" was large in every country. The ratio is especially large in Japan. It accounts for about 80% and a half in it is "Medical sciences/Dentistry/Pharmaceutical sciences/Health sciences". The ratio of "Medical sciences/Dentistry/Pharmaceutical sciences/Health sciences" is also large in Germany, however, the contribution of "Natural sciences" is also remarkable. The ratio of bachelor's and master's degrees awarded in "Social sciences and humanities was high in France, however, as for doctoral degrees, "Natural science and engineering" accounted for about 60%.

(C) Doctoral degrees awarded



Note: <Japan> Accounted for the number of doctoral degrees awarded from April of the year represented to March of the following year.

<U.S.> Accounted for the number of doctoral degrees awarded in the year starting from September of the year represented.

<Germany> Accounted for the number of successful applicants in the examination for doctoral degree in winter term of the year represented and summer term of the following year.

<France> The number of doctoral degrees awarded (8 years) in the year represented (calendar year). Accounted for "Natural sciences", "Engineering" and "Agricultural sciences" together.

<U.K.> Accounted for the number of advanced academic degrees awarded from universities and higher education colleges in the year represented (calendar year).

<Korea> The number of doctoral degrees awarded from March of the year represented to February of the following year. Accounted for "Natural sciences", "Engineering" and "Agricultural sciences" together.

Source: The same as Chart 3-4-3

(4) Foreign students in institutions of higher education

This section examines changes in the number of foreign students in higher education in selected countries. As used here, "foreign students" are students who are not citizens of their host countries (including international students). Although trends in their numbers do not change as much as those of international students, the degree to which students from different countries have a presence in various countries is examined.

Chart 3-4-4 shows changes in the number of foreign students at institutions of higher education in each country.

Turning first to Japan's situation, in 2008, the largest number of foreign students was from China, at 78,000. It was followed by South Korea, with about 23,000 students in Japan. In contrast, there were 2,000 students from the U.S., and less than 500 each from Germany, France and the U.K.. As for changes, the number of Chinese students peaked in 2006 and has been declining since. The number of South Korean students has been flat, while those from every other country have been increasing.

Looking at the situation in the U.S., Chinese students accounted for the largest number in 2008 at 110,000. It was followed by South Korea with 69,000 students, and Japan with 34,000. The numbers of students from both China and South Korea have been increasing, but the number from Japan has been decreasing. Although there were about 30,000 students from Japan in the U.S. during 2008, there were far fewer, less than 10,000, from Europe.

In Germany as well, Chinese students accounted for the highest number, with 25,000 in 2008. The trend, however, has been downward since about 2006. French students account for the next largest number, with 6,000, and there are a large number of South Korean students as well. There are only about 2,000 Japanese students in Germany, but that is more than there are from the U.K.

Chinese students also account for the largest number in France, with 21,000 in 2008, and the number has been increasing. German students account for the next largest number, with 7,000. All the other selected countries had roughly similar numbers of students in France, i.e., about 2,000–3,000 each.

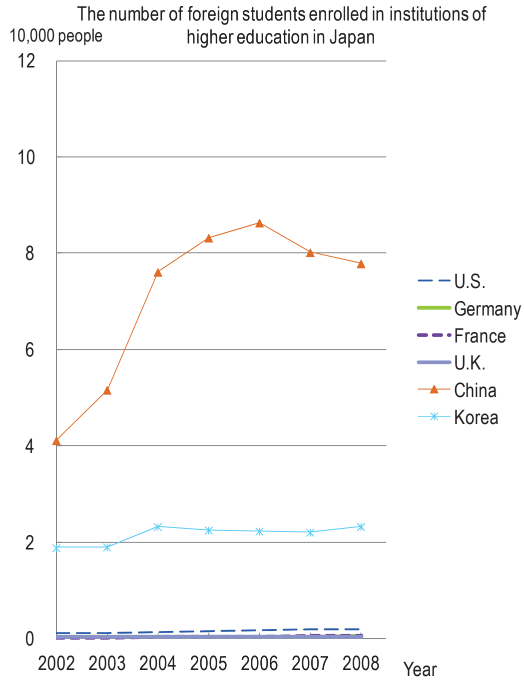
In the U.K. as well, Chinese students accounted for the largest number, with 45,000 in 2008. However, the trend has been downward since about 2006. The next largest number of foreign students, 14,000, was from the U.S. There were also about the same number from Germany. The number of students from Japan has been on a downward trend during recent years. There were 4,000 Japanese students in the U.K. during the most recent year, about the same number that was from South Korea.

China accounted for the largest number of foreign students in South Korea too, with 31,000, and the number has been increasing. The next largest number of students was from Japan, but they only numbered about 1,000.

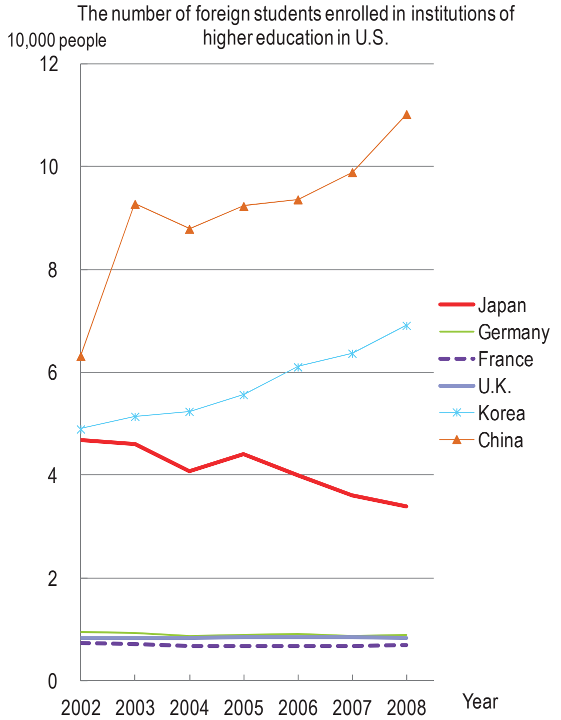
As for where the most foreign students from the different countries enroll in institutions of higher education, the U.S. accounts for the largest numbers of students from Japan, China and South Korea. The largest numbers of students from Germany and France are enrolled in the U.K. The largest number of students from the U.K. is enrolled in the U.S. The largest number of students from the U.S. is enrolled in the U.K.

Chart 3-4-4 The number of foreign students enrolled in institutions of higher education in selected countries

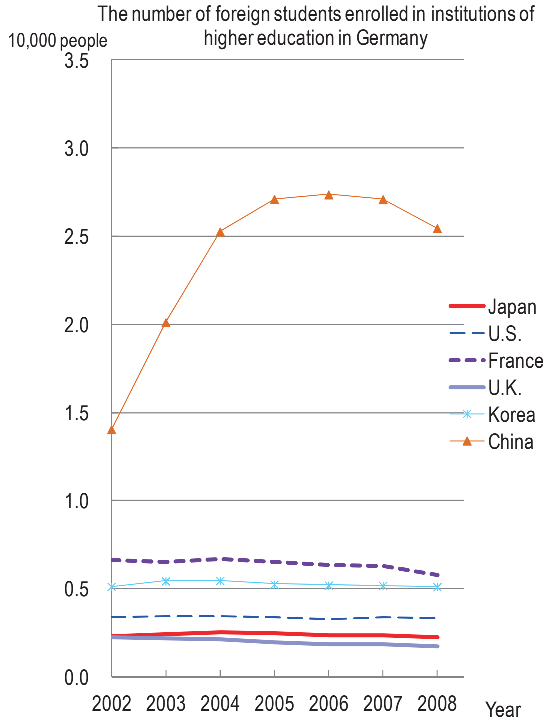
(A) Japan



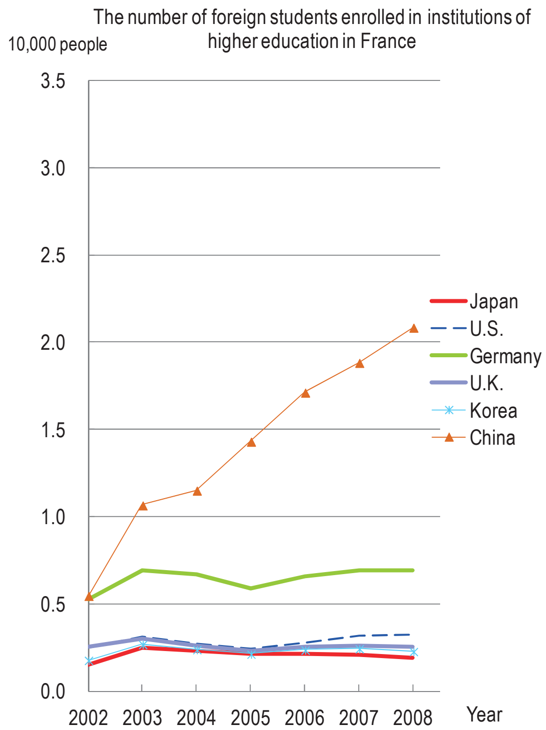
(B) U.S.



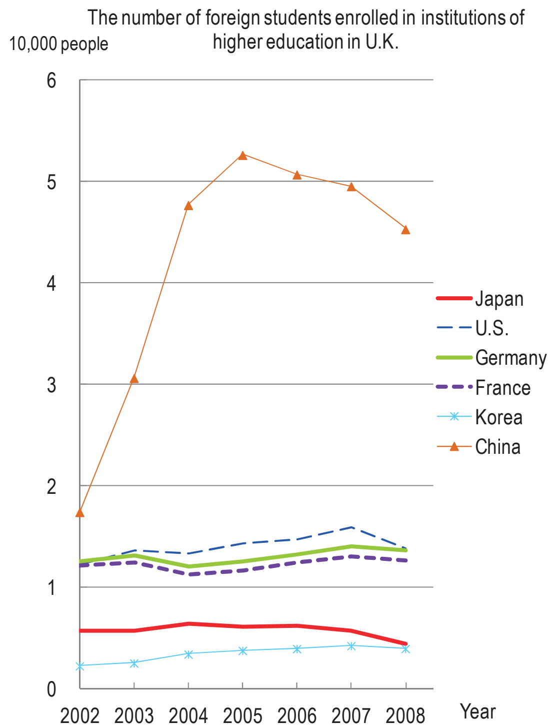
(C) Germany



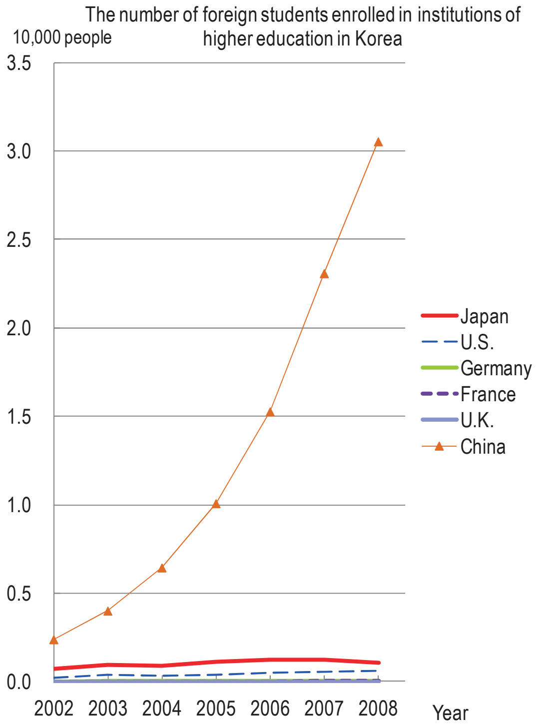
(D) France



(E) U.K.



(F) Korea



Notes: foreign students are students without permanent or log-term residency in their host countries.
For Germany, students in advance degree programs are not included.
Source: OECD, advance on at a Glances

Column: The International Science Olympiads

The International Science Olympiads are international competitions in science and technology for secondary students in participating countries. Their purposes are to find talented students in various countries and provide them with opportunities to develop their talents, to facilitate international interactions among students and educators and to promote the development of the relevant research areas. They originally began with the International Mathematical Olympiad. In addition to mathematics, there are Olympiads for fields such as physics, chemistry, biology and informatics. This column will compare medal counts for the five Olympiads mentioned above.

Chart 3-5-1 shows comparative national medal counts for the Olympiads since 2003.

The International Mathematical Olympiad began in 1959. Japan has been participating since 1990. In the 2003 International Mathematical Olympiad, Japan had one Gold Medal, three Silvers and two Bronzes. In 2010, it increased its Gold Medal count with two Golds and three Silvers. However, not every participant was able to obtain a medal in 2011. Every Chinese participant received a Gold Medal.

The International Physics Olympiad began in 1967. Japan only recently began participating, first competing in 2006. In its first year, Japan took no Gold Medals, although four of its five team members did bring home a medal of some type. In 2009, every team member received a medal, including two Golds. In 2010, however, Japan's results were similar to those in 2006. China is prominent in the International Physics Olympiad as well, but Germany took home three Gold Medals in 2010.

The International Chemistry Olympiad was first held in 1968, and Japan began participating in 2003. Japan’s four-member team in 2003 captured two Bronze Medals. In 2010, each of the four members took home a medal; two were Gold and two were Silver. Looking at other countries in 2010, China received four Gold Medals, and Korea received three.

The first International Olympiad in Informatics was held in 1989. Japan first participated in 1994, but did not participate from 1997 through 2005. In its return in 2006, Japan took two Gold Medals and one Bronze. In 2010, with two Golds and two Silvers, every team member received a medal. As for other countries, every member of the U.S. team has won a medal in each year since 2003. In 2010, the U.S. team received three Golds and one Silver, putting it ahead of China in Gold Medals.

The International Biology Olympiad began in 1990. Japan’s participation in this Olympiad began relatively recently as well, in 2005. Japan’s four team members in 2005 took home two Bronze Medals. In 2010, every member of the Japanese team received a medal as the team captured one Gold Medal and three Silvers. Looking at other countries, every member of the American and Chinese teams received a medal in 2010. Both teams took three Golds and one Silver.

Japan began a support program for this type of international science and technology competition in 2004. Its goals are to provide outstanding math and science students with opportunities to learn and to contribute to the fostering of future researchers who can meet international standards. In addition, the program supports the holding of international science and technology competitions themselves.

Some universities have set up admission systems that give special weight on entrance examinations to good performances in one of the Olympiads. For the universities, this provides an opportunity to train human resources with demonstrated academic and problem-solving ability in specific fields.

(Yumiko Kanda)

Chart 3-5-1: Medal counts of major countries in the International Science Olympiads

Year held	Medals	Mathematics Japan	U.S.	Germany	France	U.K.	China	Korea	Physics Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	1	4	1	0	1	5	2	-	3	1	-	-	-	3
	Silver	3	2	2	2	2	1	4	-	2	2	-	-	-	2
	Bronze	2	0	1	2	3	0	0	-	0	1	-	-	-	0
2004	Gold	2	5	0	0	1	6	2	-	2	1	-	0	5	4
	Silver	4	1	3	0	1	0	2	-	2	0	-	1	0	0
	Bronze	0	0	1	4	4	0	2	-	1	3	-	1	0	1
2005	Gold	3	4	1	0	1	5	3	-	2	1	0	0	5	2
	Silver	1	2	3	0	3	1	3	-	2	1	0	0	0	0
	Bronze	2	0	2	4	2	0	0	-	1	1	5	2	0	3
2006	Gold	2	2	4	1	0	6	4	0	4	2	0	0	5	4
	Silver	3	4	0	0	4	0	2	1	1	2	2	0	0	1
	Bronze	1	0	2	3	1	0	0	3	0	1	3	5	0	0
2007	Gold	2	2	1	1	1	4	2	2	2	0	1	1	4	2
	Silver	4	3	3	0	0	2	4	2	3	5	3	1	1	3
	Bronze	0	1	1	2	3	0	0	1	0	0	1	1	0	0
2008	Gold	2	4	1	0	0	5	4	1	4	1	0	0	5	4
	Silver	3	2	2	1	4	1	2	1	1	1	4	0	0	1
	Bronze	1	0	3	4	2	0	0	1	0	3	1	4	0	0
2009	Gold	5	2	1	0	1	6	3	2	4	0	0	0	5	4
	Silver	0	4	4	1	3	0	3	1	1	5	3	3	0	1
	Bronze	1	0	1	3	2	0	0	2	0	0	2	2	0	0
2010	Gold	2	3	1	0	1	6	4	0	1	3	0	1	5	1
	Silver	3	3	3	3	1	0	2	1	2	1	3	1	0	2
	Bronze	0	0	2	1	2	0	0	3	3	1	2	3	0	2

(Unit: medals)

Year held	Medals	Chemistry Japan	U.S.	Germany	France	U.K.	China	Korea	Informatics Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	0	0	2	0	0	4	2	-	2	0	0	0	1	2
	Silver	0	1	1	2	3	0	2	-	2	2	1	2	2	2
	Bronze	2	3	1	2	1	0	0	-	0	1	1	0	1	0
2004	Gold	1	0	2	0	0	4	3	-	2	1	0	1	4	1
	Silver	0	4	2	1	2	0	1	-	2	0	0	2	0	2
	Bronze	3	0	0	2	2	0	0	-	0	3	3	0	0	0
2005	Gold	0	0	0	0	1	-	4	-	4	0	1	0	4	2
	Silver	1	3	4	1	0	-	0	-	0	2	1	1	0	1
	Bronze	3	1	0	1	3	-	0	-	0	2	1	0	0	1
2006	Gold	1	0	1	0	0	4	3	2	1	0	0	0	4	1
	Silver	3	3	2	2	1	0	1	0	3	0	1	0	0	3
	Bronze	0	1	1	1	3	0	0	1	0	2	2	2	0	0
2007	Gold	0	0	2	1	0	4	3	1	2	1	0	0	4	0
	Silver	0	3	2	0	2	0	1	1	1	0	0	0	0	2
	Bronze	4	1	0	1	2	0	0	1	1	0	3	2	0	2
2008	Gold	0	0	1	0	0	4	3	1	2	1	0	0	3	1
	Silver	0	1	0	1	2	0	0	1	2	0	0	3	1	3
	Bronze	4	3	3	3	2	0	1	2	0	2	1	0	0	0
2009	Gold	2	1	1	1	0	3	3	2	2	1	0	0	3	3
	Silver	1	3	2	1	4	1	0	1	2	0	0	0	1	0
	Bronze	1	0	1	1	0	0	1	1	0	1	4	2	0	1
2010	Gold	2	2	0	0	1	4	3	2	3	2	0	0	2	1
	Silver	2	1	3	2	2	0	1	2	1	1	1	0	2	1
	Bronze	0	1	1	2	1	0	0	0	0	0	1	1	0	2

(Unit: medals)

Year held	Medals	Biology Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	-	0	0	-	0	3	1
	Silver	-	2	2	-	1	1	3
	Bronze	-	2	2	-	3	0	0
2004	Gold	-	4	1	-	2	2	1
	Silver	-	0	2	-	2	2	3
	Bronze	-	0	1	-	0	0	0
2005	Gold	0	2	0	-	1	4	3
	Silver	0	2	3	-	2	0	1
	Bronze	2	0	1	-	1	0	0
2006	Gold	0	2	0	-	0	4	3
	Silver	0	2	2	-	3	0	1
	Bronze	3	0	2	-	1	0	0
2007	Gold	0	4	0	0	2	4	4
	Silver	1	0	1	0	1	0	0
	Bronze	3	0	2	3	1	0	0
2008	Gold	0	4	1	0	0	2	3
	Silver	3	0	1	3	3	2	1
	Bronze	1	0	2	1	1	0	0
2009	Gold	1	4	0	0	1	4	1
	Silver	3	0	3	2	3	0	3
	Bronze	0	0	1	2	0	0	0
2010	Gold	1	3	2	0	0	3	2
	Silver	3	1	1	2	2	1	2
	Bronze	0	0	1	2	1	0	0

Notes: Team sizes for the various Olympiads are six people or fewer for Mathematics, five or fewer for Physics, four or fewer for Chemistry, four or fewer for Biology and four or fewer for Informatics.
<Japan> Data are since 2006 for Physics, since 2005 for Biology and since 2006 for informatics.
<France> Data are from 2005 for Physics and 2007 for Biology.
<U.K.> Data are from 2004 for Physics.
Source: Research by the Japan Science and technology Agency, from 2010 on, information is from each Olympiad's website.

Chapter 4 : The output of R&D

In recent years, accountability for investments in R&D has become strongly demanded, and understanding the output of R&D has become a major theme. This chapter introduces changes in and features of the world's and main countries' R&D activities, focusing attention on scientific papers and patents as measurable output of such R&D activities.

4.1 Scientific Papers

Key Points

○The quantity of papers, which are the output of the world's research activities, has consistently shown an upward trend.

○Research activities themselves have changed from the activities of a single country into joint activities that are conducted by multiple countries. Now internationally co-authored papers have increased, and a difference has emerged between the "degree of participation (whole counting) in the production of papers in the world" and the "degree of contribution (fractional counting) to the production of papers in the world".

○Regarding the numbers of papers produced in Japan (the average from 2008–2010), using whole counting, Japan is ranked fifth in the world, after the U.S., China, the U.K. and Germany. Meanwhile, using fractional counting, Japan ranks third, behind the U.S. and China and slightly ahead of the U.K. in fourth place and Germany in fifth.

○Looking at high impact papers in the world, using whole counting, Japan ranked seventh in terms of the number of top 10% highly cited papers (average for 2008–2010), behind the U.S., the U.K., Germany, China, France and Canada. Using fractional counting, Japan was fifth, after the U.S., the U.K., China and Germany.

○China has increased both in terms of the "degree of participation in the production of papers in the world" and the "degree of contribution to the production of papers in the world" since the late 1990s, holding second place in the world during the latter half of the 2000s.

○Looking at the balance of the fields in Japan, the share of Chemistry has decreased and that of Clinical medicine has increased.

○The percentage of international co-authorship for 2010 was 51% for Germany, 52% for the U.K. and 53% for France, while the U.S. was 33% and Japan was 27%.

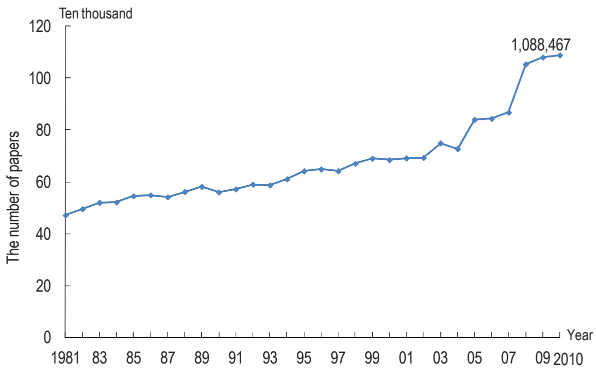
4.1.1 Quantitative and qualitative changes in research activities in the world

(1) The change in the numbers of papers

Chart 4-1-1 shows the change in the quantity of the world's papers. Revisions to the bibliographic data on papers in the Thomson Reuters database are made when necessary. It should be noted therefore that the figures in the charts in this report and the figures in Research Material 187 do not match.

Compared with the early 1980s, the quantity of papers presented in the world has more than doubled, and the world's research activities have a consistent tendency to expand from a quantitative standpoint today. For this period, journals recorded in Databases, which have been used for analysis, were revised in order of precedence, and the numbers of the journals has been enlarged. This factor is contributing to expanding the numbers of papers as well.

Chart 4-1-1: The change in the numbers of papers in the world



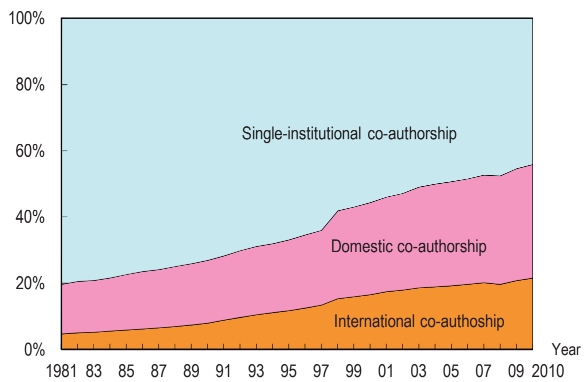
Note: Analyzed article, letter, note, review by whole counting
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

(2) The change in the style of the production of papers

While research activities in the world have moved toward a quantitative expansion, the style of research activities has changed to a large extent. Chart 4-1-2 shows the change in form of the co-authorship of papers in main countries by the three categories: ① Single-institutional co-authorship papers (Papers by authors who belong to a single institute), ② Domestic co-authorship papers (Papers by authors who belong to multiple institutes located in a single country), ③ Internationally co-authored papers (Papers by authors who belong to institutes located in different countries).

This figure shows that the ratio of single-institutional co-authorship papers has declined, and that of domestic co-authorship papers and internationally co-authored papers has increased. In the 1980s, single-institutional co-authorship papers accounted for approximately 80%, however, after that, domestic co-authorship papers and internationally co-authored papers increased. It can be said that activities for knowledge production have been done by transcending the framework of institutes and countries. As of 2010, single-institutional co-authorship papers accounted for 44.1%, domestic co-authorship papers for 34.3%, and internationally co-authored papers for 21.6%.

Chart 4-1-2: The change in the ratio of the co-authorship forms in the world



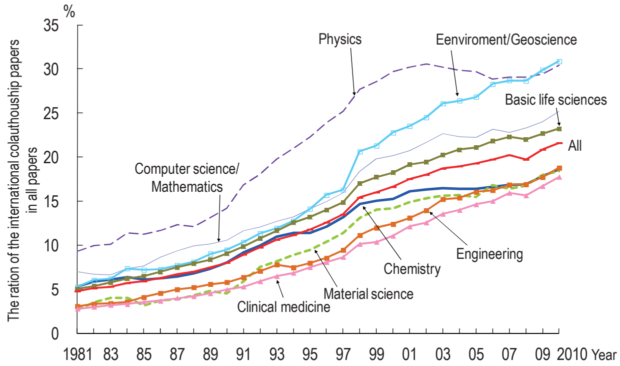
Note: Analyzed article, letter, note, review by whole counting
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI: Science)

Moreover, since internationally co-authored papers are a fruit made from international research cooperation and joint activities, they depend upon the background of each field. For instance, in a case where it is impossible for every country to have large research facilities, joint research is promoted by countries with them becoming core. Chart 4-1-3 shows the change of the ratio on internationally co-authored papers by field.

In every field, the ratio of internationally co-authored papers has been on an upward trend from the early 1980s up to the present date. It is higher in Environment/Geoscience at 30.9% and Physics at 30.4% than in other fields. At the same time, its share of Clinical medicine is 17.8%, which is the lowest ratio of internationally co-authored papers.

Chart 4-1-3: Internationally co-authored papers by field

(A) The change in the percentage



(B) Classification fields

Category	Consolidated ESI 22 field classification
Chemistry	Chemistry
Material science	Material science
Physics	Physics, Space science
Computer science/ Mathematics	Computer science, Mathematics
Engineering	Engineering
Environment/ Geoscience	Environment/Ecology, Geoscience
Clinical Medicine	Clinical medicine, Psychiatry/Psychology
Basic life sciences	Agricultural science,Biology・Biochemistry, Immunology, Microbiology, Molecular biology・Genetics, Neuroscience・Behavioristics, Pharmacology・Toxicology, Botany・Zoology

Note: 1) Analyzed article, letter, note, review by whole counting
2) Used (B) for the classification fields of (A).
3) Reclassified the papers included in "Web of Science" by ESI22 classification fields and analyzed by field for the classification fields of (B). By http://www.in-cites.com/journal-list/index.html (2010 March) for the classification of journals. Analyzed ESI19 classification fields excluded Economics/Economic & Business, Multidisciplinary and Social science general.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI: Science)

4.1.2 A comparison of research activities by country

(1) International comparison of countries by "the degree of participation in the production of papers in the world" and "the degree of contribution to the production of papers in the world"

As an "easily understandable indicator", the numbers of papers is used for measuring the quantity of a country's capacity for scientific research, and the number of times cited or the number of top 10% papers is applied to indicate quality. Top 10% papers mean papers which the number of times cited (value at the end of 2010) enter into the top 10% in each field. Since the average number of times cited is different for each field, top 10% papers are analyzed by field in order to standardize differences. The fields are pursuant to Chart 4-1-3.

There are two methods for the counting (Chart 4-1-4), which are the whole counting and the fractional counting. It is considered that the whole counting measures "the degree of participation in the production of papers in the world" and the fractional counting measures "the degree of contribution to the production of papers in the world".

Chart 4-1-5 shows the numbers of each country or region's papers, that of Top 10% papers and a ranking in the world by applying the method of whole counting and fractional counting. Since the numbers of each country's papers is different according to the method of counting, the rankings may be different in each case.

For 1988–1990, differences were not seen on each country's ranking in the world by the counting method, however, for 1998–2000 and 2008–2010, it is can be seen that differences have appeared. This is the result of internationally co-authored papers having increased and differences in intensity by counting of international co-authorship. As shown in Chart 4-1-11, there are large differences between countries with high ratio of international co-authorship and countries with low ratio. The ratio of international co-authorship is high in Europe, but trends lower in Japan and the U.S.

Chart 4-1-4: The methods of whole counting and fractional counting

	Whole counting method	Fractional counting method
The ways of counting	In the case of international co-authorship papers, 1 is counted for each country. Therefore, when the world shares of the number of papers for each country are summed up, it is over 100%.	In case of international co-authorship papers (for instance, co-authorship by Country A and Country B), the counting is done so that Country A is 1/2 and Country B is 1/2. Therefore, when the world shares of the number of papers for each country are summed up, it totals 100%.
The sorts of targeted papers for analysis	Article, Review, Letter & Note	Article, Review, Letter & Note
The number of papers	Degree of Participation in producing papers in the world	Degree of Contribution to the production of papers in the world
The number of the top 10% papers	Degree of Participation in high impact papers in the world	Degree of Contribution to the production high impact papers in the world

Note: Top 10% papers means the papers which the number of times cited make the top 10% in each field. The fields are made according to the note of Chart4-1-3(B).
The value of the end of 2010 is used for the number of times cited.

Chart 4-1-5: The numbers of the papers presented by country and region: Top 25 countries and regions

	1988 - 1990 (Average) The number of papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	195,791	34.5	1	185,402	32.7	1
U.K.	48,093	8.5	2	43,888	7.7	2
Japan	42,568	7.5	3	40,713	7.2	3
Germany	41,613	7.3	4	37,272	6.6	4
Russia	37,889	6.7	5	37,064	6.5	5
France	30,866	5.4	6	27,445	4.8	6
Canada	25,728	4.5	7	22,903	4.0	7
Italy	16,311	2.9	8	14,431	2.5	8
India	14,184	2.5	9	13,628	2.4	9
Australia	12,196	2.1	10	11,083	2.0	10
Netherlands	11,403	2.0	11	9,997	1.8	11
Sweden	9,707	1.7	12	8,400	1.5	12
Spain	9,000	1.6	13	8,163	1.4	13
Switzerland	7,726	1.4	14	6,172	1.1	15
China	7,682	1.4	15	6,897	1.2	14
Israel	6,087	1.1	16	5,149	0.9	16
Poland	5,698	1.0	17	4,906	0.9	17
Belgium	5,484	1.0	18	4,589	0.8	18
Denmark	4,621	0.8	19	3,931	0.7	19
Czech	4,054	0.7	20	3,655	0.6	20
Finland	3,697	0.7	21	3,255	0.6	21
Austria	3,523	0.6	22	3,025	0.5	23
South Africa	3,451	0.6	23	3,221	0.6	22
Brazil	3,170	0.6	24	2,755	0.5	24
New zealand	2,748	0.5	25	2,476	0.4	25

	1988 - 1990 (Average) The number of Top 10 papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	31,507	56.5	1	29,498	52.9	1
U.K.	5,492	9.8	2	4,722	8.5	2
Germany	3,594	6.4	3	2,912	5.2	4
Japan	3,548	6.4	4	3,245	5.8	3
Canada	3,123	5.6	5	2,594	4.6	5
France	2,910	5.2	6	2,329	4.2	6
Netherlands	1,544	2.8	7	1,275	2.3	7
Italy	1,349	2.4	8	1,035	1.9	10
Sweden	1,344	2.4	9	1,102	2.0	9
Australia	1,341	2.4	10	1,140	2.0	8
Switzerland	1,194	2.1	11	860	1.5	11
Israel	628	1.1	12	454	0.8	12
Denmark	578	1.0	13	440	0.8	13
Belgium	553	1.0	14	400	0.7	14
Spain	519	0.9	15	396	0.7	15
Russia	409	0.7	16	340	0.6	16
Finland	383	0.7	17	311	0.6	17
China	309	0.6	18	216	0.4	21
Norway	309	0.6	18	244	0.4	19
India	306	0.5	20	259	0.5	18
Austria	282	0.5	21	201	0.4	22
New zealand	269	0.5	22	222	0.4	20
Poland	221	0.4	23	145	0.3	23
South Africa	158	0.3	24	130	0.2	25
Brazil	156	0.3	25	100	0.2	26

	1998 - 2000 (Average) The number of papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	213,229	31.3	1	188,366	27.6	1
U.K.	62,662	9.2	2	50,983	7.5	3
Japan	62,457	9.2	3	56,736	8.3	2
Germany	56,795	8.3	4	45,223	6.6	4
France	42,267	6.2	5	33,620	4.9	5
Canada	28,918	4.2	6	22,971	3.4	6
Italy	27,291	4.0	7	22,204	3.3	7
Russia	24,560	3.6	8	20,662	3.0	9
China	24,405	3.6	9	21,286	3.1	8
Spain	20,006	2.9	10	16,473	2.4	10
Australia	18,571	2.7	11	15,026	2.2	12
India	16,558	2.4	12	15,124	2.2	11
Netherlands	16,088	2.4	13	12,225	1.8	13
Sweden	13,202	1.9	14	9,888	1.5	14
Switzerland	12,042	1.8	15	8,196	1.2	16
Korea	10,701	1.6	16	9,309	1.4	15
Taiwan	8,720	1.3	17	7,910	1.2	17
Brazil	8,616	1.3	18	6,992	1.0	18
Belgium	8,614	1.3	19	6,143	0.9	20
Israel	8,169	1.2	20	6,307	0.9	19
Poland	7,728	1.1	21	5,963	0.9	21
Denmark	6,860	1.0	22	4,882	0.7	22
Finland	6,262	0.9	23	4,822	0.7	23
Austria	6,026	0.9	24	4,472	0.7	24
Turkey	4,927	0.7	25	4,416	0.6	25

	1998 - 2000 (Average) The number of Top 10 papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	33,455	49.7	1	29,009	43.1	1
U.K.	7,848	11.7	2	5,753	8.5	2
Germany	6,578	9.8	3	4,628	6.9	3
Japan	5,020	7.5	4	4,131	6.1	4
France	4,720	7.0	5	3,285	4.9	5
Canada	3,730	5.5	6	2,647	3.9	6
Italy	2,891	4.3	7	1,976	2.9	7
Netherlands	2,466	3.7	8	1,720	2.6	8
Australia	2,098	3.1	9	1,501	2.2	9
Switzerland	2,006	3.0	10	1,211	1.8	11
Spain	1,810	2.7	11	1,246	1.9	10
Sweden	1,763	2.6	12	1,156	1.7	12
China	1,393	2.1	13	1,035	1.5	13
Belgium	1,086	1.6	14	648	1.0	15
Denmark	1,042	1.5	15	654	1.0	14
Israel	920	1.4	16	582	0.9	16
Finland	813	1.2	17	537	0.8	18
Korea	759	1.1	18	576	0.9	17
Russia	703	1.0	19	308	0.5	23
Austria	644	1.0	20	403	0.6	21
Taiwan	604	0.9	21	493	0.7	19
India	598	0.9	22	455	0.7	20
Norway	526	0.8	23	322	0.5	22
Brazil	455	0.7	24	278	0.4	24
New zealand	408	0.6	25	276	0.4	25

	2008 - 2010 (Average) The number of papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	295,075	27.5	1	245,385	22.8	1
China	119,404	11.1	2	105,117	9.8	2
U.K.	81,674	7.6	3	57,047	5.3	4
Germany	79,418	7.4	4	56,705	5.3	5
Japan	70,576	6.6	5	60,665	5.6	3
France	57,851	5.4	6	40,913	3.8	6
Canada	47,986	4.5	7	34,649	3.2	9
Italy	47,054	4.4	8	35,788	3.3	7
Spain	39,665	3.7	9	30,011	2.8	10
India	39,247	3.7	10	35,014	3.3	8
Korea	34,446	3.2	11	29,538	2.8	11
Australia	33,634	3.1	12	24,493	2.3	13
Brazil	28,978	2.7	13	25,050	2.3	12
Netherlands	26,540	2.5	14	17,928	1.7	17
Russia	25,903	2.4	15	21,112	2.0	14
Taiwan	21,689	2.0	16	19,207	1.8	15
Turkey	20,586	1.9	17	18,745	1.7	16
Switzerland	19,666	1.8	18	11,425	1.1	20
Sweden	17,701	1.6	19	11,299	1.1	21
Poland	16,862	1.6	20	13,513	1.3	18
Belgium	14,663	1.4	21	9,231	0.9	22
Iran	14,066	1.3	22	12,678	1.2	19
Israel	10,483	1.0	23	7,614	0.7	23
Denmark	10,277	1.0	24	6,468	0.6	25
Austria	10,117	0.9	25	6,239	0.6	27

	2008 - 2010 (Average) The number of Top 10 papers					
	Whole counting			Fractional counting		
Country	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	36,323	43.2	1	29,226	34.7	1
U.K.	10,206	12.1	2	6,084	7.2	2
Germany	9,357	11.1	3	5,673	6.7	4
China	7,481	8.9	4	5,891	7.0	3
France	6,173	7.3	5	3,565	4.2	6
Canada	5,231	6.2	6	3,126	3.7	7
Japan	5,051	6.0	7	3,709	4.4	5
Italy	4,694	5.6	8	2,782	3.3	8
Netherlands	3,765	4.5	9	2,137	2.5	11
Spain	3,700	4.4	10	2,232	2.7	10
Australia	3,672	4.4	11	2,269	2.7	9
Switzerland	3,062	3.6	12	1,483	1.8	12
Sweden	2,113	2.5	13	1,035	1.2	15
Korea	2,015	2.4	14	1,459	1.7	13
Belgium	1,833	2.2	15	913	1.1	17
India	1,647	2.0	16	1,255	1.5	14
Denmark	1,398	1.7	17	705	0.8	18
Taiwan	1,272	1.5	18	986	1.2	16
Austria	1,188	1.4	19	558	0.7	21
Brazil	1,147	1.4	20	701	0.8	19
Israel	1,006	1.2	21	555	0.7	22
Finland	977	1.2	22	506	0.6	25
Norway	864	1.0	23	428	0.5	26
Singapore	831	1.0	24	545	0.6	23
Russia	823	1.0	25	315	0.4	31

Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

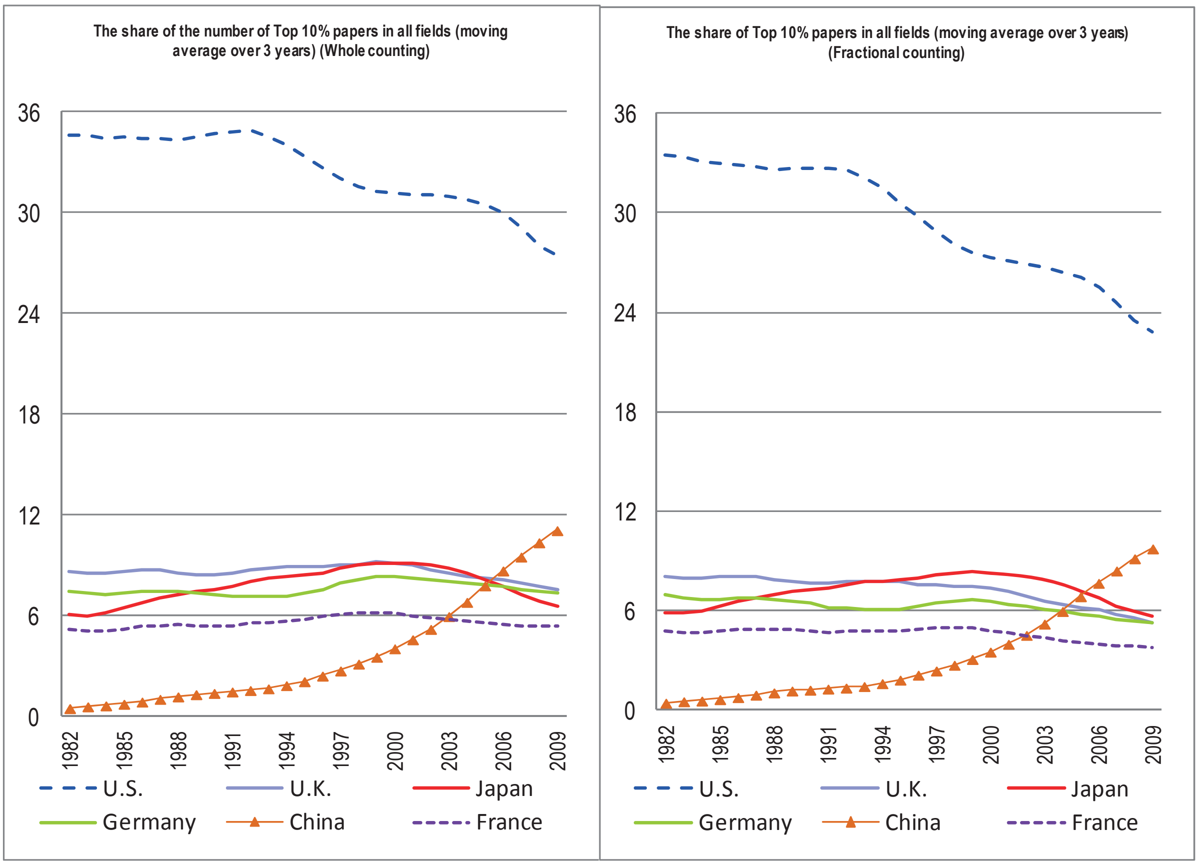
(2) A comparison of the share of the numbers of papers

First, Chart 4-1-6 shows each county's share in the number of papers in the world, in order to grasp the quantitative aspect of each country's research activities. The results of the whole counting, degree of participation in the production of papers, and of the fractional counting, degree of contribution to the production of papers, were shown. Looking at the "degree of participation in the production of papers in the world", the U.S. largely outperforms the other countries and it can be said that the U.S. is a country which produces a lot of papers. However, there has been a downward turn since the 1980s. Until the middle of the 1990s, the U.K., Japan, Germany and France continued to follow after the U.S. However, China has increased the quantity of its production of papers since the late 1990s. Japan ranked fifth in the world in 2009 (2008–2010 average), behind the U.S., China, the U.K. and Germany.

On the other hand, Japan became the world second largest in terms of the "degree of contribution to producing papers in the world" after 1995, and maintained the same position for about 10 years. However, it was surpassed by China and became the world's third largest country in 2009 (2008–2010 average). In addition, the gap between Japan and the U.K. and Germany is shrinking.

Chart 4-1-6: The change in the share of the numbers of papers in main countries (All fields, moving average over 3 years)

(A) Degree of participation in the production of papers in the world | **(B) Degree of contribution to the production of papers in the world**



Note: Moving average over 3 years of the share of the papers in all fields (if the year is 2009, the average value from 2008 to 2010). (A) is whole counting; (B) is fractional counting.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

(3) A comparison of the numbers of Top 10% papers

Next, Chart 4-1-7 shows each county's share in the number of top 10% papers in the world, in order to understand the qualitative aspect of each country's research activities. The results of the whole counting, degree of participation in the production of top 10% papers, and of the fractional counting, degree of contribution to the production of top 10% papers, were shown.

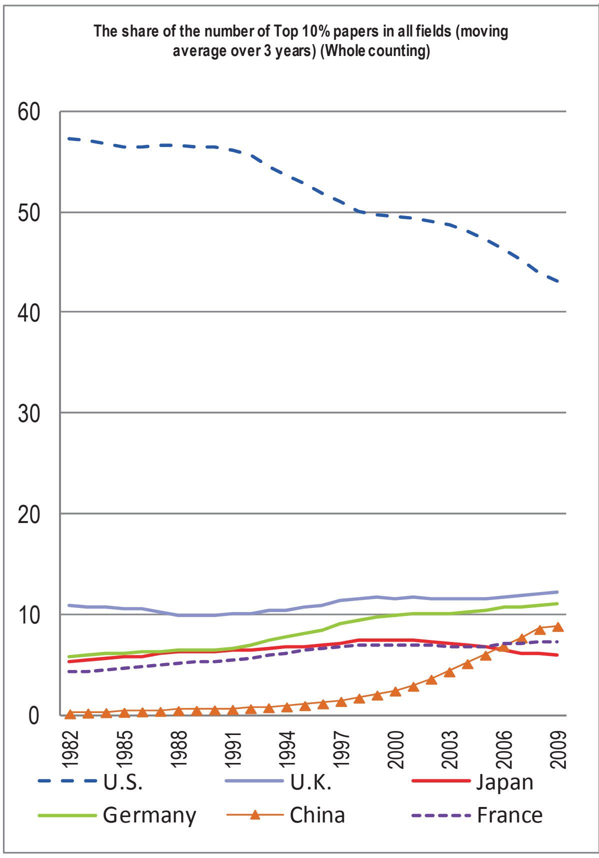
Regarding the “degree of participation in high impact papers in the world”, the U.K. and Germany have increased their share since the 1990s, and gotten a big lead on Japan. Japan has fallen to seventh place, behind the U.S., the U.K., Germany, China, France and Canada.

On the other hand, regarding the “degree of contribution to the production of high impact papers in the world”, the U.S. and the U.K. have had a downward turn over the past 20 years, and Germany has moderately increased its share, but during the 2000s the trend has been flat.

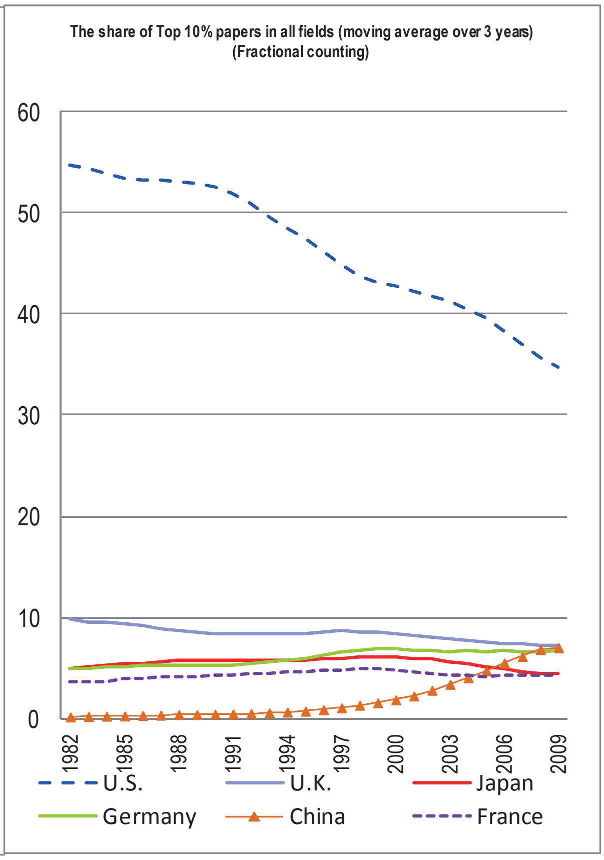
Japan’s share dropped suddenly during the 2000s. It now ranks fifth, behind the U.S., the U.K., China and Germany.

Chart 4-1-7: The change in the share of the numbers of Top 10% papers in main countries (All fields, moving average over 3 years)

(A) The degree of participation in high impact papers in the world



(B) The degree of contribution to the production of high impact papers in the world



Note: Moving average over 3 years on the share of the papers in all fields was applied (if the year is 2009, the average value from 2008 to 2010). (A) is whole counting; (B) is fractional counting.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

4.1.3 The characteristics of the research activities of main countries

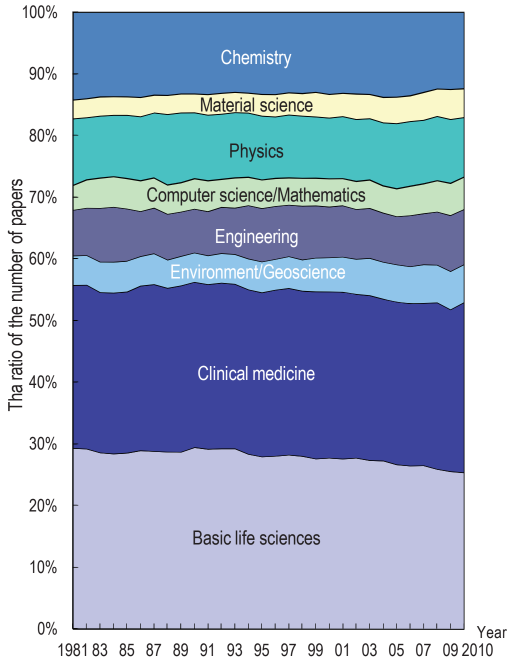
(1) The ratio of the numbers of papers in the world and main countries by field

While there are a variety of fields of research activities, the number of papers and the number of times cited are influenced by whether emphasis is placed on the production of papers in each field of research activities, by whether the number of researchers is large or small, and by whether the numbers of past papers that each paper refers to is large or small on average. Therefore, in the case of comparing countries, it is also important not only to look at the total number of papers and the number of times cited but also to understand the research activities of each field. Here, the method of whole counting is used in order to see the percentage of each field in the world and for every country.

First, Chart 4-1-8 shows the change in the ratio of the numbers of papers which each field occupies throughout the world. Comparing 1981 with 2010, Basic life sciences have fallen by 3.9 percentage points and Chemistry by 1.8 points. On the other hand, Material science has increased its share by 1.5 percentage points, Computer science/Mathematics by 1.2 points, Engineering by 1.5, Environment/Geoscience by 1.3 and Clinical medicine by 1.1.

Although there have been minor changes, the life science related fields such as Basic life sciences and Clinical medicine have retained their characteristic of accounting for about half of all papers.

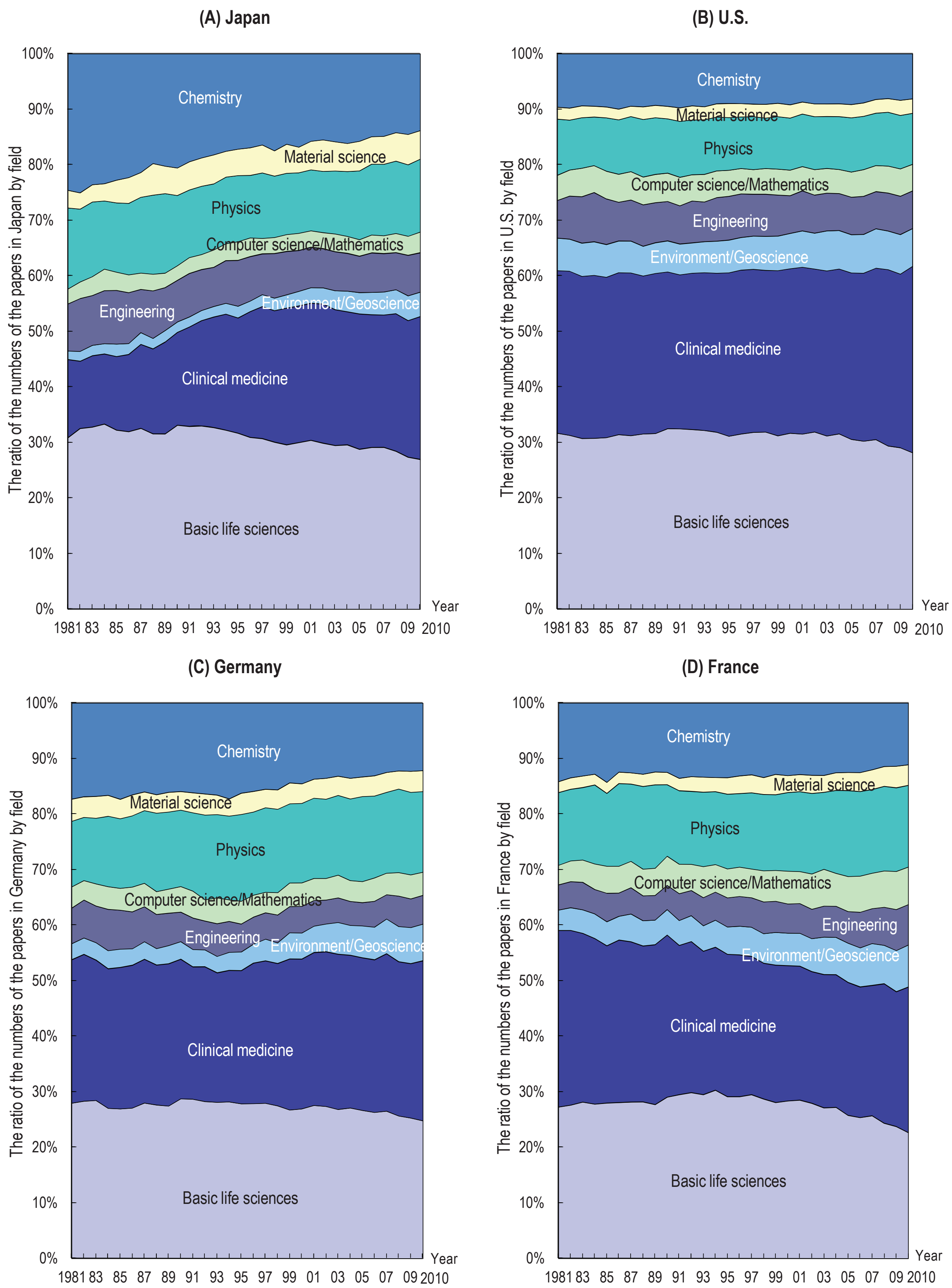
Chart 4-1-8: The change in the ratio of the numbers of the papers in the world by field

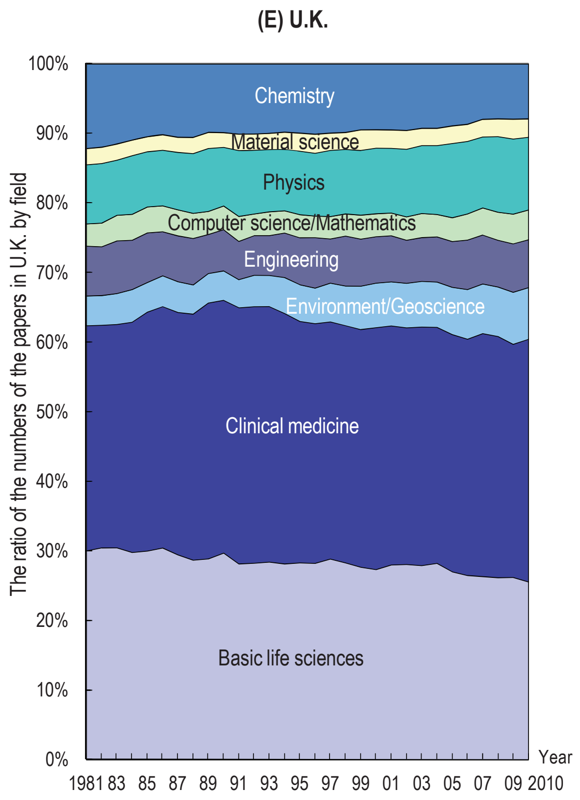


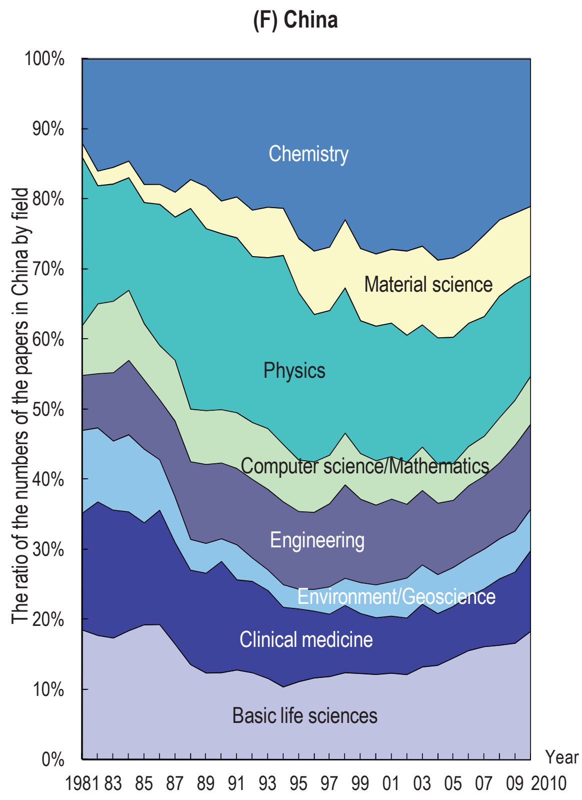
Note: The fields are in accordance with the note of Chart 4-1-3 (B).
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

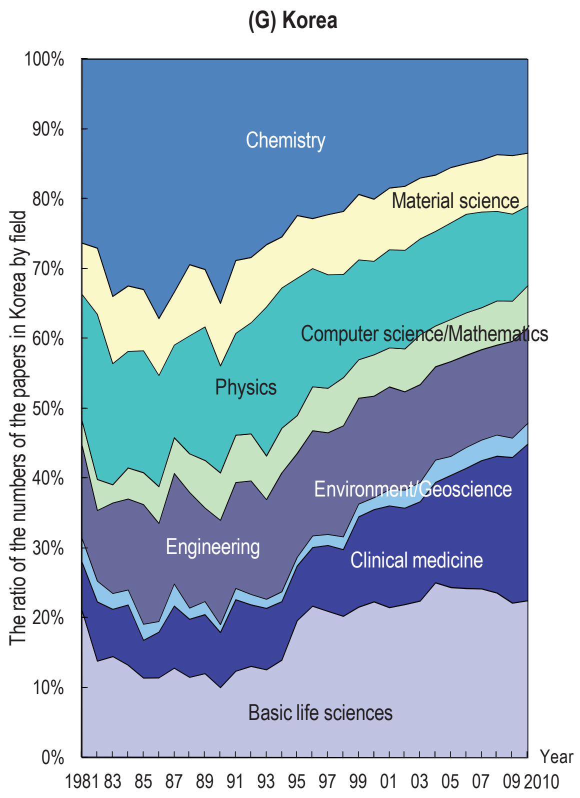
Next, Chart 4-1-9 provides the change in the share of papers in the main countries for each field, in order to see the internal structure of main countries. Japan had large shares in Basic life sciences, Chemistry and Physics in the early 1980s. Comparing 1981 with 2010, however, Chemistry has fallen by 10.2 percentage points, and Basic life sciences by 3.4 points. On the other hand, Clinical medicine has risen by 11.7 percentage points, and Environment/Geoscience and Material science have been on an expanding trend. In the U.S. since the 1980s, Basic life sciences has dropped by 3.9 points, while Clinical medicine has risen by 3.5 points. In Germany, the shares of Chemistry and Basic life sciences declined, while that of Environment/Geoscience, Clinical medicine and Physics somewhat increased. In France, shares of Environment/Geoscience and Computer science increased, while those of Clinical medicine and Basic life sciences decreased. In the U.K., percentages for Basic life sciences and Chemistry decreased, while those for Environment/Geoscience and Physics increased. As for China, its shares in the life sciences fields of Basic life sciences and Clinical medicine are lower than those of the other selected nations.

Chart 4-1-9: The change in the ratio of the numbers of the papers in main countries by field









Note: The fields are in accordance with the note of Chart 4-1-3 (B).
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

(2) A comparison of the field balance by quantity and quality in the main countries

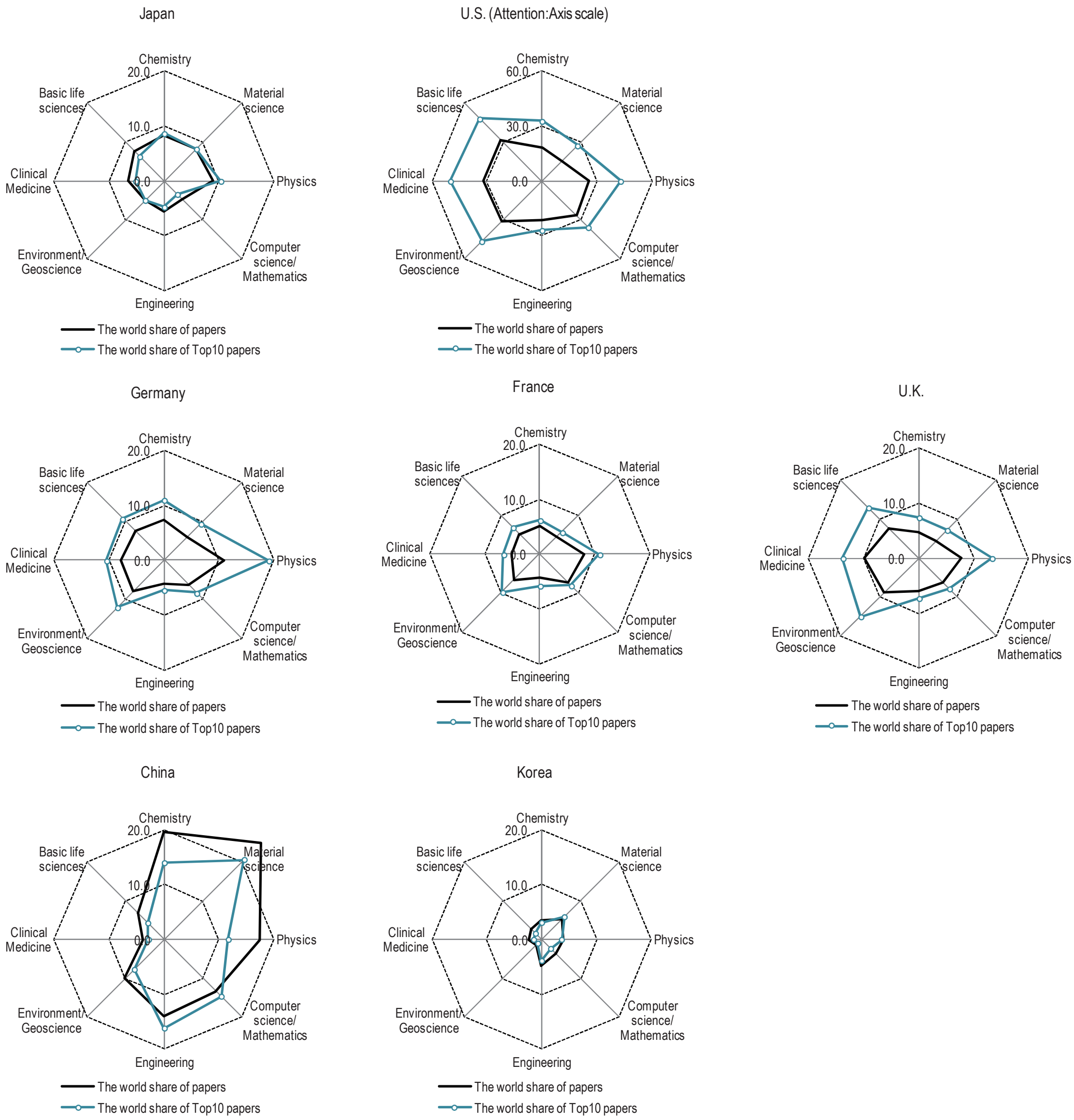
In Chart 4-1-10, a comparison is shown, which is the results of field portfolio (2008–2010) of the share of papers and the share of Top 10% papers. Here the whole counting method is used, in order to find the ratio that is occupied by each field in the world and in each country from the viewpoint of participation.

Comparing the papers share and Top 10% papers share, the countries can be divided into those where the Top 10% papers share is higher than the overall papers share (the U.S., the U.K., Germany and France) and the countries where the Top 10% share is lower than the overall papers share (Japan, China and Korea). Looking at the Top 10% papers share, the strengths and weaknesses of each country are more highlighted than in the field balance by paper share.

Japan has a portfolio in which the weights of Physics, Chemistry and Material science are heavy, while those of Computer science/Mathematics and Environment/Geoscience are light. However, the distribution is more even than it was in the past. In Chart 4-1-9, the share of Clinical medicine in Japan's papers is shown to have increased, and the share of Chemistry has declined. However, when it comes to the share against the numbers of papers for each field in the world, it can be seen that Chemistry is higher than Clinical medicine in Japan.

The strengths of the U.K. are Clinical medicine and Environment/Geoscience, while that of Germany and France is Physics. China shows a presence in shares of papers and Top 10% papers in Material science, Chemistry and Physics.

Chart 4-1-10: A comparison of the share of the papers and Top 10% papers in main countries by field (%, 2008–2010)



Note: Analyzed article, letter, note and review by the whole counting method. The fields are in accordance with the note of Chart 4-1-3 (B). The number of citations is the value as of the end of 2010.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

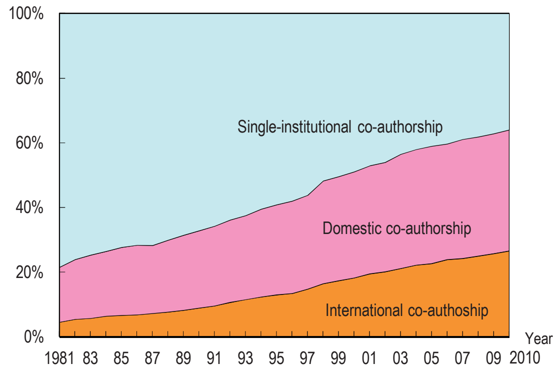
(3) The change in the production styles of papers in main countries

Chart 4-1-11 represents the change in the ratio of the numbers of papers in main countries by form of co-authorship of papers. The growth in the ratio of internationally co-authored papers is common to all the countries. As of 2010, however, compared with Japan at 26.7% and the U.S. at 33.0%, the ratio is very high in Europe, with Germany at 51.1%, France at 52.5% and the U.K. at 51.8%.

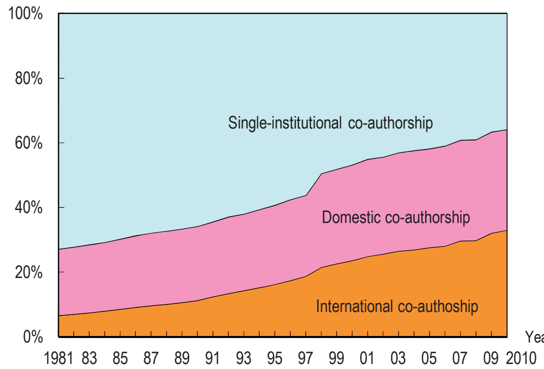
In Japan, in addition to internationally co - authored papers, the ratio of domestic co-authorship papers has increased by 20.4 percentage points. This is a larger change than in the other countries.

Chart 4-1-11: The change in the ratio of the numbers of papers in main countries by co-authorship form

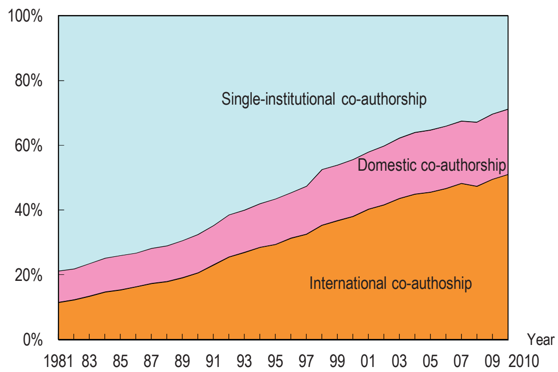
(A) Japan



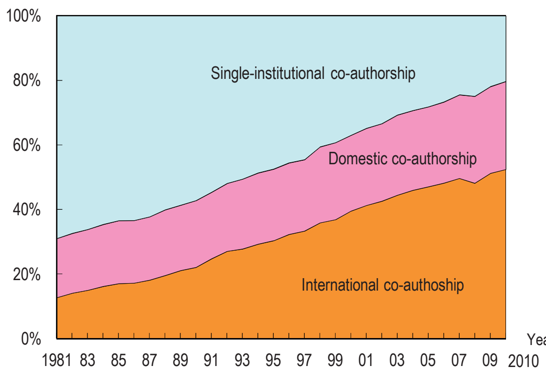
(B) U.S.



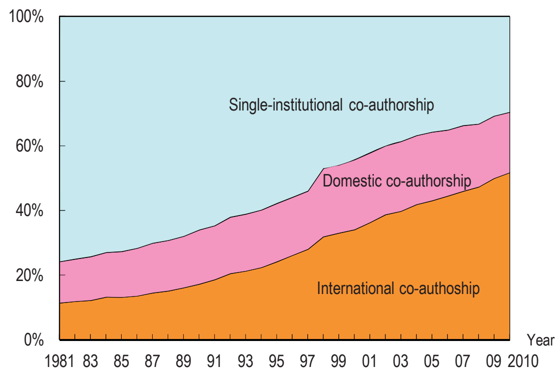
(C) Germany



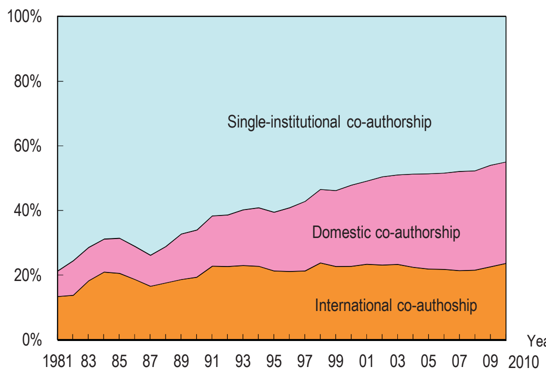
(D) France



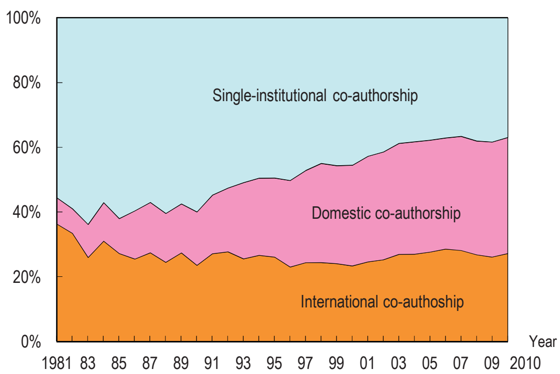
(E) U.K.



(F) China



(G) Korea



Note: Analyzed article, letter, note and review by the whole counting method.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

Column: Times cited in domestic co-authorship papers and internationally co-authored papers

What sorts of influence has the expansion of research activities across national borders given the qualitative indicator of research, that is, the number of Top 10% papers and the number of times cited? What sorts of differences exist between the research papers produced by domestic institutes (for instance, in case of Japan, it means papers produced by Japan's institutes alone) and internationally co-authored papers produced across countries (for instance, in case of Japan, co-authored papers produced by institutes in both Japan and the U.S.)?

In Chart 4-1-12, a comparison was conducted whereby the papers of main countries were divided into the research papers produced by domestic institutes (hereinafter “domestic papers”) and internationally co-authored papers. As it takes certain amount of time for the number of times cited to become stable, the period of 2005-2007 was targeted.

First, the ratios of domestic papers to all papers and of internationally co-authored papers to all papers were compared (Chart 4-1-12 (2)). It can be seen that European countries, such as the U.K., Germany and France, maintain high ratio of internationally co-authored papers.

Next, the ratio occupied by Top 10% papers within domestic papers and internationally co-authored papers was compared (Chart 4-1-12 (3)). Basically, if a country's share of Top 10% papers is higher than 10% (shaded area in Chart 4-1-12 (3)), it can be said to be producing attention-getting papers.

The ratio of Top 10% papers of internationally co-authored papers, compared with domestic papers alone, was higher in every country. This indicates that citation frequencies of internationally co-authored papers are higher than that of domestic papers alone.

Also, the times cited per paper in domestic papers and internationally co-authored papers was compared (Chart 4-1-12 (4)). In every country, the average number of times a paper was cited was higher for internationally co-authored papers than for domestic papers. This trend was the same as that for the percentage of Top 10% papers.

Also in Japan, just as the same as in the U.S., the U.K. and Germany, the number of times cited in internationally co-authored papers was higher than that of domestic papers in the case of the percentage of Top 10% papers ((3)) and the number of times cited per paper ((4)). However, as shown in Chart 4-1-12 (2), the percentage of internationally co-authored papers was low in Japan, and it is considered that this is one of the reasons why the number of times cited of entire papers was lower than for the U.K. and Germany.

(Ayaka Saka)

Chart 4-1-12: A comparison of papers in main countries, when divided into domestic papers and internationally co-authored papers (2005-2007)

Country	(1) The number of papers (Volume)			(2) The ratio of the number of papers (%)			(3) The ratio of Top 10 % papers (%)			(4) The number of times cited per paper		
	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers
Japan	198,251	151,372	46,879	100.0	76.4	23.6	8.0	6.3	13.6	7.9	6.6	11.8
U.S.	763,299	545,872	217,427	100.0	71.5	28.5	14.6	13.5	17.3	11.9	11.1	13.8
Germany	197,381	104,831	92,550	100.0	53.1	46.9	13.2	9.7	17.3	10.8	8.4	13.6
France	140,155	72,401	67,754	100.0	51.7	48.3	12.1	8.5	15.9	10.0	7.4	12.8
U.K.	208,489	115,596	92,893	100.0	55.4	44.6	13.4	10.1	17.5	11.0	8.5	14.2
China	222,154	173,775	48,379	100.0	78.2	21.8	7.4	5.9	12.5	5.9	5.0	9.0

Note: The objects for analysis are article, letter, note, and review. Analyzed by whole counting.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI:Science)

4.2 Patents

Key Points

- ○The number of world patent applications showed steady growth until 2008. However, patent applications in the selected countries decreased markedly in 2009 as a result of the recession that began with the "Lehman Brothers shock."
- ○The number of annual applications to Japan (about 350,000) is second only to those to the U.S., but it has been on a downward trend in recent years. In 2009 in particular, the number of applications fell by 10% compared with 2008. The number of applications to the U.S. (about 450,000 annually), has roughly doubled over the past 10 years, but in recent years this trend has leveled off. The number of applications to China has been increasing rapidly. Over the past 10 years (1999–2009), the number of applications has risen at an annual rate of 20%. In 2009, the number of applications was 310,000, third behind the U.S. and Japan.
- ○As for patent applications to a country of non-residence by patent applicants from the selected countries, the impact of the recession has been apparent. Looking at the number of applications to a country of non-residence, in 2009, they decreased in every one of the countries but China. The rate of decrease in the number of applications from 2008 was 33% in the U.S. and 26% in Japan. The number of applications to other countries from China, where domestic applications have also been increasing, increased by 26%. At only about 10,000, however, the number remains small.
- ○Looking at the numbers of patent applications to the JPO, the USPTO and the EPO, Japan has shown a big presence since 10 years ago. Looking at the applications by technical field, Japan has a big share in Nanotechnology and Information and communication technology.
- ○The relation between patents and scientific papers has been getting stronger. The Science Linkage, which indicates the degree to which patent literature cites scientific literature, has been increasing. From 1997–1999 to 2007–2009, the Science Linkage in all industries increased from 2.0 to 3.4. Medical and chemical manufacturing has the highest Science Linkage value. In recent years, Science Linkage has been increasing in Petroleum/Coal product manufacturing.

4.2.1 The patent applications in the world
(1) The number of patent applications in the world

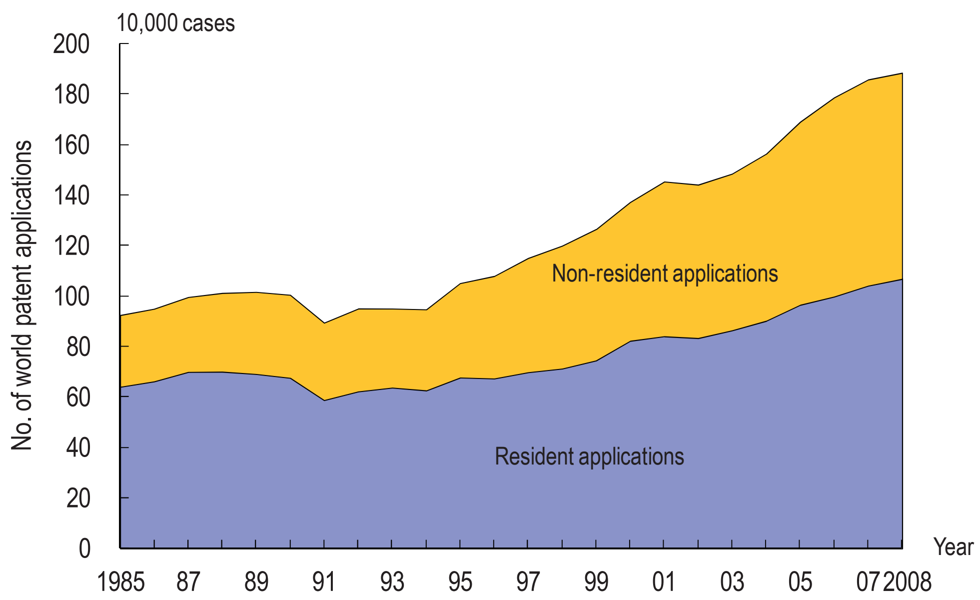
Chart 4-2-1 shows the change in the numbers of patent applications for about 230 countries and regions as of January 2011. The data is obtained from the "Statistics on Patents" by the WIPO (World Intellectual Property Organization). Here, the applications are divided to show Resident applications, which mean that the first applicants make applications directly to countries or regions in where they live, and Non-resident applications, which mean that the first applicants make applications to countries and regions where they do not have residency.

The numbers of patent applications are counted by both direct applications to patent authorities in each country or region; and PCT (Patent Cooperation Treaty) applications. As for PCT applications, applications have been transferred to the national/regional phase, were counted.

The numbers of patent application in the entire world have increased at an annual average rate of 5% since the mid 1990s, and it reached 1.90 million in 2008. Non-resident applications, which occupied about 30% in the mid 1980s, have increased more than that of Resident applications at a rapid pace, and have occupied about 40% of the total numbers of applications in recent years.

The number of world patent applications showed steady growth until 2008. As will be discussed below, however, patent applications decreased markedly in 2009 as a result of the recession that began with the "Lehman Brothers shock".

Chart 4-2-1: The change in the numbers of patent applications in the world



Note: (1)Resident applications means that first applicants make applications directly to countries or regions in where they live or do PCT applications.
(2) Non-resident applications mean that applicants make applications directly to countries or regions in where they do not live or do PCT applications.
(3) PCT applications mean applications made through PCT international patent application.
Source: The WIPO, "Statistics on Patents" (Last update: January 2011)

(2)The situation of patent applications in main countries

Next, the situation of the patent applications to and from the main countries is shown.

Chart 4-2-2 (A) shows the situation of patent applications to the main countries. The patent applications to Japan, the U.S., Europe, China, Korea, Germany, France and the U.K. are covered. The patent applications to these eight patent authorities are about 80% of the patent applications in the entire world. Here, the breakdown of the numbers of patent applications, which are divided into applications by Residents and those by Non-residents, are shown.

The number of applications to Japan is second, followed by the U.S., but in recent years it has been decreasing. In 2009 in particular, the number of applications fell by 10% compared with 2008. Looking at the breakdown, the applications to the JPO from applicants, who have their residency in Japan, accounts for over 85%.

The number of applications to the U.S. has roughly doubled over the past 10 years, but the trend has leveled off over the last few years. The ratio of applications from Residents and Non-residents has been half each. This is considered to show that the U.S. market is always attractive to overseas. The provisional application, which was introduced in 1995, is considered to be a reason that the numbers of applications has increased.

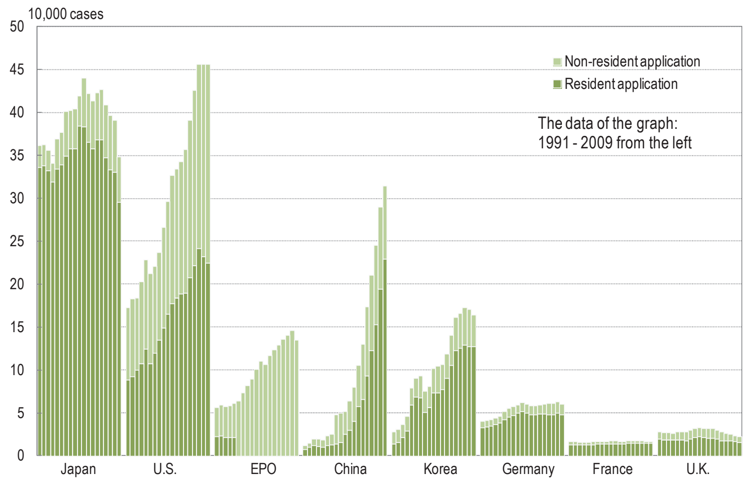
The number of applications to the EPO grew steadily until 2008, but decreased slightly in 2009. The numbers of applications to Germany and France have been broadly flat and that to the U.K. has declined. Since patent applications to the countries which have ratified European Patent Convention can be made through the applications for the European Patent Office, the numbers of applications to each country are on a flat or decreasing trend.

The number of applications to SIPO has drastically increased. They increased by an annual average of about 20% over 10 years (1999–2009). In 2009, there were about 310,000 patent applications. The number of applications from residents was about 50% from 2000 to 2002, however, it became about 70% from 2007 to 2009. This indicates that applications from applicants in China have especially increased.

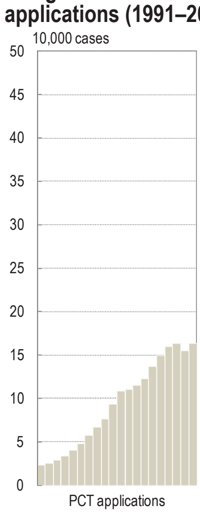
The applications based on PCT have been increasing. PCT applications can be seen a bundle of patent applications to the various patent authorities, and its feature is that a PCT application is enough to obtain the priority of designated patent authorities. Chart 4-2-2 (B) shows the numbers of PCT applications. This indicates that the numbers of PCT applications have been steadily increasing. It was about 160,000 in 2010.

Chart 4-2-2: The situation of patent applications to and from main countries

(A) The numbers of patent applications to main countries (1991–2009)



(B) The change in the numbers of patent applications (1991–2010)



Note: 1) Regarding the breakdown of the numbers of applications, in the case of Japan, it is divided according to: "direct applications from Residents" to the JPO, which is from those who live in Japan, and "direct applications from Non-residents" to the JPO, which is from those who do not live in Japan (for instance, those who live in the U.S.).
2) The value of "applications from Residents" of the EPO has not been included since 1996.
3) Includes PCT applications transferred domestically.
Source: The WIPO, "Statistics on Patents" (Last update: January 2011)

The next Chart shows the situation of patent applications from main countries (Chart 4-2-2 (C)). Here, the numbers of applications are divided into two categories and shown as applications to the country of residence and applications to a country of non-residence. Direct applications to patent authorities in each county or region; and PCT patent applications which are transferred to the national/regional phase were counted. In all countries, applications to the EPO were counted as Non-resident applications.

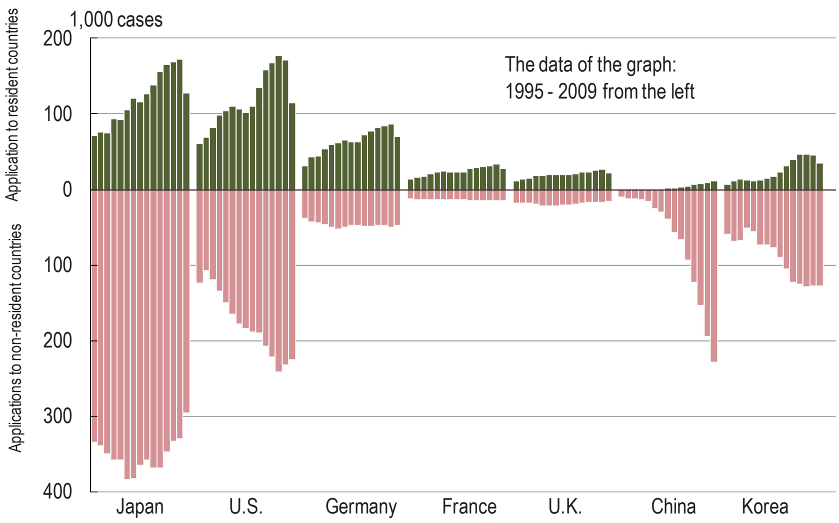
The results shown here are from the WIPO "Statistics on Patents" as of January 2011. This analysis calculates the share for each country by using the country that the first applicant or assignee belongs to. For instance, if there is a joint application with an applicant (the first) in Japan and an applicant (the second) in the U.S., only Japan is counted.

In Japan, the U.S., China and Korea, the numbers of applications to the country of residence are more than those to countries of non-residence. Approximately 70% of the total numbers of applications from Japan are to the JPO.

As for patent applications to a country of non-residence by patent applicants from the selected countries, the impact of the recession that began with the "Lehman Brothers shock" has been apparent. Looking at the number of applications to a country of non-residence, in 2009, they decreased in almost every country except for China. The rate of decrease in the number of applications from 2008 was 33% in the U.S. and 26% in Japan. The number of applications to other countries from China, where domestic applications have also been rising, increased. At only about 10,000, however, the number remains small.

Paying attention to the change in the numbers of applications to the country of residence, Japan has been decreasing recently. China has been greatly increasing. The U.S. and Korea increased through 2007, but has leveled off in recent years. In Germany, France and the U.K., the numbers of applications to the country of residence have been almost flat or a little bit decreased. One of the factors is considered to be that a certain number of patent applications, which have been applied for to the patent authorities of the country of residence, are now being applied for to the EPO.

(C)The numbers of patent applications from main countries (1995–2009)



Note: 1) Regarding the breakdown of the numbers of applications, in the case of Japan, "Applications to resident countries" refer the applications to the JPO applied by applicants who live in Japan, and "Applications to non-resident countries" refer the applications, applied by applicants who live in Japan, to other countries.
2) Every country includes the numbers of the applications to the EPO.
3) Includes PCT applications transferred domestically.
Source: The WIPO, "Statistics on Patents" (Last update: January 2011)

4.2.2 The patent applications to trilateral patent offices from the main countries

One of the points that makes an international comparison of the numbers of patent applications difficult is that a patent right is a principle of territorial jurisdiction and applications are often applied to several countries in which applicants want to have patent rights. Generally, in terms of applications made to Country A, applications from Country A comprise the majority (Home advantage). In order to improve potential international comparability, applications to the trilateral patent offices, the JPO, the EPO and the USPTO, are analyzed here.

The number of the world's patent applications in 2008 was approximately 1.90 Million, as shown in Chart 4-2-1. The numbers of applications to the trilateral patent offices accounted for about 52% of the world's patent applications. In recent years, the numbers of patent applications to China and Korea have been rapidly increasing, and the weight of the trilateral patent offices in the world has been declining.

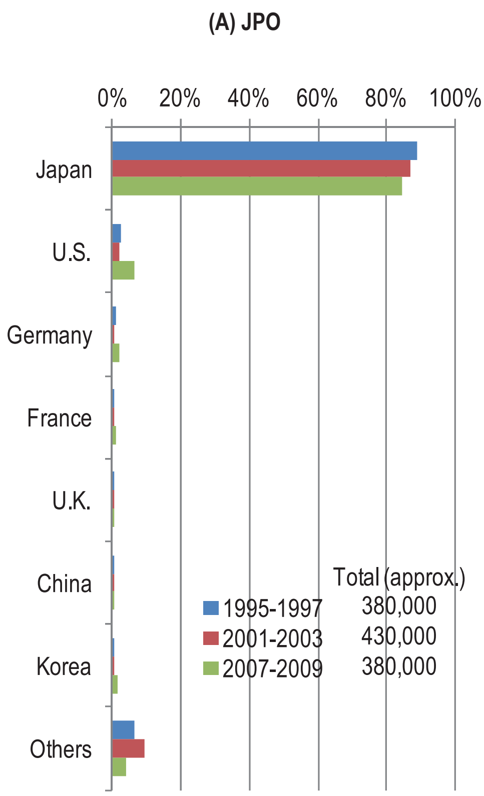
Chart 4-2-3 shows the share of the main countries of patent applications to the JPO, the EPO and the USPTO. The results shown here are from the WIPO, "Statistics on patents," as of January 2011. In this analysis, when there are multiple applicants, the country of the first applicant or assignee is used to calculate each country's share. For example, an application jointly submitted by a Japanese first applicant and an American second applicant would be counted only as a Japanese application.

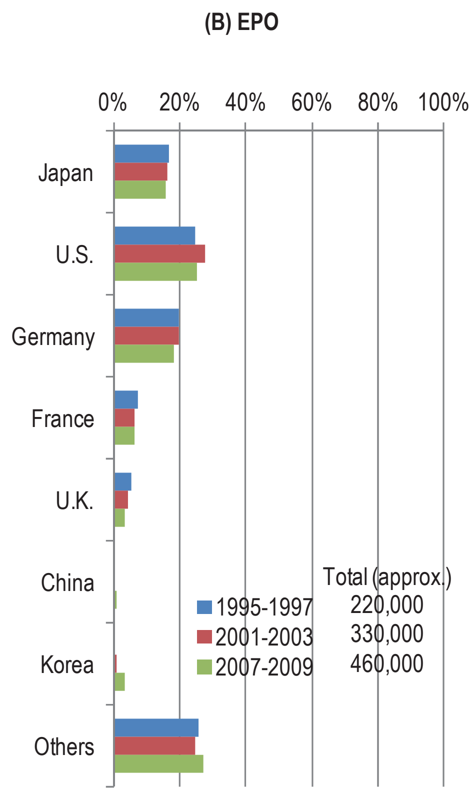
Looking at the each country's share of applications to the Japan Patent Office (Chart 4-2-3 (A)), Japan had an overwhelming share at about 84% from 2007 to 2009. The U.S. has kept second place over the past 10 years, however, its share did not reach 10%. The share of Germany was in third place (approximately 2.0% during 2007–2009). The number of applications from Korea have grown recently (approximately 1.5% during 2007–2009), and now it is closing in on Germany.

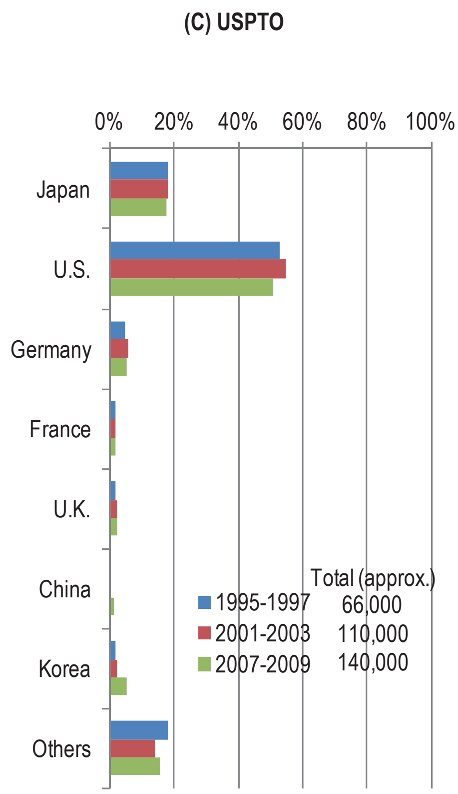
Looking at national shares of applications to the EPO (Chart 4-2-3 (B)), Japan presented the next largest number to the U.S. and Germany. By main countries' shares of patent applications from 2007 to 2009, the U.S. share was about 25%, which is in first place. Germany's share was about 18%, while Japan's was around 16%. France (about 6%) and the U.K. (about 4%) followed them. Also here, the growth of Korea was shown, it became about 3% from 2007 to 2009.

Looking at national shares of applications to the USPTO (Chart 4-2-3 (C)), the share of the U.S. was the largest. It has accounted for at least 50% since 1996. Japan has had the second largest share, at about 18% since 1996. The share of Germany was in third place, which was at about 5% from 2007 to 2009. Korea has been steadily expanding its share. At about 5%, almost the same as Germany's share, it was in fourth place in 2007–2009.

Chart 4-2-3: The share of the patent applications of the main countries to the JPO, the EPO and the USPTO







Note: Number of applications is based on application date. Country is country of residence of first applicant or assignee. Values are three-year moving averages.
Source: The WIPO, "Statistics on Patents" (last update: January 2011)

4.2.3 The patent applications by technological field

Next, the result of the analysis of the parent applications by technological field is described. Applications to the EPO and granted patents in the USPTO were analyzed in order to perform international comparison by technology. Technological fields for analysis are targeted in four fields: Biotechnology; Renewable energy; Information and communication technology; and Nanotechnology.

The patent applications for Biotechnology and Information and communication technology were extracted by using International Patent Classification (IPC). The same definition is also used in the patent analysis of OECD.

Regarding Nanotechnology, the classification called Y01N by the EPO was used. At present, there is no unified definition for Nanotechnology in the world. Therefore, the EPO defines Nanotechnology on it own accord. And then, based on it, the applications relating to Nanotechnology are extracted from the patent applications to major patent authorities in the world and given the tag of Y01N. The patent applications with Y01N tags for the EPO and the USPTO were analyzed.

As for Renewable energy, the patent applications with Y02E1 tags, which is included in the EPO's patent classification for technology related to clean energy (Y02E), was used. Y02E1 covers renewable energy that uses wind power, solar, geothermal, hydropower or oceans. See the Column below for a more detailed analysis of Y02E.

Patent applications to the JPO were excluded here. This is because the extraction accuracy of patent applications on Nanotechnology and Renewable energy was low due to a problem with the patent database.

(1) The patent applications to the EPO by field

Looking at the situation of applications to the EPO by technological field, Japan has a large share in Nanotechnology and Information and communication technology. The share of Nanotechnology was approximately 30% from 1997 to 1999; however, it was approximately 20% from 2007 to 2009. The share of Japan in Biotechnology is about 10%, and it was less than about 17% of Japan's share as a whole.

Shares for Biotechnology and Nanotechnology are large for the U.S., while Germany had a relatively large share in Renewable energy and the U.K. in Biotechnology and Renewable energy. The share of Korea has been increasing over the past 10 years. Especially, the growth in Information and communication technology and Nanotechnology is remarkable (Chart 4-2-4).

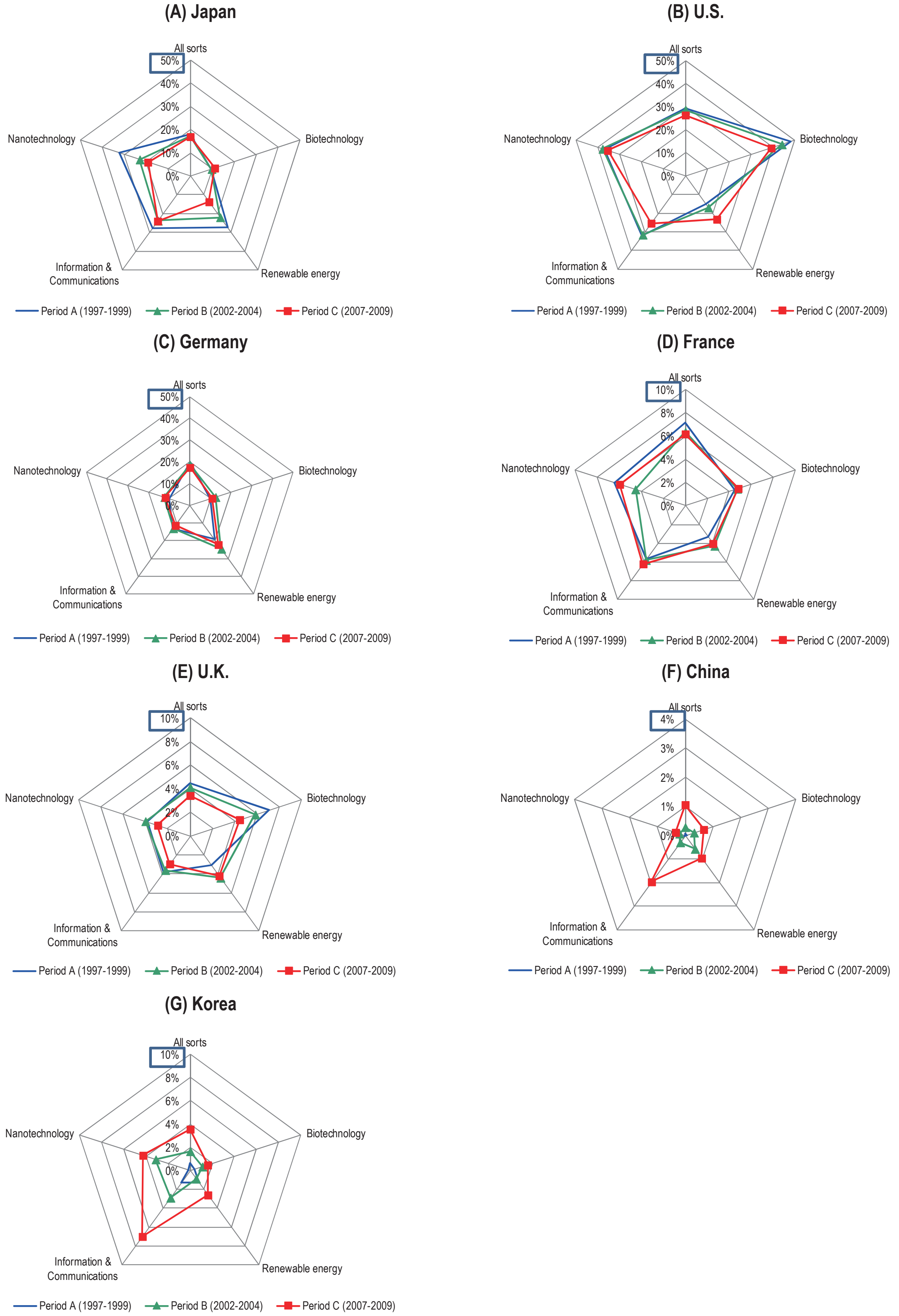
Although China's shares are increasing, it still has a small presence compared with the other six countries.

(2) The granted patents in the USPTO by field

Looking at the granted patent in the USPTO by field, Japan has a large share in Nanotechnology and Information and communication technology, the same as in the case of the EPO. Its share of Nanotechnology from 2007 to 2009 was about 26%.

Germany has a relatively large share in Renewable energy, as does the U.K. in Biotechnology and Renewable energy. Regarding Korea, it is apparent that growth in its shares in Information and communications technology and Nanotechnology are especially large (Chart 4-2-5).

Chart 4-2-4: The situation of patent applications to the EPO by field



Note: 1) Counted unexamined publications (A1, A2) for the numbers of the applications. Counted by publication data. The share of main countries is the average over 3 years

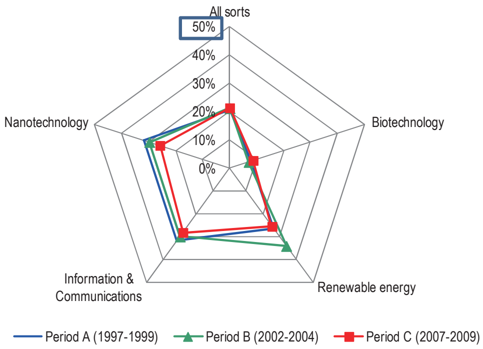
2)Uses International Patent Classification for the technological classification about Information and communications, and Biotechnology. Y01N was used for the technological classification about Nanotechnology. Y02E1 was used for the technological classification for renewable energy.

3) The ratio of inventors was counted by fractional counting per inventor.

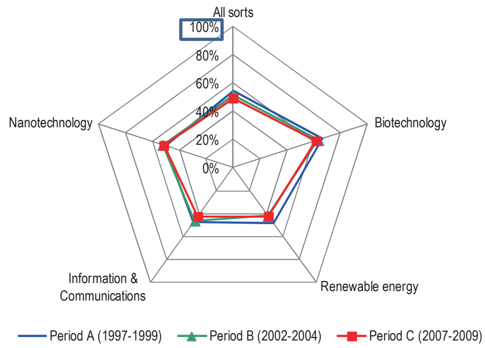
Source: Compiled by NISTEP based on PATSTAT (September 2010 version)

Chart 4-2-5: The situation of patent applications to the USPTO by field

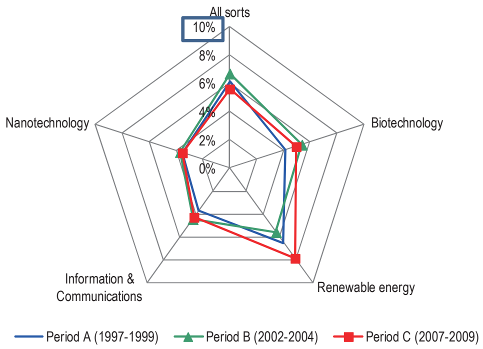
(A) Japan



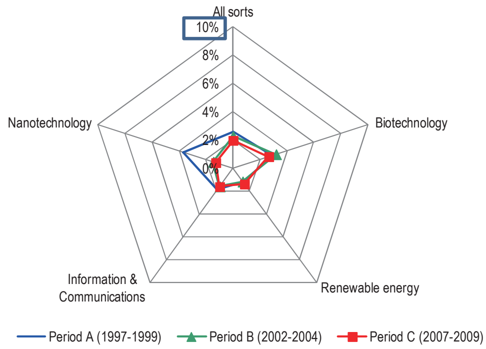
(B) U.S.



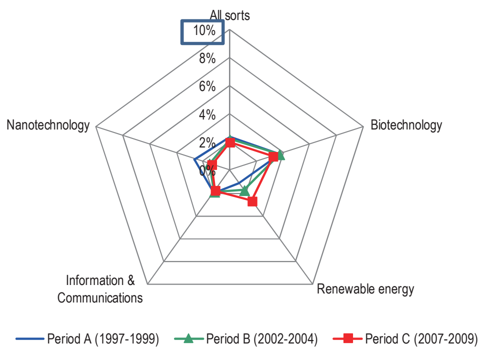
(C) Germany



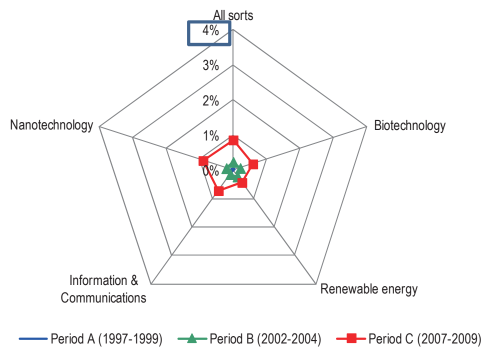
(D) France



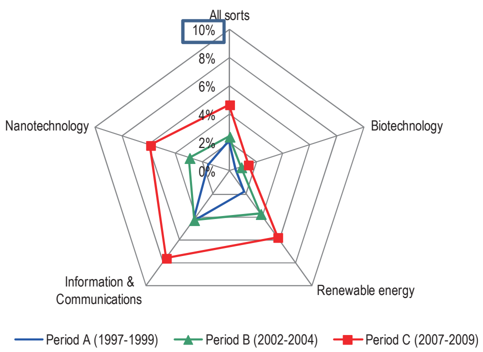
(E) U.K.



(F) China



(G) Korea



Note: 1) Counted by granted dates. The share of main countries is the average over 3 years.
2) Uses International Patent Classification for the technological classification about Information and communications, and Biotechnology. Y01N was used for the technological classification about Nanotechnology. Y02E1 was used for the technological classification for renewable energy.
3) The ratio of inventors was counted by fractional counting per inventor.
Source: Compiled by NISTEP based on PATSTAT (September 2010 version)

4.2.4 The analysis of Science Linkage for US Patents

The following describes "Science Linkage" which is an indicator for showing a close relationship between the patents and scientific literature.

Science Linkage is defined as the numbers of the citations to scientific literature per patent on the U.S. Patent Examination Reports. The U.S. Patent Examination Reports have citations of various documents and existing patents that are in close relation to the patent application. The citation to scientific literature in patents shows relevance to the relationship between technology (patents) and science. Therefore, Science Linkage is considered to indicate closeness between science and patents.

The concordance table of USPC and Standard Industrial Classification System by the USPTO was used to analyze changes in Science Linkage of the U.S. patents by the industrial classification. It is possible to analyze by International Patent Classification (IPC), in which patent documents are categorized by the types of technology, however, the image of the technology is not easily seen by this method. Therefore, the following shows the correspondence with the industrial classification.

From 2007 to 2009, the largest numbers of granted patents were for "Communication equipment and electronics components manufacturing," followed by "Machinery manufacturing (excluding Electrical);" and "Professional equipment and scientific instrument manufacturing." Paying attention to the annual average growth rate, "Communication equipment and electronics components manufacturing" is the largest at about 6%, and the second largest is "Petroleum and natural gas extraction and refining" at about 4% (Chart 4-2-6).

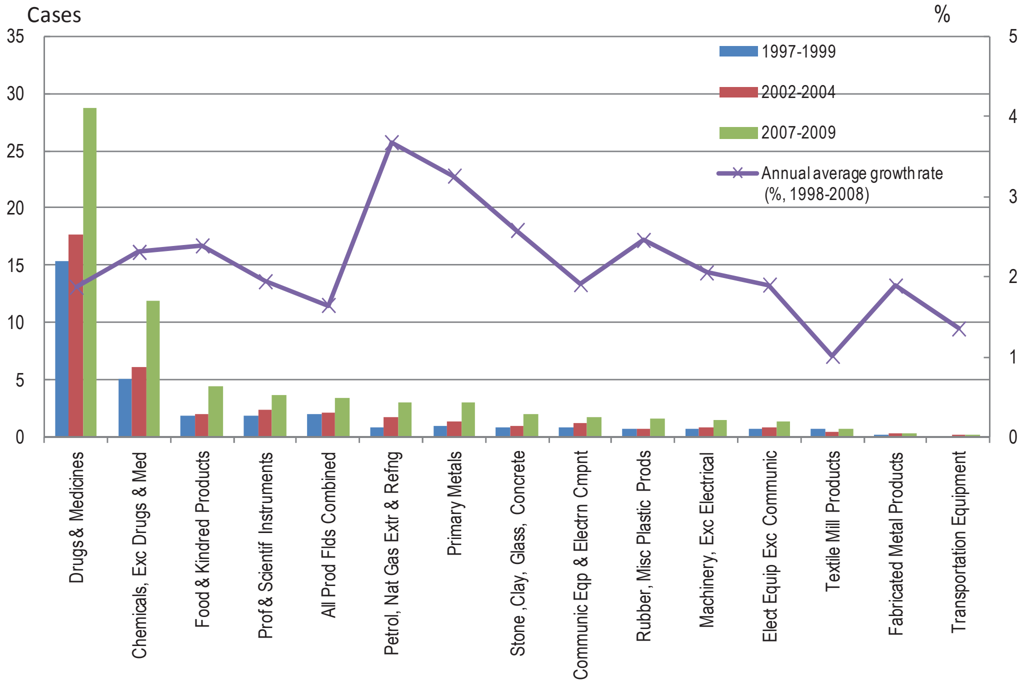
The Science Linkage tends to be increasing in all industrial classifications (Chart 4-2-7). From 1997-1999 to 2007–2009, the Science Linkage in all manufacturing increased from 2.0 to 3.4. "Drug and medicines manufacturing" had a much higher value for Science Linkage, marking 28.7 from 2007 to 2009. "Chemicals and related products (excluding drugs and medicines)" followed after it; however, the Science Linkage was less than half the value for "Drug and medicines manufacturing". "Regarding Petroleum and natural gas extraction and refining," the Science Linkage was 0.8 from 1997 to 1999, which was not so high; however, it rapidly increased to 3.1 from 2007 to 2009. Science Linkage of "Primary metals manufacturing" grew to about 3.3 times as large over 10 years (Chart 4-2-7).

Chart 4-2-6: The numbers of registrations of patents by industrial classification (the 3 years moving average)

	1996-1998	2001-2003	2006-2008	Annual average growth rate (%, 1997-2007)
All Prod Flds Combined	123,044	167,461	162,942	2.8
Communic Eqp & Electrn Cmpnt	22,235	37,579	44,902	7.3
Machinery, Exc Electrical	26,702	36,254	40,498	4.3
Prof & Scientif Instruments	17,056	21,922	21,275	2.2
Elect Equip Exc Communic	7,921	11,507	11,473	3.8
Chemicals, Exc Drugs & Med	12,227	13,825	10,194	-1.8
Transportation Equipment	5,009	7,522	6,464	2.6
Fabricated Metal Products	6,610	8,125	5,594	-1.7
Drugs & Medicines	5,122	6,281	4,908	-0.4
Rubber, Misc Plastic Prods	4,337	5,060	2,857	-4.1
Stone,Clay,Glass,Concrete	1,890	2,396	1,500	-2.3
Petrol,Nat Gas Extr & Refng	523	760	894	5.5
Primary Metals	852	1,231	793	-0.7
Textile Mill Products	705	674	429	-4.8
Food & Kindred Products	615	778	328	-6.1

Note: Annual average growth rate indicates the growth rate for 1998–2008. Values for 1998 are the average for the three years 1997–1999, and those for 2008 are from the three years 2007–2009.
Source: Compiled by NISTEP based on ipIQ, "Global Patent Scorecard 2010"

Chart 4-2-7: Science Linkage in US Patents



Note: Annual average growth rate indicates the growth rate for 1998–2008. Values for 1998 are the average for the three years 1997–1999, and those for 2008 are from the three years 2007–2009.
Source: Compiled by NISTEP based on ipIQ, "Global Patent Scorecard 2010"

"

Column: Patent applications regarding technologies related to clean energy

The EPO adopted the Y02E patent classification in 2010 in order to extract and classify items related to clean energy from among the world's patent documents. Classification of technology requires specialist knowledge. The EPO obtains the cooperation of the Intergovernmental Panel on Climate Change (IPCC) and other outside experts in order to enhance the reliability of its classification of patent documents. This column will discuss the results of analysis that used the Y02E classification to examine Japan's strength in technologies related to clean energy as seen through patent applications.

As shown in Chart 4-2-8, the Y02E comprises seven main groups of technologies. Y02E1, for example, is the classification for technologies related to energy generation through renewable energy sources. Y02E1 is further divided into the subgroups such as wind, solar, geothermal, hydropower oceanic, etc.

Chart 4-2-9 shows changes in the number of patent families in six main Y02E groups (Because the number of patent families in Y02E7 is low, that category was not analyzed.). The group with the largest number of patent families was "technologies with potential or indirect contribution to greenhouse gas emissions mitigation" (battery technologies, storage technologies, fuel cells, etc.). In 2006, the number of patent families in that classification was about 1,100. The number increased rapidly beginning in the mid-1990s. The 2006 figure was about four times that of the early 1990s. By comparison, the total number of patent families roughly doubled during the same period, indicating the remarkable size of the increase. At the subgroup level, the increase in fuel cell patent families was particularly notable.

The second largest number of patent families was in "Energy generation through renewable energy sources" (wind, solar, geothermal, hydropower, oceanic, etc.). In 2006, there were about 500 such patent families. Compared with the early 1990s, that was five times as many patent families. At the subgroup level, energy generation through solar power accounted for the largest number of families.

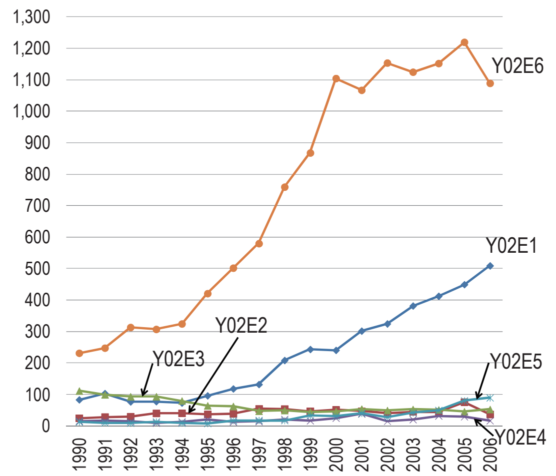
Turning to increases in the number of patent families, there were seven times as many "technologies for the production of fuel of non-fossil origin" (biofuels, fuels from waste, etc.) in 2006 as there were at the beginning of the 1990s, but the absolute number remains low (89 in 2006). The number of patent families in the "energy generation of nuclear origin" category has been on a downward trend.

Chart 4-2-8: The seven main groups of clean energy technologies (Y02E)

Main group	Type of technology
Y02E1	Energy generation through renewable energy sources (wind, solar, geothermal, hydropower, oceanic, etc.)
Y02E2	Combustion technology with potential to reduce greenhouse gas emissions
Y02E3	Energy generation of nuclear origin (nuclear reactor and nuclear fusion reactor)
Y02E4	Technologies for efficient electrical power generation, transmission or distribution
Y02E5	Technologies for the production of fuel of non-fossil origin (biofuels, fuels from waste, etc.)
Y02E6	Technologies with potential or indirect contribution to greenhouse gas emissions mitigation (battery technologies, storage technologies, fuel cells, etc.)
Y02E7	Other energy conversion or management systems reducing greenhouse gas emissions

Source: Created by the National Institute of Science and Technology Policy based on the EPO PATSTAT (September 2010 version).

Chart 4-2-9: Changes in the number of patent families concerning clean energy technologies



Note: Y02E was used for clean energy classification. All INPADOC patent families filed in Japan, Europe and the U.S. were subjected to analysis. When counting patent families, the earliest date of priority and inventors' countries of residence were used to make a fractional count with countries as the unit.
Source: Tabulated by the National Institute of Science and Technology Policy based on the EPO PATSTAT (September 2010 version).

Next, countries' shares in terms of inventors were analyzed. This analysis covered patent families with priority date during the five years from 2002 to 2006. During the five years, the total number of patent families was about 300,000. Japan's share was 32%. Looking at Japan's share of each main group relative to the average share, Japan had relatively high shares in technologies with potential or indirect contribution to greenhouse gas emissions mitigation and technologies for efficient electrical power generation, transmission or distribution (Chart 4-2-10(A)).

Looking in detail at technologies with potential or indirect contribution to greenhouse gas emissions mitigation (see Chart 4-2-10(B)), Japan's share in the two subgroups of battery technology and storage technology; and fuel cells was high at 46% in each case. The U.S. held the next highest share behind Japan for each of those technologies. South Korea also held a share of more than 10% in battery technology and storage technology.

As for energy generation through renewable energy sources, Japan's share is the same as it is for the patent families as a whole. Viewed in more detail, however, there are differences depending on the type of technology (Chart 4-2-10(C)).

In solar thermal energy and solar energy, Japan's share was somewhat high at 36%, but it was relatively low at 22% in wind power. Germany has the highest share (25%) in wind power.

Japan's share is relatively low in energy generation of nuclear origin and technologies for the production of fuel of non-fossil origin. France's share of energy generation of nuclear origin is strikingly high.

Thus, among clean energy technologies, Japan's share is relatively high in battery technology and storage technology, fuel cells, solar thermal energy and solar energy. However, looking at relatively more recent applications to the EPO (2007–2008), Japan's shares in battery technology and storage technology, solar thermal energy and solar energy are on a downward trend compared with five years ago. Additionally, there are many issues concerning the link between technology and industrial competitiveness, as seen in recent years in the solar battery market, where manufacturers from other countries have taken over. R&D of clean energy is vigorous around the world, so it is necessary to maintain an ongoing understanding of the situation.

(Masatsura Igami)

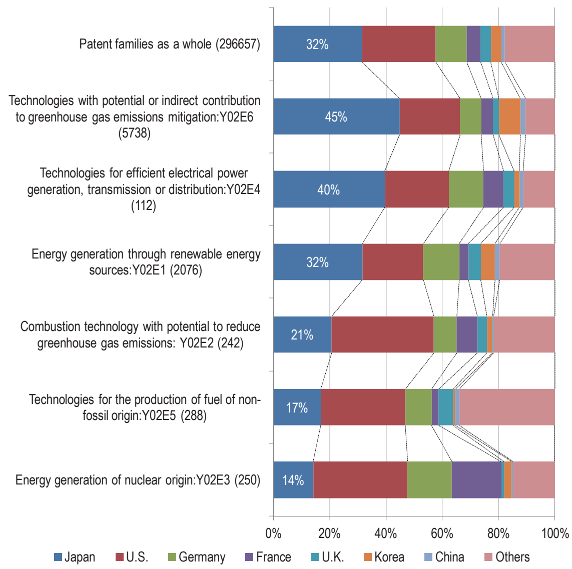
(Measurement method for patent families)

In order to compare clean energy related patent applications from the selected countries, patent families were used for analysis. Patent families are groups of patent applications directly or indirectly linked through priority rights. There are a variety of definitions of patent families, but the ones analyzed in this column are INPADOC patent families filed with the JPO, the EPO and the USPTO. The database used was the EPO's PATSTAT (September 2010 version). When counting patent families, earliest date of priority and inventor country of residence according to the OECD Patent Statistics Manual were used to make a fractional count with countries as the unit.

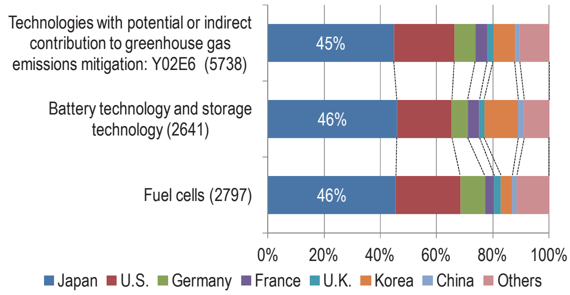
Only those patent families that were filed with the JPO, the EPO and the USPTO were subject to analysis and measurement. Because the time lag between international filing to PCT and transfer to domestic filing can take up to 30 months, the most recent year for which stable analysis of the number of patent families is possible is 2006.

Chart 4-2-10: Selected countries' shares of patent families

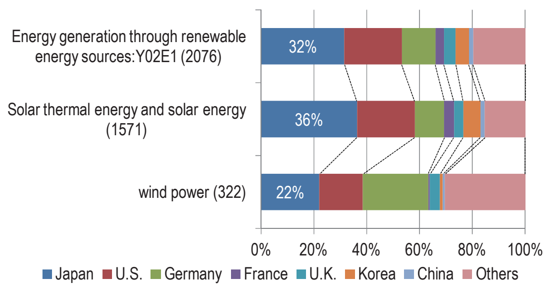
(A) Main groups of clean energy technologies



(B) Technologies with potential or indirect contribution to greenhouse gas emissions mitigation (details)



(C) Energy generation through renewable energy sources (details)



Note: Same as Chart 4-2-9.
Source: Same as Chart 4-2-8.

Chapter 5: Science, technology and innovation

In recent years, there has been a strong need for initiatives that link the results of science and technology to the creation of new value through innovation. Indicators that can show the influence of science and technology on innovation have therefore become important. At this point, however, it is difficult to grasp such influence, and there is little quantitative data.

In this chapter, indicators of technology trade and high-technology trade, which show international technological competitiveness, are examined. Using data on trademarks and patent families, the state of innovation in each of the countries will be considered. In addition, a comparison of the innovation activities of Japanese and the U.S. business enterprises is made based on surveys of businesses in those countries. Finally, long-term changes in Total Factor Productivity (TFP), which is frequently used as a proxy for the outcome of innovation, are examined.

5.1 Technology trade

Key Points

○ Japan's technology trade balance as a ratio was 3.8 in 2009, with an export surplus continuing since 1993. However, the amount of technology trade decreased during the most recent two years. Technology trade exclusive of trade with overseas affiliates, i.e., that between parent companies and subsidiaries, can be considered a better indicator of technology strength. Using that criterion, Japan's technology trade balance in 2009 was 1.3. Japan has had a surplus since 2006.

5.1.1 International comparison of technology trade

In general, technology exports means that the rights of using a technology[(1)], are given to business enterprises or individuals located in or having residence overseas in exchange for payment, and technology imports (technology introduction) means that the rights of using a technology are received from business enterprises or individuals located in or having residence in overseas in exchange for payment. This is called technology trade. It is used as an indicator for international measurement of countries' technology levels. The size of technology exports (receipts) or its ratio to the size of technology imports (payments), i.e., the technical trade balance, is used as an indicator that reflects technology strength. As the technology trade of each country is different in various contexts, the comparison cannot be made simply. Thus, here it is considered by focusing on changes over time and the correlation between the amounts for technology exports and technology imports of each country.

Looking at the amount of the technology trade in major countries (Chart 5-1-1 (A)), the trend for each country is not the same; however, it has generally been increasing on the whole. Looking at the trend by country, the amount of technology exports for Japan has shown an export surplus since FY 1993, which means that the amount of technology exports is higher than that of technology imports. The amount of technology exports was approximately approx. ¥2, 015.3 billion and that of technology imports was about 534.9 billion in FY 2009. The amounts of technology exports and imports have both decreased since FY2007.

The U.S. has by far the world's largest technology export amount. In 2009, it was five times that of Japan. As for trends, both technology imports and exports had consistently increased, but exports fell during 2009 (by 3.6% from the previous year).

In Germany, both the amount of technology

(1) Including rights related to the technologies of intellectual property rights, engineering drawings, blueprints and so-called know-how as provided for by the laws of patent rights, utility model rights, trademark rights, design rights and copy rights.

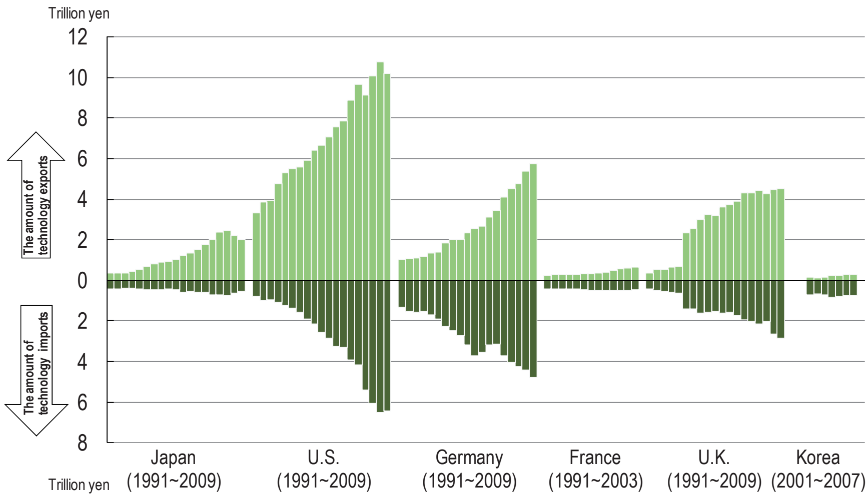
exports and imports greatly exceeds that of Japan. The amount of technology exports has consistently increased over time. The amount of technology imports has fluctuated since 2002, but the overall trend in recent years has been upwards.

Of the countries in the Chart, France is one of the countries which have a small amount of both technology exports and technology imports. Looking at the change over time, its amount of technology exports has tended to increase after 1998, and its amount of technology exports has remained flat. The technology trade balance has had an export surplus since 2000. (Note that the most recent year for which French statistics were available is 2003.)

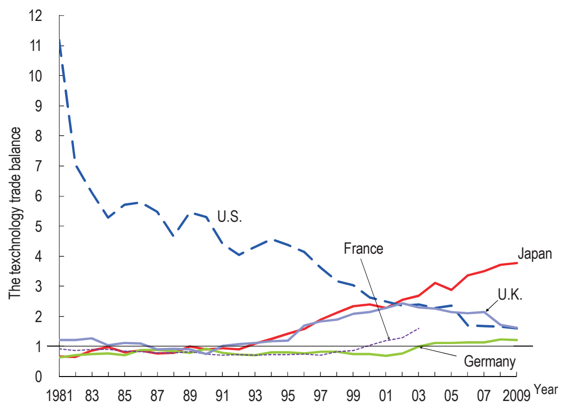
Regarding the U.K., it is necessary to be careful when looking at the change over time because the ways of gathering statistics was changed after 1996. However, the amount of technology exports has tended to be flat in recent years. Since 1996, there has consistently been a surplus in the technology trade balance.

Chart 5-1-1: The technology trade of main countries

(A) The trend in the amount of technology trade



(B) The trend in the technology trade balance



Note :<Japan> Data are for fiscal years.
The sorts of technology trade are as follows (excluding trademark rights):
(1) Patent rights, utility model rights and copy rights
(2)Design rights
(3)Each kind of technological know-how provision and technical guidance (excluding free provision)
(4)Technological aid for developing countries (including government-commissioned works)
<U.S.> Through 2000, only royalties and licenses. For 2001–2005, research, development and testing services were added. Since 2006, computers, data processing services, etc., have been included.
<Germany>West Germany until 1990. Until 1985 includes patents, know-how, trademarks, and design. From 1986, additionally included technical services, computer services and R&D in industrial fields.
<U.K.>from 1984, included oil companies. From 1996, includes patents, inventions, know-how, trademarks, design and services related to technology and R&D.
Statistical reference E was used for purchasing power parity conversion.
Source :<Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development.”
<U.S., Germany, France, U.K. and Korea>OECD, “Main Science and Technology Indicators 2010/2.”

Looking at the technology trade balance (the amount of technology exports/the amount of technology imports), the technology trade balance of Japan has increased since it was more than 1 for the first time in 1993, and the amount of the FY 2009 marked the high figure of 3.8.

The technology trade balance of the U.S. is tending to decrease in the long run. It has been below that of Japan since 2001, and had an export surplus of 1.6 in 2009.

The technology trade balance of Germany passed 1 in 2003, and has been gradually increasing since then.

That of France was over 1 for the first time in 2000, and has shown high figures since then. It marked 1.6 in 2003.

The U.K.'s technology trade balance began growing in the 1990s. It surpassed 2.3 in 2003, but has been slowly declining in recent years.

When the data on technology trade is looked at, it can be seen that a significant ratio of technology trade among nations is accounted for technology transfers within corporate groups such as technology trade with affiliated companies overseas. Technology trade with affiliated companies is an indicator for international transfer of technical knowledge; however, it is not a strong indicator for the international competitiveness of technological strength. When technology trade is used as an indicator for seeing each country's technological strength, it is better to consider it by excluding technology transfers within corporate groups. Thus, regarding the amount of technology exports and imports of Japan and the U.S. whose data it is available, technology trade between affiliated companies and that between other companies are compared.

In Japan's survey(2), "Parent companies and subsidiaries" is defined as where the controlling share is over 50% in the capital ties between technology exporters and importers. With this definition, technology trade among parent companies and subsidiaries, and that among other companies are surveyed.

As shown in Chart 5-1-2(A), Japan's technology exports, excluding those between parent companies and subsidiaries, were ¥588.1 billion in FY2009, accounting for 29.2% of the whole. In the FY 2001, it was approx. ¥539.9 billion and accounted for 43.3% of the total. Compared with the FY 2008 and the FY 2001, there was a decrease of 14.1 points. However, the amount of technology trade was ¥534.9 billion in the FY 2009, and companies excluding parent companies and subsidiaries accounted for 86.2% for the total. Looking at the ratio of the total in the long run, it has consistently had a proportion of over 80%.

In the data for the U.S., technology trade of "associated companies" is defined as the companies which own directly or indirectly 10% or more of voting rights or shares.

The amount of technology exports of companies excluding associated companies in 2007 was approx. ¥2,851.8 billion and accounted for 28.7% of the total. Compared with 1999 (approx.¥1,684.4 billion, 26.2%) at the time of changing the U.S. industry classification to the current one, the amount of technology exports of companies excluding associated companies has increased to 1.7 times as much; however, the percentage of the total is 28.7%, which shows less change. Regarding the amount of technology imports, the amount of technology imports of companies excluding associated companies was approx. ¥648.4 billion in 2007, which accounted for 21.5% of the total. Compared with it being approx. ¥442.8 billion and 20.9% of the total in 1999, the amount of technology imports of companies excluding associated companies has increased by to 1.5 times, with a slight increase of 0.7 percentage points in the ratio.

Regarding technology trade of companies excluding parents companies and subsidiaries or associated companies, both exports and imports of the U.S. account for 20-30% of the total. However, differences can be seen in the technology imports

(2)Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development" was a survey conducted on the Source of the technology trade of Japan by dividing it into the amount of the technology trade of parent companies and subsidiaries, and that for companies excluding parent companies and subsidiaries, since the survey for the FY 2002.

and exports of Japan: exports are about 30%, and imports are about 80% .

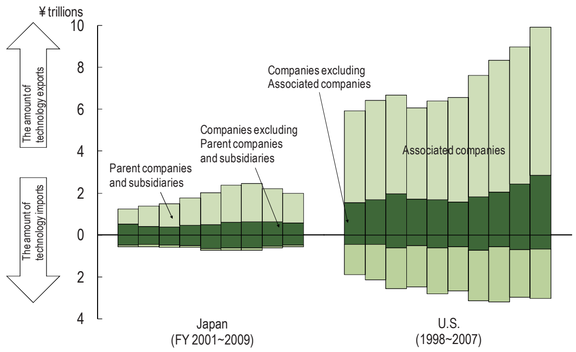
Also, looking at the technology trade balance of companies excluding parent companies, subsidiaries and affiliates (Chart 5-1-2 (B)), Japan has fluctuated around 1, and the U.S. has moved around 3. The amount of the U.S. in 2007 was an export surplus of 4.4.

Since definitions for parent companies and subsidiaries in Japan or associated companies in the U.S. are different, a simple comparison cannot be made. However, the data indicates that the technological strength of the U.S. surpasses that of Japan (See Chart 5-1-2(C) for definitions of parent companies and subsidiaries in Japan and the U.S.).

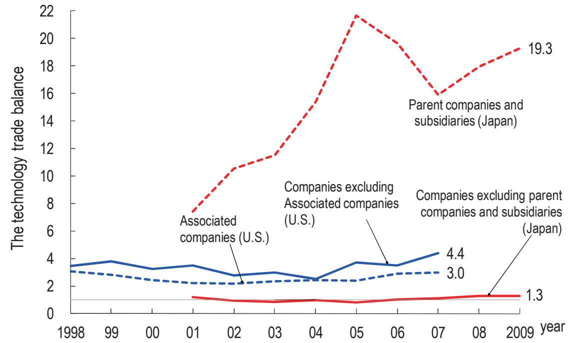
Chart 5-1-2: The change in the amount of technology trade in Japan and the U.S. (Technology trade among parent companies and subsidiaries, associated companies and others)

Attention to international comparison

(A) The amount of technology trade



(B) Technology trade balance



(C) Definitions of parent companies and subsidiaries (associated companies) by capital ties, and the amount of technology trade

(Unit: ¥ trillions)

	Japan (FY2009) Technology Exports	Japan (FY2009) Technology imports	U.S. (FY2007) Technology Exports	U.S. (FY2007) Technology imports	
Capital ties And/over 50% ↑	1.4	0.1	7.1	2.4	Capital ties ↑ And/over 10%
Under 50% ↓	0.6	0.5	2.9	0.6	↓ Under 10%

Note: Attention should be paid to when international comparisons are done, because definitions for parent companies and subsidiaries (affiliated companies) are different in Japan and in the U.S. Differences are as follows:
1) Japan's parent companies and subsidiaries are companies whose controlling share is over 50%.
2) U.S.'s associated companies are companies which own directly or indirectly 10% or more voting rights or shares.
<Japan> 1) Types of technology are the same as in Chart 5-1-1.
2) For classifying industries, the industry classification of the "Survey of Research and Development" based on the Japan Standard Industry Classification was used. For before 2006, the Japan Standard Industry Classification revised edition 2002 (the 11th) was used. For the FY 2008, Japan Standard Industry Classification revised edition 2008 (the 12th) was used.
<U.S.> 1) Types of technology trade are royalties and licenses only.
2) NAICS was used for industry classification.
3) Excludes FFRDCs from 2001.

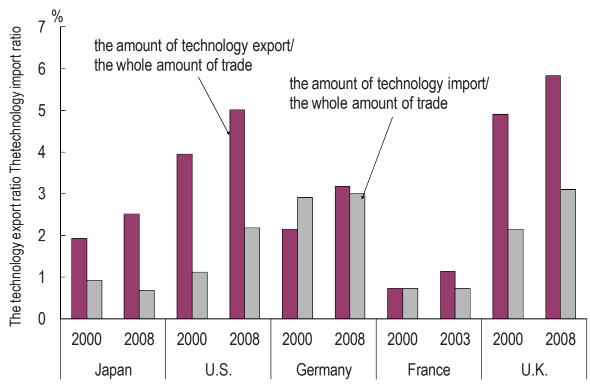
Source :<Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development."
<U.S.>NSF, "Science & Engineering Indicators 2010."

Chart 5-1-3 is the ratio of the amount of the technology trade against the whole amount of trade. The level of the amount of the technology trade is shown by comparison with the entire trade amount of goods and services. Hereinafter, the ratio of the amount of technology exports which it occupies out of total exports is called the "Technology export ratio," and that for technology imports is called the "Technology import ratio."

The U.K. had the highest technology export ratio. It was 5.8% in 2008. Already high at 4.9% in 2000, it increased by 0.91 percentage points over that period. Japan's technology export ratio in 2008 was 2.5%, which was an increase of 0.6 points over the 2000 figure (1.9%). The U.S. in 2008 had a ratio of 5.0%, an increase of 1.1 points since 2000 (4.0%).

The technology import ratio of the U.K. was highest (3.1% in 2008), having increased by 0.9 points since 2000 (2.2%). Next highest was Germany at 3.0% in 2008, which was about the same as its technology export ratio. It changed little from 2000, when it was 2.9%. The ratio for the U.S. in 2008 was 2.2%, double the 2000 figure (1.1%). Japan's technology import ratio in 2000 was 0.9%; in 2008, it was down to 0.7%.

Chart 5-1-3: The ratio of the amount of technology trade against the whole amount of trade



Note: 1) The sorts of technology trade are the same as in Chart 5-1-1.
2) The amount of technology imports and exports is the same as in Chart 5-1-1.
Source: <The amount of technology imports and exports>is the same as in Chart 5-1-1.
<The amount of the whole imports and exports>, OECD, "Annual National Accounts

5.1.2 The Technology Trade of Japan

Key Points

○Looking at the amount of technology exports of Japan, “Transportation equipment manufacturing” accounts for about 50% of all industries, and it is followed by “Drugs and medicines”, which accounts for about 10% of all industries. Regarding “Transportation equipment manufacturing”, ” the ratio of technology exports made among parent companies and subsidiaries is approximately 80%. However, that of “Drugs and medicines” remains at approximately 50%. “Drugs and medicines” can be said to be an industry involving more international technology transfer for technology exports in Japan, many of which transactions are made among parent companies and subsidiaries.

○Looking at partners for technology exports from Japan, the U.S. accounts for 35.6% of the total. Compared with 2004, however, both the share and the amount have decreased. China has the next highest share at 13.8%. China's share and amount have both been increasing. Regarding technology imports, on the other hand, the U.S. accounts for 72.0% of all imports, followed by Germany, France and the U.K. with 5% or less.

(1) Technology trade by industry classification

Looking at the technology trade of Japan by industry classification (Chart 5-1-4(A)), the industry which had the largest amount of technology exports in the FY 2009 was “Transportation equipment manufacturing.” The amount was approx. ¥972.1 billion and accounted for 48.2% of the entire industries. It was followed by “Drugs and medicines” (approx. ¥261.2 billion, 13.0%) and “Information and communication electronics equipment” (approx. ¥232.4 billion, 11.5%). Compared with the FY 2004, there was a 6.4 point decrease in the ratio of “Transportation equipment manufacturing”, a 2.6 point increase in that of “Drugs and medicines” and a 1.0 point increase in that of “Information and communication electronics equipment.”

On the other hand, looking at in the FY 2009, the industry which had the large amount of technology imports was “Information and communication electronics equipment.” The amount was approx. ¥250.7 billion and accounted for 46.9% of the entire industries. It was followed by "Drugs and medicines" (¥44.9 billion, 8.4%) and "Transportation equipment manufacturing" (¥34.9 billion, 6.5%). Compared with the FY 2004, there was a large increase of 13.6 points in the ratio of “Information and communication electronics equipment”, and a 4.2 point decline in “Information and communications”.

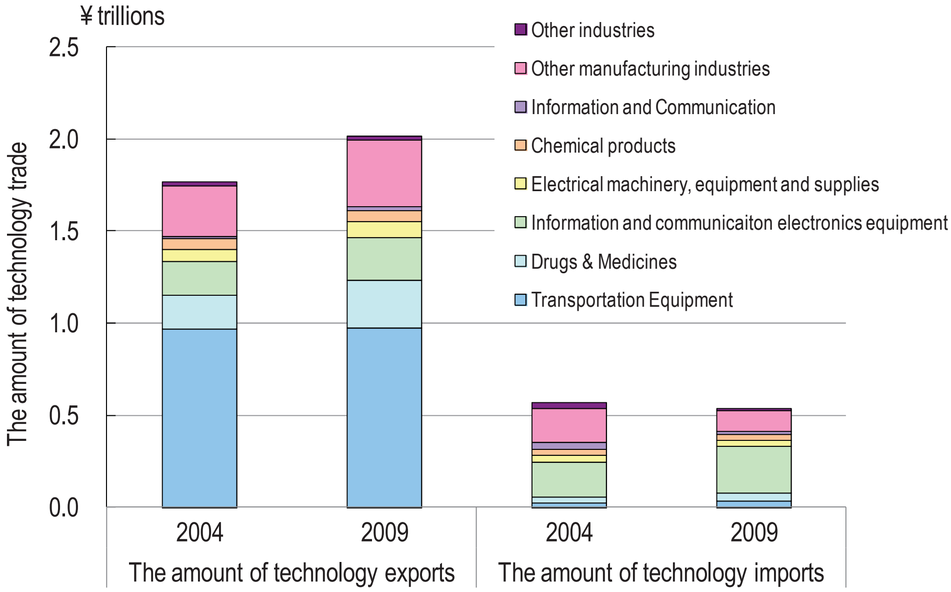
Looking by industry classification at the amount of technology trade of parent companies and subsidiaries and that of companies excluding parent companies and subsidiaries (Chart 5-1-4(B and, C)), in most industries, parent companies and subsidiaries have a larger amount for technology trade.

Trade among companies excluding parent companies and subsidiaries accounts for about 20% of the total in “transportation equipment manufacturing” which occupies the large amount of technology exports." In "Drugs and medicines" and "Information and communication electronics equipment," the percentage of trade among companies excluding parent companies and subsidiaries is large. About 50% of trade in "Drugs and medicines" and "Information and communication electronics equipment" is in companies excluding parent companies and subsidiaries. During FY2004, about 60% of trade in "Drugs and medicines" was among companies excluding parent companies and subsidiaries.

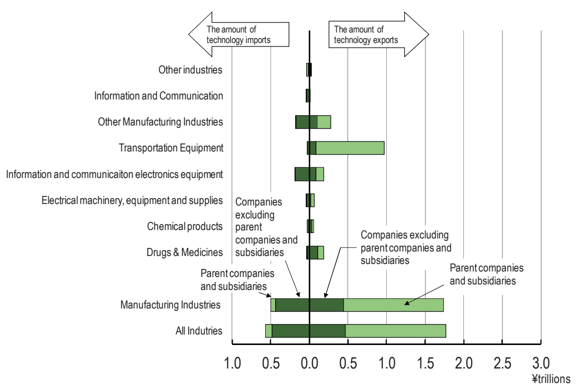
As for technology imports, the percentage of imports that were not among parent companies and subsidiaries was higher in almost every industry. Looking at the amount of technology imports, "Information and communication electronics equipment" was highest, followed by "Drugs and medicines." Almost all the trade in those industries was among parent companies and subsidiaries.

Chart 5-1-4: The technology trade of Japan by industry classification

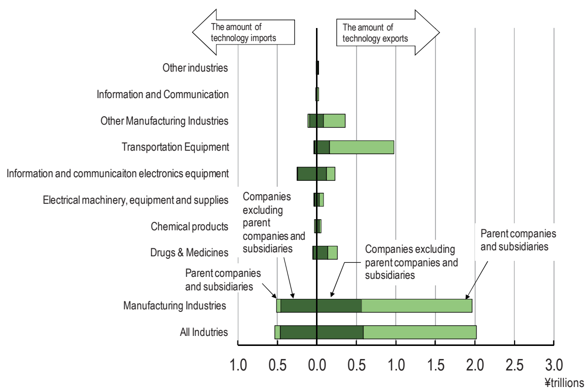
(A) The amount of technology trade



(B) The amount of technology trade of parent companies and subsidiaries, and that of companies excluding parent companies and subsidiaries (the FY 2004).



(C) The amount of technology trade of parent companies and subsidiaries, and that of companies excluding parent companies and subsidiaries (the FY 2009)



Note: 1) For the names of the components, the names of the components in the latest Survey of Research and Development are used.
2) For the industry classification for the FY 2003, the industry classification of the Survey of Research and Development based on Japan Standard Industry Classification revised edition 2002 (the 11th) is used.
3) For the industry classification for the FY 2008, used the industry classification of the Survey of Research and Development based on Japan Standard Industry Classification revised edition 2008 (the 12th) is used.
4) The targets for technology trade are patent, know-how and technical guidance.
5) Parent companies and subsidiaries are defined that their controlling share is over 50%.
Source: Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”

(2) Technology trade by industry classification and partner

In this section, technology trade statistics are used to examine Japan in terms of its partners in order to elucidate technology relations between Japan and the other countries.

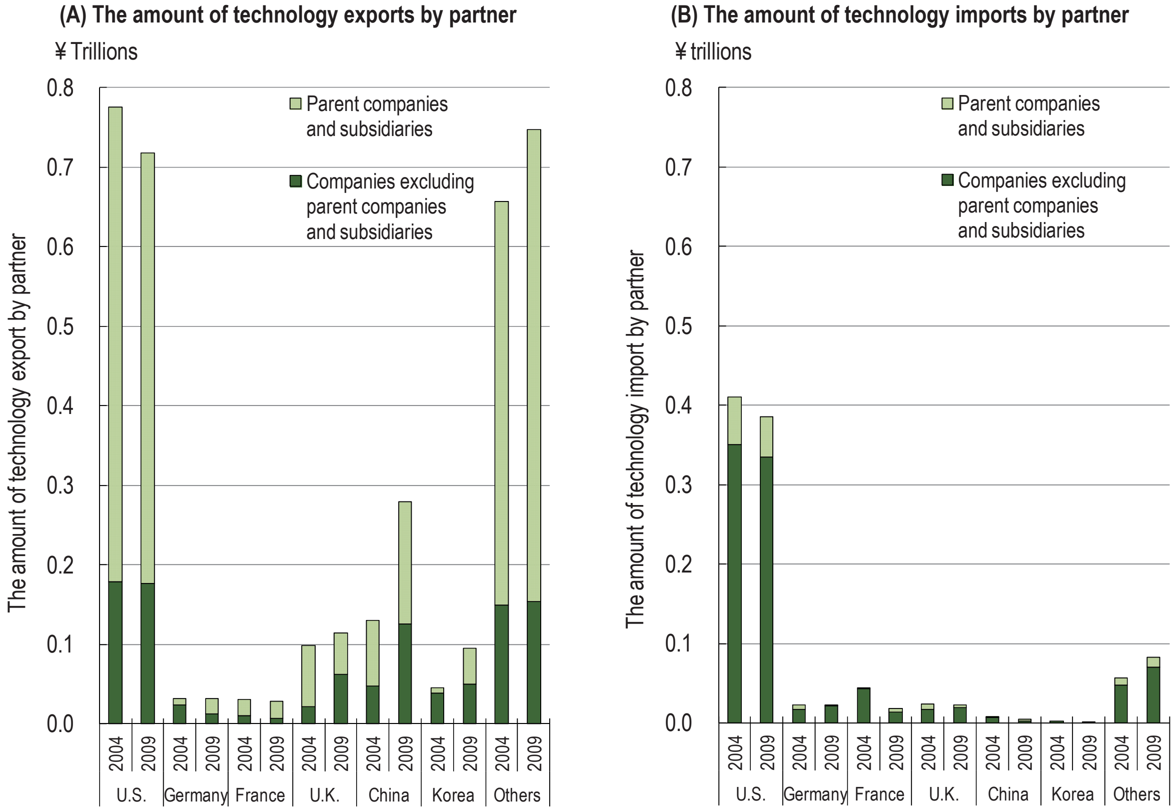
Chart 5-1-5 shows how much technology trade Japan engages in with selected countries and whether the trading enterprises are parent companies and subsidiaries.

As shown in Chart 5-1-5(A), Japan's amount of technology exports in FY2009, i.e., the amount of value received from partner countries, was especially large from the U.S. It was ¥718.0 billion, accounting for 35.6% of the amount from all partner countries. Next largest was China at ¥278.9 billion (13.8% of the total). The total technology export amount from countries other than the six shown in Chart 5-1-5(A) was higher than that from the U.S. Those countries include Thailand, Taiwan and Canada. The amount of technology exports from trade among parent companies and subsidiaries is high in every country. In the U.K., however, the technology export amount from companies other than parent companies and subsidiaries is large. Compared with 2004, there was an increase in all the countries except the U.S. and France. Looking at the amount of technology exports for the U.S., exports to companies excluding parent companies and subsidiaries hardly decreased at all.

Turning to Chart 5-1-5(B), Japan's amount of technology imports, i.e., the amount of value paid to partner countries, was largest for the U.S. in FY2009. It was ¥385.0 billion, accounting for 72% of the total for all countries. For each of the countries, technology imports not among parent companies and subsidiaries were larger.

Compared with FY2004, all six countries shown in 5-1-5(B) showed decreases, and the amount of technology imports from countries other than those six increased.

Chart 5-1-5: The amount of technology trade of Japan by partner (FY 2004 and 2009)



Note: Same as the Chart 5-1-4
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development."

5.2 High-technology industry trade

Key Points

○World high-technology trade consistently increased from 2001 to 2008, roughly doubling overall. The "Radio, Television and Communication Equipment" accounts for the largest share at about 40%.

○Looking by country, the trade scale of the U.S. was large and is tending to expand. However, China has increased its trade amount rapidly during recent years and to the value of its exports has surpassed that of the U.S. The trade amount of Germany has also rapidly expanded. Japan has followed it, and is in fourth place. However, high-technology trade declined in each country in the most recent year, 2009.

○The trade balance of Japan's high-technology industry had an export surplus of over 3 in the early 1990s. After that, the trade balance tended to decrease and it was an export surplus of over 1.2 in 2008. South Korea has been on an upward trend in recent years and passed Japan in 2003. China, at 1.3, passed Japan for the first time in 2009. Europe has moved around 1 since 1990s, and the U.S. has shifted to less than 1 since 2000, which means it now has an import surplus.

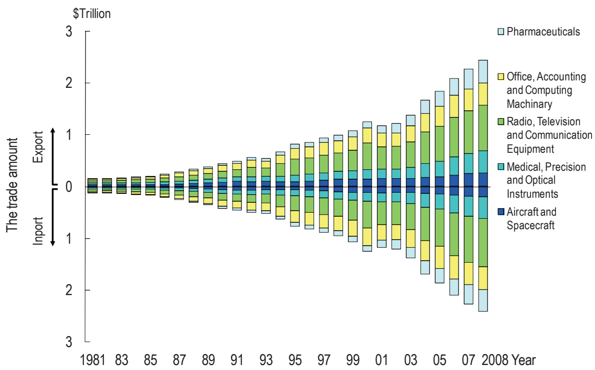
○Looking at it by field, the "Radio, Television and Communication Equipment" industry showed a large ratio, and particularly the amount of the imports and the exports of China have been larger than those of the U.S. in recent years.

○The "Radio, Television and Communication Equipment" industry and the "Medical, Precision and Optical Instruments" industry of Japan have an export surplus. The "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft" industries of the U.S. have export surpluses, as do the "Pharmaceuticals," "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft" industries of Germany.

The trade amount of high-technology industries is not data regarding direct exchanges of science and technology knowledge in the sense that technology trade is. However, it is a direct indicator of science and technology knowledge that has been applied to the development of actual products. "High-technology industries" as used herein are based on definitions used by the OECD (they are sometimes called "R&D intensive industries"). They are "Pharmaceuticals," "Office, Accounting and Computing Machinery," "Radio, Television and Communication Equipment," "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft."

In Chart 5-2-1, regarding 34 OECD member-countries and 6 Non-OECD countries and regions[(3)], the change in the total amount of the trade amount[(4)] (export amount and import amount) of high-technology industry is shown. This can be considered total world trade in high-technology industries. The trade amount for imports and exports of "Radio, Television and Communication Equipment" is the largest, accounting for about 40% of the whole.

Chart 5-2-1: The change of the trade amount of the high-technology industry of 34 OECD member-countries and 6 Non-OECD countries and regions



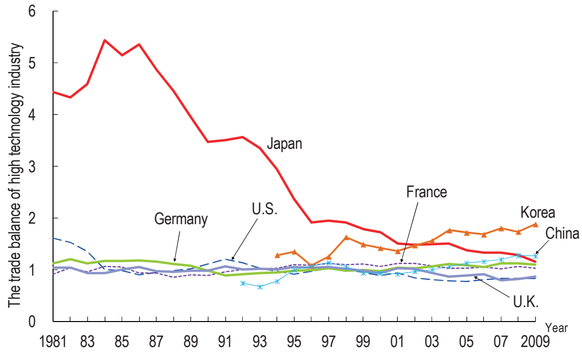
Note: The non-member countries and regions are Algeria, China, Russia, Singapore, Romania and South Africa
Source : OECD, " Main Science and Technology Indicators 2010/2"

(3) Algeria, China, Russia, Singapore, Romania, and South Africa
(4) Summed up the amount which each country trades with other countries.

Chart 5-2-2 shows the change in the trade balance of the entire high-technology industry. Japan's balance ratio peaked in 1984 and has been on a long-term downward trend. Japan's ratio was passed in 2003 by South Korea's and in 2009 by China's. However, the trade balance ratio has never fallen below 1. France's trade balance ratio has consistently remained near 1 since 1992.

On the other hand, the U.S. trade balance ratio has been below 1 since 1999, and that of the U.K. since 2003.

Chart 5-2-2: Changes in the trade balance ratios for high-technology industries in selected countries



Source: OECD, "Main Science and technology Indicators 2010/2"

Chart 5-2-3 shows changes in the trade amounts for high-technology industries in selected countries. As indicated in the chart, in 2009 the trade amount for high-technology industries declined in each of the countries, i.e., Japan, the U.S., Germany, France, the U.K., China and South Korea.

Japan's trade balance for high-technology industries ran a large surplus around 1990, with "Radio, Television and Communication Equipment" making a large contribution. In recent years, the size of the overall surplus has declined. "Radio, Television and Communication Equipment" and "Medical, Precision and Optical Instruments" were in the black, although their balances have been shrinking. Both "Aircraft and Spacecraft" and "Pharmaceuticals" consistently show import surpluses.

The highest export amount for the U.S. was in "Radio, Television and Communication Equipment." It had export surpluses in "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft."

Germany's largest export amount was in "Medical, Precision and Optical Instruments." It had export surpluses in "Pharmaceuticals" and "Aircraft and Spacecraft."

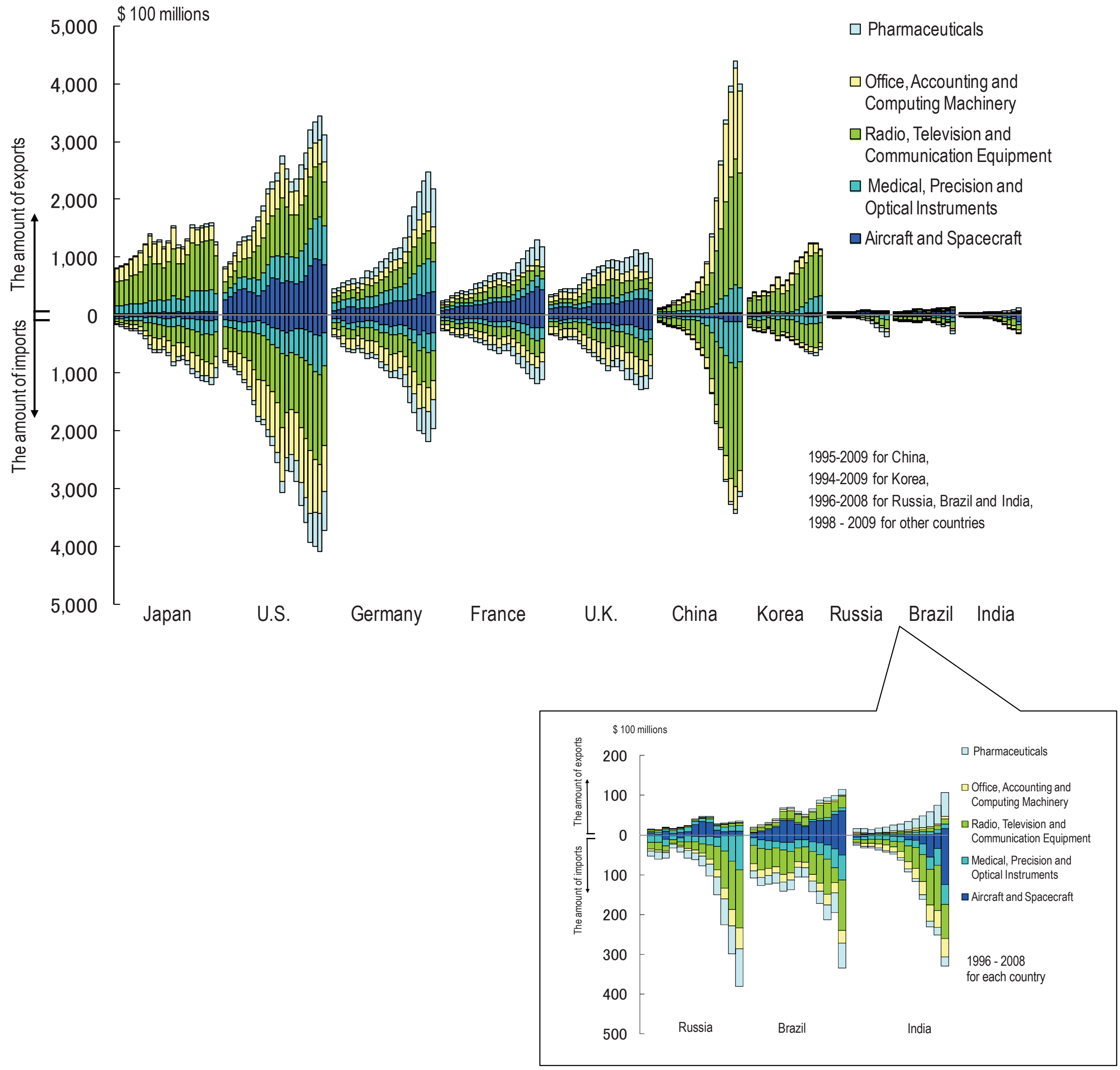
France's highest export amount was in "Aircraft and Spacecraft," for which it also had a high trade balance ratio. The U.K. has developed a high export amount in "Pharmaceuticals." It also had a surplus in "Aircraft and Spacecraft" and "Pharmaceuticals."

The amount of China's high-technology industries trade has grown sharply. The increase in "Radio, Television and Communication Equipment" has been especially dramatic. It first developed a surplus in that industry in 2008. It has had surpluses in "Pharmaceuticals" and "Office, Accounting and Computing Machinery" since the 1990s.

South Korea has also seen a striking rise in "Radio, Television and Communication Equipment." It had surpluses in "Office, Accounting and Computing Machinery" and "Radio, Television and Communication Equipment."

Looking at the data for the BRICs with their remarkable economic development, Russia, Brazil, India all had large import amounts. Focusing on export amounts, Russia recently had a large amount for "Medical, Precision and Optical Instruments," but still had an import surplus. Brazil has a large export amount and an export surplus for "Aircraft and Spacecraft," as does India for "Pharmaceuticals."

Chart 5-2-3: The change in the trade amount of high technology industry in main countries



Sources: <Japan, U.S., Germany, France, U.K., China, Korea, Russia> OECD, "Main Science and Technology Indicators 2010/2"
<Brazil and India> OECD, "STAN Bilateral Trade Database (Edition 2008)"

5.3 Trademark applications and trilateral patent families

Key Points

- ○ Looking at the per-capita numbers of transnational trademark applications and trilateral patent families (patents with the same content submitted in Japan, the U.S. and Europe), in 2006–2008, Japan, Germany and South Korea had relatively high numbers of trilateral patent families. The U.S. and the U.K., on the other hand, had more trademark applications than trilateral patent families.
- ○ Comparing 2000–2002 with 2006–2008, the number of trademark applications increased sharply in Germany and the U.K., while the number of trilateral patent families increased slightly in those countries. In Japan, on the other hand, the number of trademark applications and the number of trilateral patent families both decreased slightly. In the U.S., the number of trademark applications has been decreasing.

Chart 5-3 shows the number of transnational trademark applications and the number of trilateral patent families in selected countries. Both values are standardized by population for each country.

When business enterprises bring new products or services to the market, they apply for trademarks in order to distinguish them from market competitors. Thus, the number of trademark applications is related to the realization of innovation in the form of new products and services, and to associated marketing activities. In that sense, it can be considered data that reflect the relationship between innovation and markets.

"Transnational applications" as used here are applications for trademarks in foreign countries. When applying for a trademark, there is a strong tendency to apply for it in the home country. In addition, because there are differences in the number of applications because of factors such as national size and systems, values were corrected using the number of applications from Japan, Germany, France, the U.K. and South Korea to the U.S. Patent and Trademark Office and from the U.S. to Japan and Europe (See Chart 5-3, Note: 1.).

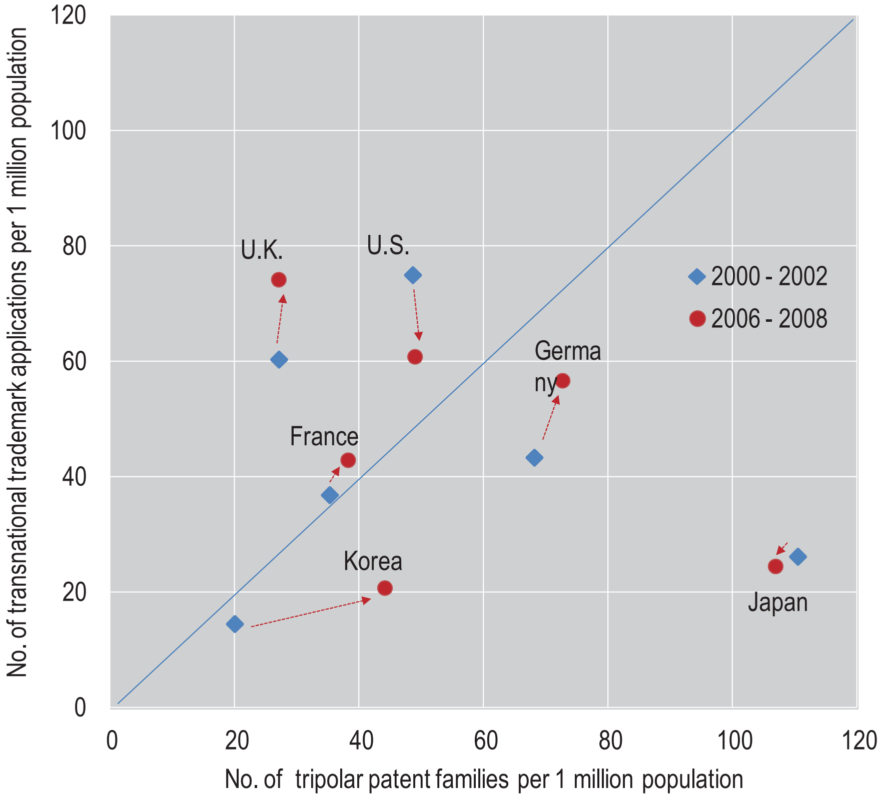
Patents are used as an indicator of countries' technological prowess. Bias is introduced because there are advantages to filing patent applications in one's own country and because of the influence of geography. The number of trilateral patent families was used because it is less susceptible to such effects.

In 2006–2008, Japan had a large number of trilateral patent families, but a relatively small number of trademark applications. South Korea also had a relatively low number of trademark applications. Germany had a large number of trilateral patent families, but its number of trademark applications was not small. The U.S. and the U.K. both had more trademark applications than trilateral patent families.

It is believed that countries with powerful manufacturing industries or those specializing in the information and communications industry tend to have more patent applications than trademark applications, while countries weighted towards service industries tend to have more trademark applications. Country characteristics may thus be appearing in the data. Data on international applications was used for both trademarks and patent families. In Japan's case, because international business development differs in manufacturing industries and service industries, this may affect the data.

Comparing 2000–2002 with 2006–2008, the number of trademark applications increased sharply in Germany and the U.K., while the number of trilateral patent families increased slightly in those countries. In Japan, on the other hand, the number of trademark applications and the number of trilateral patent families both decreased slightly. In the U.S., the number of trademark applications has been decreasing.

Chart 5-3: Per-capita transnational trademark applications and trilateral patent families



Notes: 1)*Transnational trademarks refer to the following.
For the number of trademarks in Japan, Germany, France, the U.K. and South Korea, the number filed with the U.S. Patent and Trademark Office (USPTO).
The number of trademarks for the U.S. is the average of (i) and (ii).
(i) The corrected number of the U.S. applications, based on the ratio of Japanese and the U.S. applications to the Office for Harmonization in the Internal Market (OHIM) = (number of the U.S. applications to the OHIM / number of Japanese applications to the OHIM) × number of Japanese applications to the USTPO.
(ii) The corrected number of the U.S. applications, based on the ratio of European and the U.S. applications to the Japan Patent Office (JPO) = (number of the U.S. applications to the JPO / number of EU-15 applications to the JPO) × number of EU-15 applications to the USTPO.
2) Three-year averages.
Sources: WIPO, "Trademark Statistics, January 2010"
OECD, "Main Science and Technology Indicators 2010/2"

5.4 The relationship between R&D and innovation: A Japan-the U.S. comparison

Key Points

○ Looking at the achievement of innovation in business enterprises that carry out R&D activities, in both Japan and the U.S., enterprises with higher R&D expenditures achieve innovation at a higher rate.

○ In the case of Japanese business enterprises that carry out R&D activities, "product innovation related to services" has a lower rate of innovation than "product innovation related to goods" and "process innovation," regardless of the size of R&D expenditures.

○ In the case of the U.S. business enterprises that carry out R&D activities, "product innovation related to services" has a lower rate of innovation than "product innovation related to goods" and "process innovation," regardless of the size of R&D expenditures. However, the difference is not as large as it is for Japan.

In 2009, the National Institute of Science and Technology Policy carried out the "Second Japanese National Innovation Survey." The survey collected data on the state of innovation in Japanese business enterprises(5). The survey generally followed the "Oslo Manual," which sets forth international standards for surveys of innovation. Enterprises' innovation activities were defined as "Initiatives on design, R&D, market research and so on needed to develop novel products or services or processes that aim to improve work" in carrying out the survey of the state of innovation activities.

Product innovation in the "Second Japanese National Innovation Survey" is defined as "placement of new products or services on the market. New products and services include not only those that have novel functions, performance, design, materials, components or applications, but also those that combine existing technologies or that advance existing products or services to higher technological levels. However, it does not include mere design changes that leave the functions or purposes of products and services unchanged, nor simply selling or providing the products or services of another company." Process innovation is defined as "adoption of a new process or improvement of an existing process. Process innovation includes not only the adoption or improvement of methods for product or service manufacture and production or logistics and distribution, but also the adoption or improvement of maintenance or computer systems for manufacturing, production, logistics of distribution."

In the U.S., the "Business R&D Innovation Survey" carried out in 2008 surveyed the state of product innovation and process innovation in the U.S. business enterprises.

As shown in Chart 5-4-1, the populations for the Japanese and the U.S. innovation surveys differed (companies with 10 or more employees in Japan and 5 or more in the U.S.). There were also some differences in the form of questions asked. To the extent possible, however, this section will compare the state of innovation in Japanese and the U.S. business enterprises.

Chart 5-4-1: Number of companies in the Japanese and U.S. survey populations

(Unit: Companies)

	Japan	U.S.
All companies	331,037	1,545,100
Companies that performed R&D	51,445	46,800
Companies with R&D expenditure (internal + external) of less than $100 million	48,506	44,800
Companies with R&D expenditure (internal + external) of $100 million to less than $500 million	286	1,300
Companies with R&D expenditure (internal + external) of $500 million to less than $1 billion	64	300
Companies with R&D expenditure (internal + external) of $1 billion or more	91	400
Companies that did not perform R&D	279,592	1,498,300

Notes: 1) Companies that had R&D expenditures, whether internal or external, during FY2006–2008 are considered to have engaged in R&D activities. Classification of R&D expenditures is based on the amount during FY2008. The R&D expenditures of Japanese business enterprises were calculated in the U.S. dollars at 2008 purchasing power parity.
2) Because some companies in the Japanese survey did not enter an amount for FY2008, the number of companies that carried out R&D and the total number of companies classified by amount of expenditures do not match.
3) In the U.S. survey, the 327,300 companies that did not report on whether they carried out R&D activities are not included in the weighted totals.
4) Populations were companies with at least 10 employees for the Japanese survey and at least 5 employees for the U.S. survey.

Sources: ＜Japan＞Tabulated by the National Institute of Science and Technology Policy based on data from the Second Japanese National Innovation Survey (performed in 2009).
＜U.S.＞NSF, "InfoBrief (NSF Releases New Statistics on Business Innovation)"

(5) National Institute of Science and Technology Policy, NR no. 144, "Report on Japanese National Innovation Survey 2009" (9/2010)

Chart 5-4-2 classifies Japanese and the U.S. companies that performed R&D according to the size of their R&D expenditures and shows the percentages that achieved innovation. "R&D expenditures" as used here are combined internal and external R&D expenses. Because activities that aim to achieve innovation are carried out both internally and externally, R&D expenditures were measured in the same way.

Innovation is classified as (i) product innovation related to goods, (ii) product innovation related to services or (iii) process innovation.

Looking at the state of Japanese innovation, business enterprises with higher R&D expenditures tended to have higher rates of innovation, while those with low expenditures tended to have lower rates of innovation. However, the highest innovation rate for "product innovation related to goods" (88%) was the second tier of businesses, those utilizing 500 million dollars to less than 1 billion dollars, rather than the highest tier.

At every level of R&D expenditures, there was a lower rate of innovation for "product innovation related to services" than for "product innovation related to goods" or for "process innovation."

Regarding "product innovation related to goods" and "process innovation," over 50% of all businesses that carried out R&D activities achieved innovation, a 40 percentage point gap compared to the rate for businesses that did not carry out R&D activities.

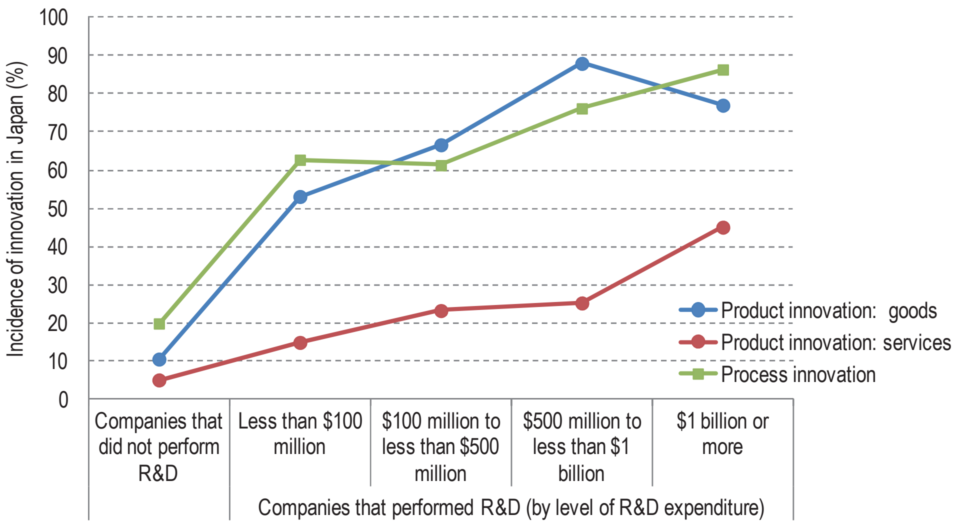
In the U.S. as in Japan, business enterprises with higher R&D expenditures tended to have higher rates of innovation.

At every level of R&D expenditures, there was a lower rate of innovation for "product innovation related to services" than for "product innovation related to goods" and "process innovation." However, the difference was not as large as it was in Japan.

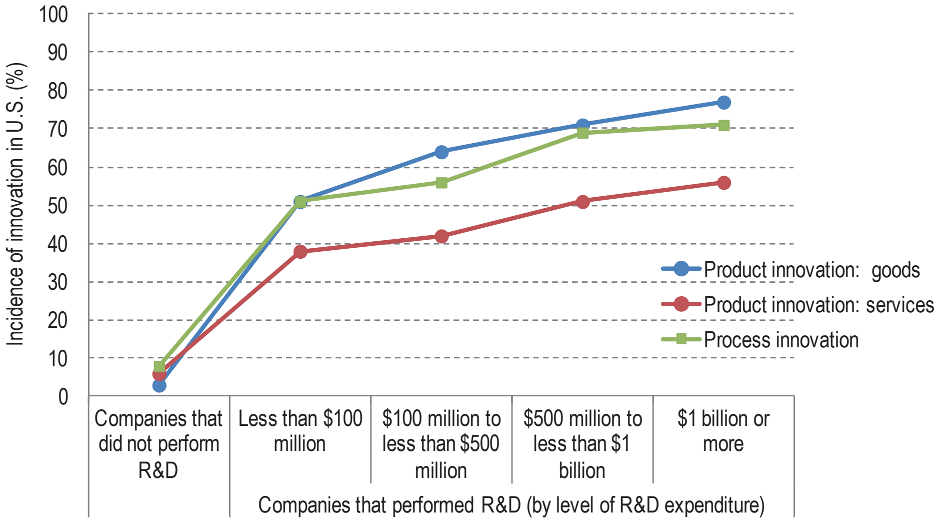
For all three types of innovation activities, businesses with at least 1 billion dollars in R&D expenditures had the highest rate of innovation. For "process innovation," however, the rate for businesses utilizing 500 million dollars to less than 1 billion dollars was 69%, while that for businesses with R&D expenditures of at least 1 billion dollars was 71%, so they were approximately the same.

Chart 5-4-2: The state of innovation by businesses in Japan and the U.S.: by level of R&D expenditures (2006–2008)

(A) Japan



(B) U.S.



Note: Same as Chart 5-4-1.
Sources: Same as Chart 5-4-1.

5.5 Total Factor Productivity (TFP)

Key points

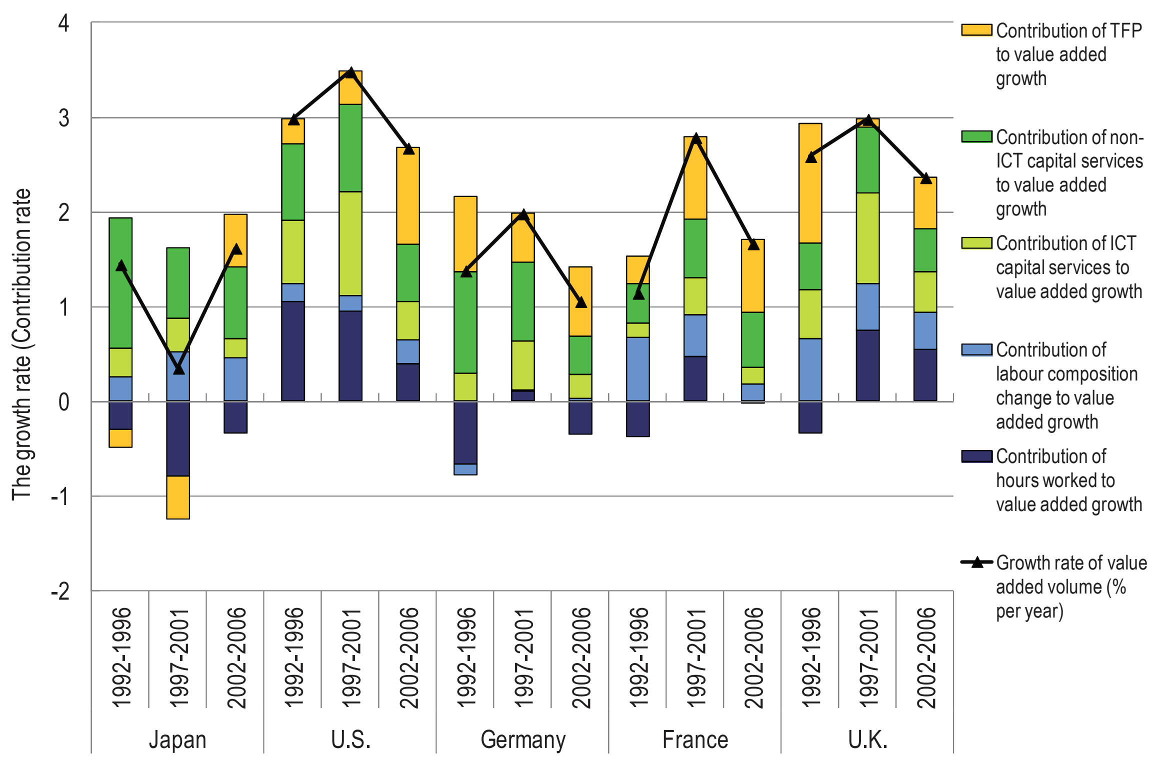
○The contribution of Total Factor Productivity (TFP) to economic growth during 2002–2006 was highest in the U.S. (1.2%). Following the U.S. were France (0.77%) and Germany (0.73%) at levels roughly equal to each other. Japan (0.55%) and the U.K. (0.54%) were also roughly equal to one another.

Total Factor Productivity (TFP) is a figure indicating that portion of economic growth that cannot be explained by the contributions of increased investment in capital and labor. It is often used as an indicator showing the outcome of innovation through technological advancement. In this section, the factors of economic growth of countries are divided by 5 factors (Contribution of hours worked, Contribution of labor composition change, Contribution of ICT capital services, Contribution of non-ICT capital services and Contribution of TFP) based on EU-KLEMS Database, and the data is looked at by average amount every 5 years (Chart 5-5).

Japan's growth rate of value added volume declined during 1997–2001, but it rose during 2002–2006. The pattern was reversed in the U.S., Germany, France and the U.K.; the rate rose during 1997–2001, but fell during 2002–2006.

The contribution of TFP to economic growth during 2002–2006 was highest in the U.S. (1.2%). Following the U.S. were France (0.77%) and Germany (0.73%) at levels roughly equal to each other. Japan (0.55%) and the U.K. (0.54%) were also roughly equal to one another.

Chart 5-5 The breakdown of the factors of economic growth rates in main countries



Note: 1) Amounts are 5-year averages. For instance, in the case of 1992–1996, the amount for the 5 years 1992, 1993, 1994, 1995 and 1996
2) Regarding data for Japan, some variables in the JIP Database 2009, which is the original data of the EU-KLEMS Database, were changed, so the trend differs from the S&T Indicators for 2009.
Source: Made by EU-KLEMS Database, November 2009

Reference materials

Reference Materials: Indicators for the regions

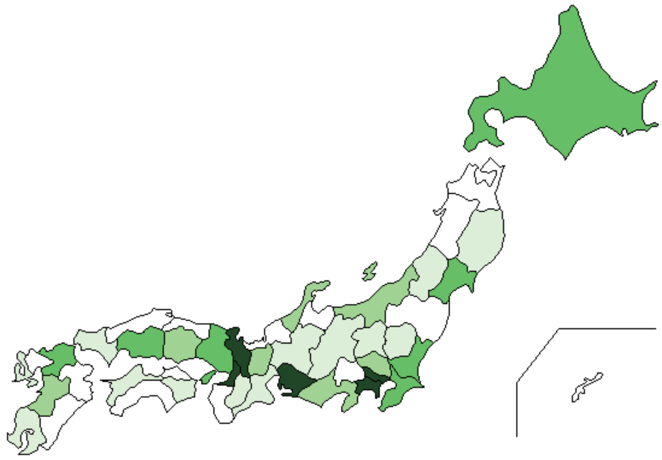
Here, regarding the following 7 items representing the situation of the output of scientific technology activities, the distributions or the changes in the values for the prefecture of Japan indicated are given.

1. The number of graduate students in national, public and private Universities and Colleges
2. The number of papers (all fields)
3. The number of papers (the field of Life sciences)
4. The number of papers (in fields other than Life sciences)
5. The balance of papers between the field of Life sciences and fields other than Life sciences
6. The number of patent applications
7. The number of inventors

In making these charts, the methods of grouping by the prefecture were standardized as far as possible.

1. The number of graduate students in national, public and private universities and colleges

Chart 1-1: The share of the number of graduate students in national, public and private universities and colleges
The average value for 2007–2009

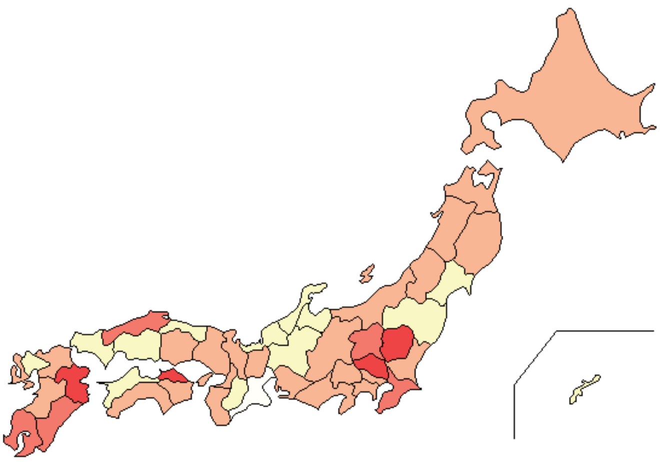


Legend	Classification			The number of prefectures
	5.00% or over	～		5
	2.00%	～	Under 5.00%	7
	1.00%	～	2.00%	7
	0.50%	～	1.00%	13
		～	0.50%	15

Top 5	Share	Low rank 5	Share
Tokyo	26.56%	Akita	0.28%
Osaka	6.92%	Miyazaki	0.30%
Kyoto	6.77%	Wakayama	0.30%
Aichi	5.82%	Shimane	0.32%
Kanagawa	5.49%	Fukushima	0.34%

Source: MEXT, "School Basic Survey"

Chart 1-2: The share increase rate of the number of graduate students in national, public and private universities and colleges
The comparison of the average values between 2002–2004 and 2007–2009



Legend	Classification			The number of prefectures
	1.15 or over	～		4
	1.05	～	under 1.15	5
	0.95	～	1.05	24
	0.85	～	0.95	13
		～	0.85	1

Top 5	Growth rate	Low rank 5	Growth rate
Kagawa	1.20	Mie	0.82
Oita	1.20	Ishikawa	0.87
Saitama	1.16	Fukui	0.87
Tochigi	1.15	Toyama	0.88
Chiba	1.12	Ehime	0.89

Source: MEXT, "School Basic Survey"

[Key Points]

- The prefecture, which has major metropolitan areas, have more graduate students (Chart 1-1).
- Looking at the share increase rate from 2002–2004 to 2007–2009, they were high in Shikoku, Kyushu and the Prefectures around Tokyo, with Kagawa Prefecture highest at 1.20. On the other hand, there were 14 prefectures whose share increase rate were less than 0.95 (Chart 1-2).

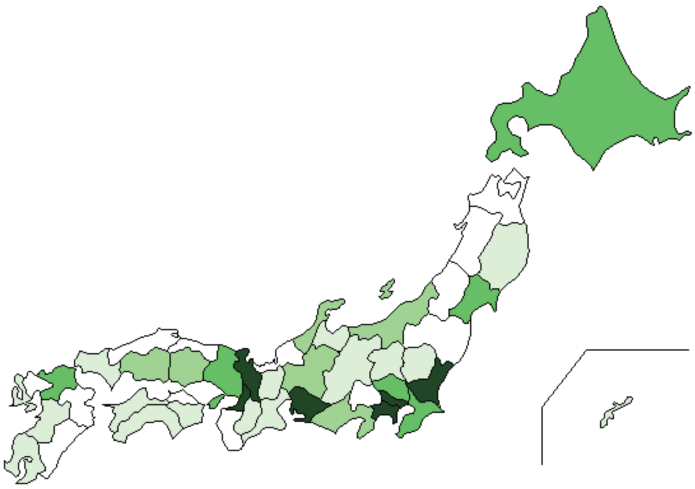
Table 1: The number of graduate students in national, public and private universities and colleges

Prefectures	3-year moving average 2002-2004 Unit case	2007-2009 Unit case	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	8,486	9,207	3.64%	3.50%	0.961
Aomori	815	935	0.35%	0.36%	1.016
Iwate	1,239	1,343	0.53%	0.51%	0.961
Miyagi	7,359	7,736	3.16%	2.94%	0.932
Akita	665	738	0.29%	0.28%	0.984
Yamagata	1,341	1,500	0.58%	0.57%	0.991
Fukushima	854	883	0.37%	0.34%	0.916
Ibaraki	6,226	7,006	2.67%	2.66%	0.997
Tochigi	1,550	2,017	0.67%	0.77%	1.153
Gunma	1,630	1,981	0.70%	0.75%	1.077
Saitama	3,807	4,977	1.63%	1.89%	1.159
Chiba	7,776	9,534	3.34%	3.63%	1.087
Tokyo	60,183	69,831	25.83%	26.56%	1.028
Kanagawa	13,451	14,424	5.77%	5.49%	0.950
Niigata	4,107	4,725	1.76%	1.80%	1.020
Toyama	1,271	1,266	0.55%	0.48%	0.882
Ishikawa	4,014	3,934	1.72%	1.50%	0.868
Fukui	1,123	1,102	0.48%	0.42%	0.870
Yamanashi	1,027	1,117	0.44%	0.42%	0.964
Nagano	2,110	2,364	0.91%	0.90%	0.993
Gifu	2,058	2,154	0.88%	0.82%	0.927
Shizuoka	2,423	2,735	1.04%	1.04%	1.000
Aichi	13,441	15,292	5.77%	5.82%	1.008
Mie	1,430	1,319	0.61%	0.50%	0.818
Shiga	2,346	2,712	1.01%	1.03%	1.024
Kyoto	15,554	17,797	6.68%	6.77%	1.014
Osaka	16,605	18,199	7.13%	6.92%	0.971
Hyogo	8,731	9,891	3.75%	3.76%	1.004
Nara	2,251	2,352	0.97%	0.89%	0.926
Wakayama	720	783	0.31%	0.30%	0.964
Tottori	1,087	1,121	0.47%	0.43%	0.914
Shimane	662	835	0.28%	0.32%	1.118
Okayama	4,019	4,493	1.72%	1.71%	0.991
Hiroshima	5,703	6,027	2.45%	2.29%	0.937
Yamaguchi	1,814	1,930	0.78%	0.73%	0.943
Tokushima	2,237	2,455	0.96%	0.93%	0.973
Kagawa	681	925	0.29%	0.35%	1.204
Ehime	1,364	1,365	0.59%	0.52%	0.887
Kouchi	971	1,122	0.42%	0.43%	1.024
Fukuoka	10,620	12,125	4.56%	4.61%	1.012
Saga	947	1,005	0.41%	0.38%	0.940
Nagasaki	1,534	1,707	0.66%	0.65%	0.987
Kumamoto	2,401	2,786	1.03%	1.06%	1.028
Oita	822	1,113	0.35%	0.42%	1.199
Miyazaki	633	780	0.27%	0.30%	1.092
Kagoshima	1,751	2,085	0.75%	0.79%	1.055
Okinawa	1,169	1,200	0.50%	0.46%	0.910
Whole	233,008	262,929	100.00%	100.00%	-

Note: "The number of graduate students" is the total of national, public and private universities and colleges. Surveyed by the address with graduate courses in which students enroll.
Source: MEXT, "School Basic Survey"

2. The number of papers (all fields)

Chart 2-1: The share of the number of papers (all fields) The average value of 2007–2009

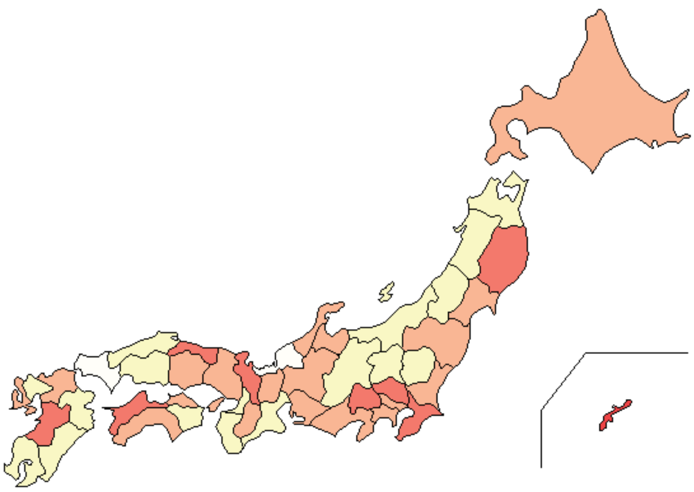


Legend	Classification			The number of prefectures
	5.00% or over	~		6
	2.00%	~	Under 5.00%	6
	1.00%	~	2.00%	6
	0.50%	~	1.00%	16
		~	0.50%	13

Top 5	Share	Low rank 5	Share
Tokyo	19.87%	Wakayama	0.32%
Osaka	7.70%	Miyazaki	0.35%
Ibaraki	6.78%	Fukushima	0.36%
Kanagawa	6.69%	Shimane	0.37%
Kyoto	6.17%	Yamanashi	0.38%

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

Chart 2-2: The share increase rate of the number of papers (all fields)
The comparisons of the average value between 2002–2004 and 2007–2009



Legend	Classification			The number of prefectures
	1.15 or over	~		1
	1.05	~	under 1.15	8
	0.95	~	1.05	19
	0.85	~	0.95	17
		~	0.85	2

Top 5	Growth rate	Low rank 5	Growth rate
Okinawa	1.28	Yamaguchi	0.78
Tottori	1.13	Fukui	0.82
Chiba	1.12	Tochigi	0.86
Saitama	1.11	Niigata	0.87
Iwate	1.10	Akita	0.88

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

[Key Points]

・ Looking at the distribution of shares of the number of papers, they were higher in prefectures with large metropolitan areas. The top 10 prefectures were the same as in 2002–2004 (Chart-2-1).

・ The five prefectures with the highest shares of the number of papers were not necessarily in the top five in terms of share increase rate. On the other hand, there were 19 prefectures whose shares decreased and whose share increase rate was less than 0.95 (Chart 2-2).

Table 2: The number of the papers (all fields)

Prefectures	3-year moving average				
	2002-2004 Unit: case	2007-2009 Unit: case	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	2,677	2,799	4.19%	4.04%	0.963
Aomori	315	311	0.49%	0.45%	0.909
Iwate	326	389	0.51%	0.56%	1.099
Miyagi	2,476	2,800	3.88%	4.04%	1.041
Akita	283	271	0.44%	0.39%	0.880
Yamagata	322	323	0.50%	0.47%	0.925
Fukushima	239	252	0.37%	0.36%	0.969
Ibaraki	4,382	4,696	6.87%	6.78%	0.987
Tochigi	570	535	0.89%	0.77%	0.863
Gunma	572	589	0.90%	0.85%	0.949
Saitama	1,723	2,082	2.70%	3.00%	1.113
Chiba	2,128	2,578	3.33%	3.72%	1.116
Tokyo	12,225	13,771	19.16%	19.87%	1.037
Kanagawa	4,361	4,638	6.83%	6.69%	0.979
Niigata	809	768	1.27%	1.11%	0.874
Toyama	493	513	0.77%	0.74%	0.958
Ishikawa	859	887	1.35%	1.28%	0.950
Fukui	333	295	0.52%	0.43%	0.817
Yamanashi	229	261	0.36%	0.38%	1.053
Nagano	605	590	0.95%	0.85%	0.898
Gifu	631	693	0.99%	1.00%	1.012
Shizuoka	994	1,062	1.56%	1.53%	0.984
Aichi	3,524	3,861	5.52%	5.57%	1.009
Mie	448	441	0.70%	0.64%	0.905
Shiga	453	498	0.71%	0.72%	1.013
Kyoto	3,721	4,275	5.83%	6.17%	1.058
Osaka	5,299	5,334	8.30%	7.70%	0.927
Hyogo	1,757	1,982	2.75%	2.86%	1.039
Nara	547	565	0.86%	0.82%	0.952
Wakayama	217	222	0.34%	0.32%	0.943
Tottori	283	346	0.44%	0.50%	1.125
Shimane	264	254	0.41%	0.37%	0.887
Okayama	1,102	1,209	1.73%	1.74%	1.011
Hiroshima	1,261	1,249	1.98%	1.80%	0.912
Yamaguchi	507	431	0.79%	0.62%	0.783
Tokushima	529	517	0.83%	0.75%	0.900
Kagawa	294	330	0.46%	0.48%	1.035
Ehime	389	459	0.61%	0.66%	1.088
Kouchi	310	347	0.49%	0.50%	1.030
Fukuoka	2,708	2,970	4.24%	4.29%	1.010
Saga	316	314	0.50%	0.45%	0.914
Nagasaki	534	585	0.84%	0.84%	1.009
Kumamoto	561	640	0.88%	0.92%	1.051
Oita	268	270	0.42%	0.39%	0.928
Miyazaki	246	242	0.39%	0.35%	0.906
Kagoshima	413	417	0.65%	0.60%	0.929
Okinawa	260	361	0.41%	0.52%	1.278
Unknown	56	80	0.09%	0.12%	1.324
Whole	63,818	69,300	100.00%	100.00%	-

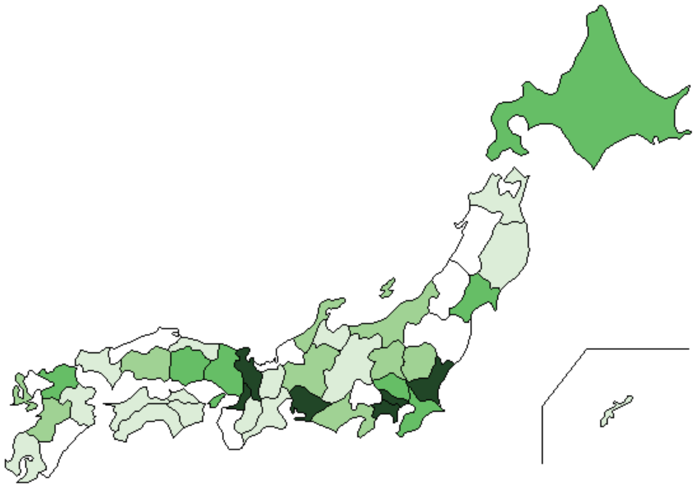
Note: 1) The papers of the prefectures are done by fractional counts by the locations of the prefectures those institutions (faculties, research courses) to which the authors of papers belong. Especially, in case of international co-authorship papers, which institutions overseas are engaged in, the parts of Japan's institutions alone are done by fractional counts. As for the parts of institutions overseas, they are not counted. For example, if a paper is written collectively by Tokyo University (the faculty of Engineering department) (Tokyo), Tokyo University (the faculty of Natural sciences) (Tokyo), Keio University (Tokyo), Chiba University (Chiba Prefecture), Stanford University (the U.S.), the result of the count becomes third-quarters of Tokyo and a quarter of Chiba.

2) Since there are some magazines that can not be classified, the total of Chart 3 and Chart 4 is not added up to the entire figures (Chart 2).

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

3. The number of papers (the field of Life sciences)

Chart 3-1: The share of the number of papers (the field of Life sciences)
The average value of 2007–2009

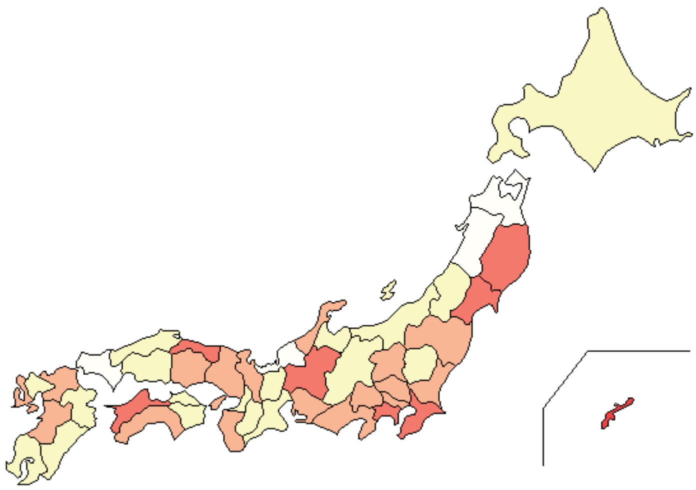


Legend	Classification	The number of prefectures
	5.00% or over ～	6
	2.00% ～ Under 5.00%	7
	1.00% ～ 2.00%	9
	0.50% ～ 1.00%	16
	～ 0.50%	9

Top 5	Share	Low rank 5	Share
Tokyo	20.39%	Saga	0.39%
Osaka	7.24%	Fukui	0.40%
Kanagawa	5.47%	Yamagata	0.42%
Kyoto	5.26%	Yamanashi	0.43%
Aichi	5.09%	Fukushima	0.44%

Source: Collected by NISTEP based on Thomson Reuters Scientific "Web of Science"

Chart 3-2: Share increase rate for number of papers (Life sciences)
Comparison of average values for 2002–2004 and 2007–2009



Legend	Classification	The number of prefectures
	1.15 or over ～	1
	1.05 ～ under 1.15	7
	0.95 ～ 1.05	17
	0.85 ～ 0.95	18
	～ 0.85	4

Top 5	Growth rate	Low rank 5	Growth rate
Okinawa	1.31	Fukui	0.75
Ehime	1.14	Akita	0.79
Tottori	1.13	Yamaguchi	0.82
Kanagawa	1.10	Aomori	0.84
Iwate	1.10	Tochigi	0.85

Source: Collected by NISTEP based on Thomson Reuters Scientific "Web of Science"

[Key Points]

- Data for Life sciences are shown here after papers were divided into the fields of Life sciences and the fields other than Life Sciences. The fields of Life sciences are Clinical medicine, Psychiatric Psychology, Agricultural science, Biology・Biochemistry, Immunology, Microbiology, Molecular biology and Genetics, Neural science and Behavioral science, Pharmacology・Toxicology, and Botany・Zoology(1).
- As for the distribution of shares of the number of papers in the Life sciences (Chart 3-1), many of these prefectures had shares of 0.5%-1.0% (16). Few, however, had shares of 5% or more.
- Prefectures with high shares in the number of papers did not necessarily have high share increase rates, but it is noteworthy that Kanagawa Prefecture had a relatively high share of papers in both 2002–2004 and 2007–2009, as well as the fourth-highest rate of increase. On the other hand, there were 22 prefectures whose shares decreased and whose share increase rate was less than 0.95 (Chart 3-2).

Table 3: The number of papers (the field of Life sciences)

Prefectures	3-year moving average				
	2002-2004 Unit case	2007-2009 Unit case	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,830	1,889	5.09%	4.83%	0.949
Aomori	255	233	0.71%	0.59%	0.839
Iwate	236	283	0.66%	0.72%	1.101
Miyagi	947	1,098	2.63%	2.81%	1.066
Akita	206	177	0.57%	0.45%	0.791
Yamagata	174	163	0.48%	0.42%	0.858
Fukushima	159	174	0.44%	0.44%	1.008
Ibaraki	1,737	1,959	4.83%	5.01%	1.037
Tochigi	464	432	1.29%	1.10%	0.855
Gunma	372	394	1.03%	1.01%	0.973
Saitama	988	1,043	2.75%	2.67%	0.971
Chiba	1,166	1,363	3.24%	3.48%	1.075
Tokyo	6,987	7,976	19.43%	20.39%	1.049
Kanagawa	1,783	2,141	4.96%	5.47%	1.104
Niigata	491	473	1.36%	1.21%	0.887
Toyama	318	322	0.89%	0.82%	0.930
Ishikawa	541	574	1.51%	1.47%	0.975
Fukui	189	155	0.53%	0.40%	0.753
Yamanashi	160	170	0.44%	0.43%	0.980
Nagano	369	357	1.03%	0.91%	0.888
Gifu	376	443	1.05%	1.13%	1.082
Shizuoka	661	713	1.84%	1.82%	0.992
Aichi	1,759	1,991	4.89%	5.09%	1.040
Mie	327	332	0.91%	0.85%	0.932
Shiga	287	296	0.80%	0.76%	0.949
Kyoto	1,883	2,056	5.24%	5.26%	1.004
Osaka	2,830	2,833	7.87%	7.24%	0.920
Hyogo	980	1,104	2.72%	2.82%	1.036
Nara	355	353	0.99%	0.90%	0.914
Wakayama	165	183	0.46%	0.47%	1.020
Tottori	224	276	0.62%	0.71%	1.133
Shimane	189	178	0.53%	0.45%	0.861
Okayama	767	836	2.13%	2.14%	1.002
Hiroshima	733	754	2.04%	1.93%	0.946
Yamaguchi	309	275	0.86%	0.70%	0.820
Tokushima	344	355	0.96%	0.91%	0.948
Kagawa	234	238	0.65%	0.61%	0.934
Ehime	270	335	0.75%	0.86%	1.138
Kouchi	242	259	0.67%	0.66%	0.985
Fukuoka	1,675	1,788	4.66%	4.57%	0.982
Saga	157	154	0.44%	0.39%	0.902
Nagasaki	433	473	1.20%	1.21%	1.006
Kumamoto	401	443	1.12%	1.13%	1.015
Oita	218	220	0.61%	0.56%	0.924
Miyazaki	197	194	0.55%	0.50%	0.905
Kagoshima	332	320	0.92%	0.82%	0.887
Okinawa	202	288	0.56%	0.74%	1.314
Unknown	42	58	0.12%	0.15%	1.269
Whole	36,260	38,030	100.00%	100.00%	-

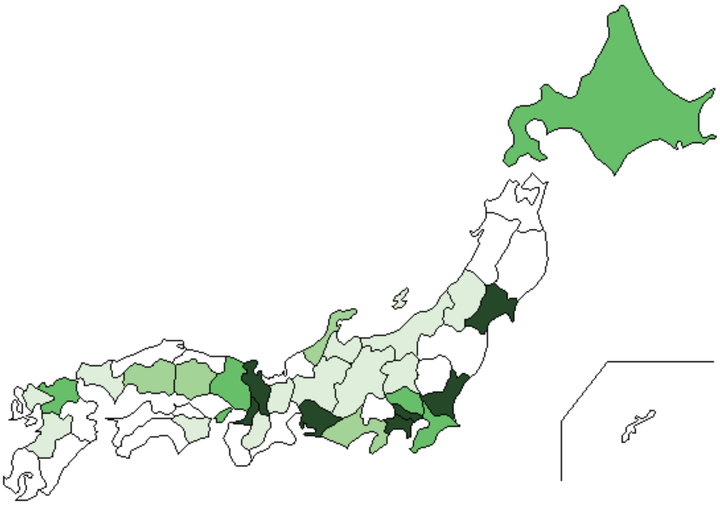
Note: The method of counting the papers is in accordance with the note for Table 2.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science".

(1) Refer to NISTEP, "Benchmarking Research & Development Capacity of Japan Based on Dynamic Alteration of Research Activity in the World" p.3

4. The number of papers (fields other than Life sciences)

Chart 4-1: The share of the number of papers (fields other than Life sciences)

The average value for 2007–2009



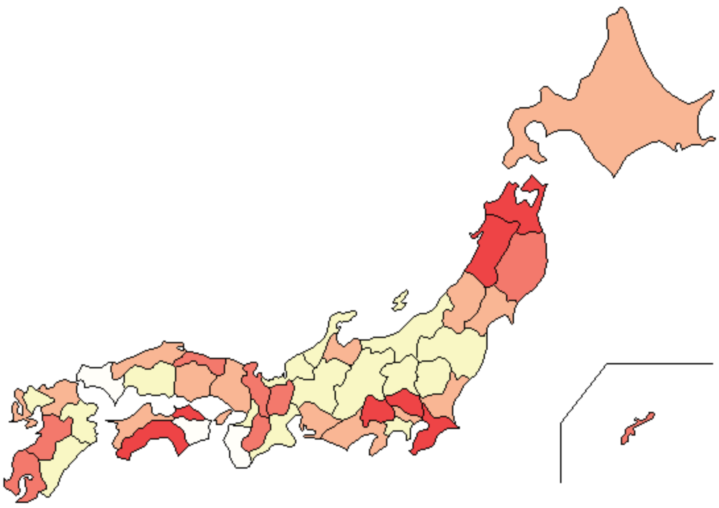
Legend	Classification			The number of prefectures
	5.00% or over	～		7
	2.00%	～	under 5.00%	5
	1.00%	～	2.00%	4
	0.50%	～	1.00%	12
		～	0.50%	19

Top 5	Share	Low rank 5	Share
Tokyo	18.99%	Wakayama	0.13%
Ibaraki	9.16%	Miyazaki	0.16%
Kanagawa	8.33%	Oita	0.16%
Osaka	8.31%	Okinawa	0.23%
Kyoto	7.32%	Tottori	0.23%

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

Chart 4-2: The share increase rate of the number of papers (fields other than Life sciences)

A comparison of average values between 2002–2004 and 2007–2009



Legend	Classification			The number of prefectures
	1.15 or over	～		7
	1.05	～	under 1.15	8
	0.95	～	1.05	14
	0.85	～	0.95	15
		～	0.85	3

Top 5	Growth rate	Low rank 5	Growth rate
Kagawa	1.54	Wakayama	0.70
Saitama	1.31	Yamaguchi	0.74
Yamanashi	1.31	Tokushima	0.83
Aomori	1.23	Mie	0.85
Kochi	1.19	Hiroshima	0.85

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

[Key points]

- The fields other than Life sciences are Chemistry, Material science, Physics, Space science, Computer science, Mathematics, Engineering, Environment/Ecology and Geoscience.[(2)]
- Regarding the share of the number of papers in fields other than Life sciences, the shares of the top five prefectures account for 52.1% (The total for all papers is about 47.2%, while that for Life sciences fields only is 43.4%) (Chart 4-1). The top five prefectures did not change between 2002–2004 and 2007–2009 (Table 4).
- Looking at the share increase rate, it is noteworthy that Saitama Prefecture, which has a relatively large share of the number of papers (2007–2009: 3.44%, top 10), had the second-highest rate of share increase. On the other hand, there were 18 prefectures whose shares decreased and whose share increase rate was less than 0.95 (Chart 4-2).

Table 4: The number of papers (fields other than Life sciences)

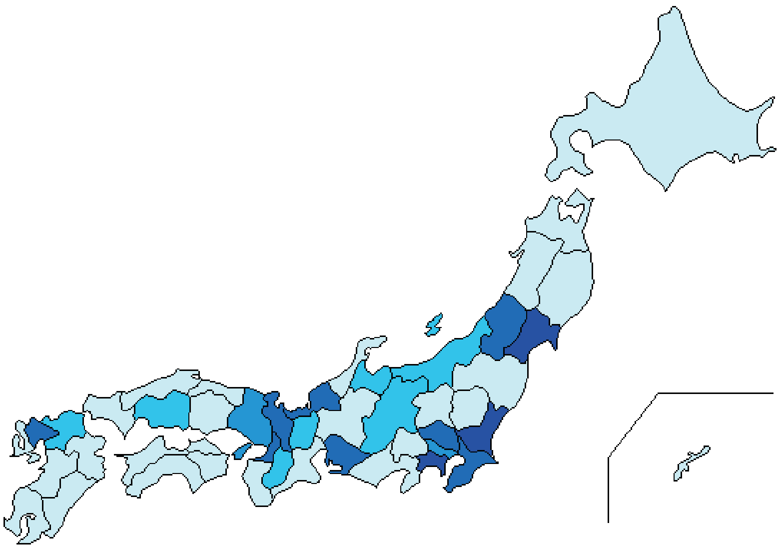
Prefectures	3-year moving average 2002-2004 Unit case	2007-2009 Unit case	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share
Hokkaido	816	889	3.06%	3.01%	0.984
Aomori	55	76	0.21%	0.26%	1.233
Iwate	86	105	0.32%	0.36%	1.101
Miyagi	1,479	1,683	5.56%	5.71%	1.027
Akita	72	92	0.27%	0.31%	1.155
Yamagata	145	159	0.54%	0.54%	0.993
Fukushima	76	77	0.29%	0.26%	0.907
Ibaraki	2,547	2,700	9.57%	9.16%	0.957
Tochigi	99	97	0.37%	0.33%	0.889
Gunma	190	192	0.71%	0.65%	0.910
Saitama	696	1,013	2.62%	3.44%	1.313
Chiba	928	1,194	3.49%	4.05%	1.162
Tokyo	4,988	5,598	18.74%	18.99%	1.013
Kanagawa	2,442	2,456	9.17%	8.33%	0.908
Niigata	299	289	1.12%	0.98%	0.871
Toyama	165	189	0.62%	0.64%	1.037
Ishikawa	301	305	1.13%	1.04%	0.914
Fukui	136	139	0.51%	0.47%	0.923
Yamanashi	63	91	0.23%	0.31%	1.311
Nagano	223	228	0.84%	0.77%	0.924
Gifu	248	245	0.93%	0.83%	0.895
Shizuoka	311	340	1.17%	1.15%	0.985
Aichi	1,687	1,827	6.34%	6.20%	0.978
Mie	113	106	0.42%	0.36%	0.851
Shiga	159	196	0.60%	0.66%	1.109
Kyoto	1,773	2,157	6.66%	7.32%	1.098
Osaka	2,364	2,450	8.88%	8.31%	0.935
Hyogo	742	856	2.79%	2.90%	1.042
Nara	177	206	0.66%	0.70%	1.051
Wakayama	49	39	0.19%	0.13%	0.703
Tottori	55	68	0.21%	0.23%	1.127
Shimane	72	76	0.27%	0.26%	0.954
Okayama	325	365	1.22%	1.24%	1.012
Hiroshima	514	486	1.93%	1.65%	0.854
Yamaguchi	185	151	0.69%	0.51%	0.737
Tokushima	171	157	0.64%	0.53%	0.832
Kagawa	53	91	0.20%	0.31%	1.537
Ehime	112	121	0.42%	0.41%	0.978
Kouchi	65	86	0.24%	0.29%	1.194
Fukuoka	999	1,156	3.75%	3.92%	1.045
Saga	150	157	0.56%	0.53%	0.944
Nagasaki	94	104	0.35%	0.35%	1.000
Kumamoto	153	194	0.58%	0.66%	1.141
Oita	47	48	0.18%	0.16%	0.916
Miyazaki	45	46	0.17%	0.16%	0.927
Kagoshima	80	96	0.30%	0.33%	1.083
Okinawa	55	67	0.21%	0.23%	1.113
Unknown	14	21	0.05%	0.07%	1.420
Whole	26,618	29,482	100.00%	100.00%	-

Note: The ways of the count of the papers is followed by Note of Table 2.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

(2 Refer to NISTEP, "Benchmarking Research & Development Capacity of Japan Based on Dynamic Alteration of Research Activity in the World" p.3

5. The balance of papers between Life sciences fields and fields other than Life sciences

Chart 5: The balance of papers between Life sciences fields and fields other than Life sciences (non–Life sciences/Life sciences)



Legend	Classification	The number of prefectures	
	1.500 or over ～	3	The number of non-Life sciences is very large (Approximately over twice)
	1.100 ～ under 1.500	8	The number of non-Life sciences is slightly large
	0.900 ～ 1.100	2	The number of non-Life sciences and Life sciences are fifty-fifty split
	0.750 ～ 0.900	7	The number of Life sciences is slighly large
	～ 0.750	27	The number of Life sciences is very large (The number of non-Life sciences is under half of that of Life sciences)

Source: Compiled by NISTEP based on Thomson Reuters Scientific: Web of Science:

[Key Points]

- The balance of share of papers between fields other than Life sciences and Life sciences fields is shown for each prefecture (Chart 5). To calculate the balance, the share of papers in fields other than Life sciences during 2007–2009 was divided by the share of papers in the field of Life sciences.
- Overall, there were many prefectures whose shares of papers in Life sciences fields were larger than those for fields other than Life sciences. In contrast, few prefectures with at least 1% of the share of papers in fields other than Life sciences had a balance above 1. They included Miyagi Prefecture (2.03), Ibaraki Prefecture (1.83), Kanagawa Prefecture (1.52), Kyoto Prefecture (1.39) and Saitama Prefecture (1.29).

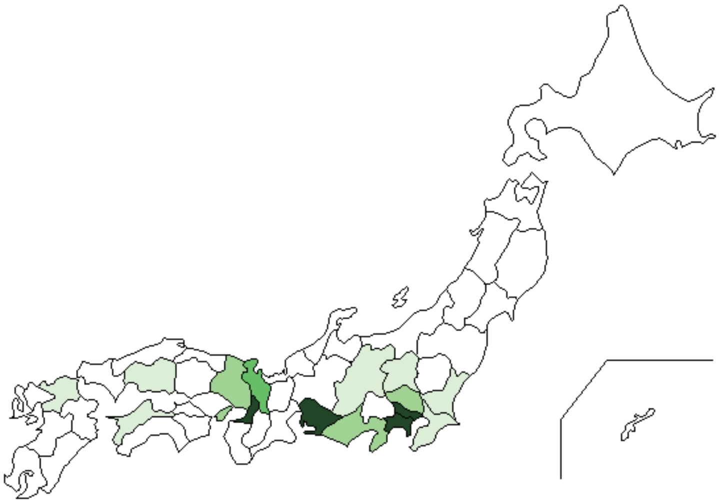
Table 5: Shares of and balance between papers in Life science fields and fields other than Life sciences

Prefectures	Non-Life sciences 3-year moving average			Life sciences 3-year moving average			Balance
	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share (B)/(A)	2002-2004 Share (C)	2007-2009 Share (D)	The growth rate of the share (D)/(C)	non-Life sciences (B)/ Life sciences (D)
Hokkaido	3.06%	3.01%	0.98	5.09%	4.83%	0.949	0.624
Aomori	0.21%	0.26%	1.23	0.71%	0.59%	0.839	0.432
Iwate	0.32%	0.36%	1.10	0.66%	0.72%	1.101	0.494
Miyagi	5.56%	5.71%	1.03	2.63%	2.81%	1.066	2.033
Akita	0.27%	0.31%	1.15	0.57%	0.45%	0.791	0.688
Yamagata	0.54%	0.54%	0.99	0.48%	0.42%	0.858	1.301
Fukushima	0.29%	0.26%	0.91	0.44%	0.44%	1.008	0.584
Ibaraki	9.57%	9.16%	0.96	4.83%	5.01%	1.037	1.829
Tochigi	0.37%	0.33%	0.89	1.29%	1.10%	0.855	0.300
Gunma	0.71%	0.65%	0.91	1.03%	1.01%	0.973	0.646
Saitama	2.62%	3.44%	1.31	2.75%	2.67%	0.971	1.288
Chiba	3.49%	4.05%	1.16	3.24%	3.48%	1.075	1.162
Tokyo	18.74%	18.99%	1.01	19.43%	20.39%	1.049	0.931
Kanagawa	9.17%	8.33%	0.91	4.96%	5.47%	1.104	1.522
Niigata	1.12%	0.98%	0.87	1.36%	1.21%	0.887	0.809
Toyama	0.62%	0.64%	1.04	0.89%	0.82%	0.930	0.780
Ishikawa	1.13%	1.04%	0.91	1.51%	1.47%	0.975	0.706
Fukui	0.51%	0.47%	0.92	0.53%	0.40%	0.753	1.188
Yamanashi	0.23%	0.31%	1.31	0.44%	0.43%	0.980	0.708
Nagano	0.84%	0.77%	0.92	1.03%	0.91%	0.888	0.849
Gifu	0.93%	0.83%	0.89	1.05%	1.13%	1.082	0.735
Shizuoka	1.17%	1.15%	0.99	1.84%	1.82%	0.992	0.632
Aichi	6.34%	6.20%	0.98	4.89%	5.09%	1.040	1.218
Mie	0.42%	0.36%	0.85	0.91%	0.85%	0.932	0.425
Shiga	0.60%	0.66%	1.11	0.80%	0.76%	0.949	0.876
Kyoto	6.66%	7.32%	1.10	5.24%	5.26%	1.004	1.392
Osaka	8.88%	8.31%	0.94	7.87%	7.24%	0.920	1.148
Hyogo	2.79%	2.90%	1.04	2.72%	2.82%	1.036	1.030
Nara	0.66%	0.70%	1.05	0.99%	0.90%	0.914	0.774
Wakayama	0.19%	0.13%	0.70	0.46%	0.47%	1.020	0.280
Tottori	0.21%	0.23%	1.13	0.62%	0.71%	1.133	0.328
Shimane	0.27%	0.26%	0.95	0.53%	0.45%	0.861	0.566
Okayama	1.22%	1.24%	1.01	2.13%	2.14%	1.002	0.579
Hiroshima	1.93%	1.65%	0.85	2.04%	1.93%	0.946	0.856
Yamaguchi	0.69%	0.51%	0.74	0.86%	0.70%	0.820	0.727
Tokushima	0.64%	0.53%	0.83	0.96%	0.91%	0.948	0.589
Kagawa	0.20%	0.31%	1.54	0.65%	0.61%	0.934	0.506
Ehime	0.42%	0.41%	0.98	0.75%	0.86%	1.138	0.480
Kouchi	0.24%	0.29%	1.19	0.67%	0.66%	0.985	0.440
Fukuoka	3.75%	3.92%	1.05	4.66%	4.57%	0.982	0.858
Saga	0.56%	0.53%	0.94	0.44%	0.39%	0.902	1.354
Nagasaki	0.35%	0.35%	1.00	1.20%	1.21%	1.006	0.291
Kumamoto	0.58%	0.66%	1.14	1.12%	1.13%	1.015	0.581
Oita	0.18%	0.16%	0.92	0.61%	0.56%	0.924	0.288
Miyazaki	0.17%	0.16%	0.93	0.55%	0.50%	0.905	0.317
Kagoshima	0.30%	0.33%	1.08	0.92%	0.82%	0.887	0.398
Okinawa	0.21%	0.23%	1.11	0.56%	0.74%	1.314	0.310
Unknown	0.05%	0.07%	1.42	0.12%	0.15%	1.269	0.492
Whole	100.00%	100.00%	-	100.00%	100.00%	-	1.00

Note: The method of counting the papers was in accordance with the note to Table 2. The values of the 3-year moving averages for fields other than Life sciences and for Life sciences fields were the same as in Table 3 and Table 4.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

6. The number of patent applications

Chart 6-1: The share of the number of the patent applications
The average value between and 2007–2009

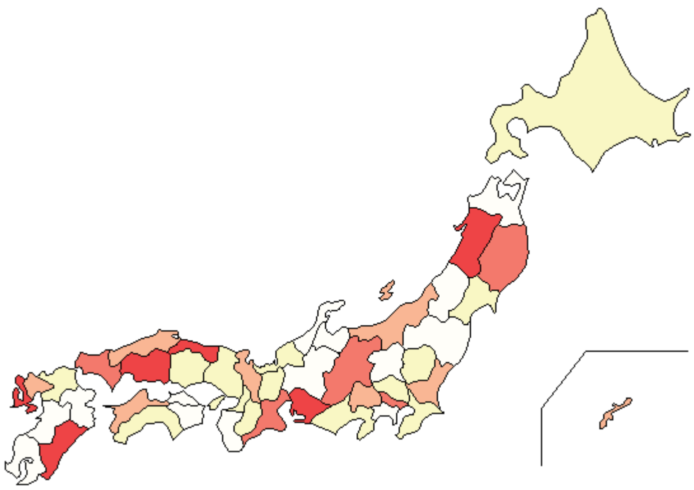


Legend	Classification			The number of prefectures
	5.00% or over	～		4
	2.00%	～	under 5.00%	1
	1.00%	～	2.00%	3
	0.50%	～	1.00%	7
		～	0.50%	32

Top 5	Share	Low rank 5	Share
Tokyo	51.60%	Aomori	0.04%
Osaka	15.85%	Tottori	0.05%
Aichi	8.99%	Oita	0.05%
Kanagawa	5.36%	Okinawa	0.05%
Kyoto	2.89%	Kochi	0.06%

Source: Japan patent Office, "Japan Patent Office Annual Report"

Chart 6-2: The share increase rate of the number of the patent applications
Comparison of average values for 2002–2004 and 2007–2009



Legend	Classification			The number of prefectures
	1.15 or over	～		6
	1.05	～	under 1.15	5
	0.95	～	1.05	8
	0.85	～	0.95	14
		～	0.85	14

Top 5	Growth rate	Low rank 5	Growth rate
Akita	1.31	Yamagata	0.58
Hiroshima	1.31	Wakayama	0.61
Miyazaki	1.25	Kumamoto	0.66
Aichi	1.24	Aomori	0.67
Nagasaki	1.17	Gifu	0.71

Source: Japan Patent Office, "Japan Patent Office Annual Report"

[Key Points]

- Looking at the distributions of the share of the number of patent applications, Tokyo alone accounts for 51.6%. Moreover, the top 4 prefectures alone account for about over 80% (Chart 6-1). This is because the headquarters of many business enterprises are concentrated in Tokyo and there are many cases that the addresses of the headquarters are written down when patents are applied for.
- Looking at the share increase rate from 2002–2004 to 2007–2009, the growing prefectures included Akita and Hiroshima Prefectures. However, looking at the whole, there were 28 prefectures whose share increase rate was less than 0.95% and which represents over half of all prefectures (Chart 6-2).

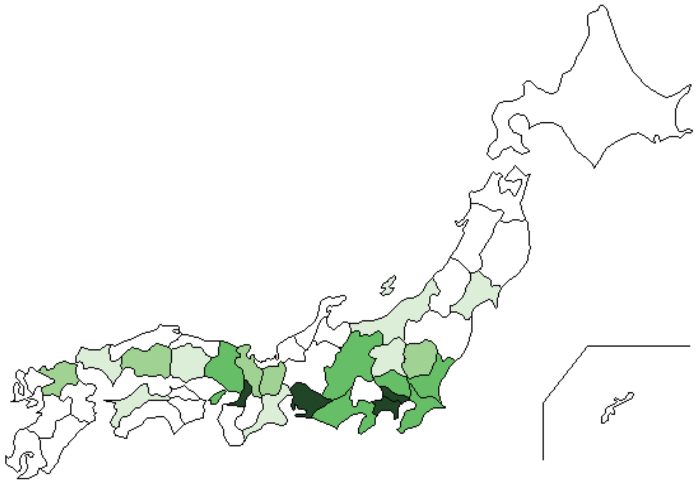
Table 6: The number of patent applications

Prefectures	3-year moving average				
	2002-2004 Unit: case	2007-2009 Unit: case	2002-2004 Share (A)	2007-2009 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,128	905	0.31%	0.28%	0.920
Aomori	248	144	0.07%	0.04%	0.666
Iwate	286	264	0.08%	0.08%	1.059
Miyagi	1,355	1,004	0.37%	0.31%	0.851
Akita	202	231	0.06%	0.07%	1.314
Yamagata	486	245	0.13%	0.08%	0.577
Fukushima	360	263	0.10%	0.08%	0.838
Ibaraki	2,008	1,670	0.55%	0.52%	0.955
Tochigi	650	505	0.18%	0.16%	0.892
Gunma	2,647	1,812	0.72%	0.57%	0.786
Saitama	5,996	4,450	1.63%	1.39%	0.852
Chiba	3,422	2,706	0.93%	0.85%	0.907
Tokyo	178,764	164,934	48.73%	51.60%	1.059
Kanagawa	27,011	17,124	7.36%	5.36%	0.728
Niigata	1,331	1,106	0.36%	0.35%	0.953
Toyama	1,073	721	0.29%	0.23%	0.771
Ishikawa	967	657	0.26%	0.21%	0.779
Fukui	882	680	0.24%	0.21%	0.886
Yamanashi	858	720	0.23%	0.23%	0.963
Nagano	2,737	2,672	0.75%	0.84%	1.121
Gifu	1,609	989	0.44%	0.31%	0.706
Shizuoka	5,621	4,465	1.53%	1.40%	0.912
Aichi	26,539	28,751	7.23%	8.99%	1.243
Mie	1,386	1,294	0.38%	0.40%	1.072
Shiga	1,062	850	0.29%	0.27%	0.919
Kyoto	10,544	9,233	2.87%	2.89%	1.005
Osaka	62,287	50,677	16.98%	15.85%	0.934
Hyogo	8,106	6,311	2.21%	1.97%	0.894
Nara	615	499	0.17%	0.16%	0.931
Wakayama	893	476	0.24%	0.15%	0.612
Tottori	144	147	0.04%	0.05%	1.166
Shimane	426	376	0.12%	0.12%	1.014
Okayama	1,555	1,283	0.42%	0.40%	0.947
Hiroshima	2,754	3,141	0.75%	0.98%	1.309
Yamaguchi	1,596	1,487	0.44%	0.47%	1.069
Tokushima	609	408	0.17%	0.13%	0.769
Kagawa	620	459	0.17%	0.14%	0.849
Ehime	1,820	1,651	0.50%	0.52%	1.041
Kouchi	229	176	0.06%	0.06%	0.884
Fukuoka	3,368	2,582	0.92%	0.81%	0.880
Saga	235	195	0.06%	0.06%	0.954
Nagasaki	222	227	0.06%	0.07%	1.174
Kumamoto	461	264	0.13%	0.08%	0.659
Oita	206	150	0.06%	0.05%	0.834
Miyazaki	239	260	0.07%	0.08%	1.250
Kagoshima	290	212	0.08%	0.07%	0.839
Okinawa	207	173	0.06%	0.05%	0.963
Others	809	94	0.22%	0.03%	0.134
Whole	366,862	319,641	100.00%	100.00%	-

Note:1) By Japanese people.
2) The column for others indicates that the prefecture cannot be determined.
3) The address of the first listed applicant is counted
Source: Japan Patent Office, "Japan Patent Office Annual Report"

7. The number of inventors

Chart 7-1: The share of the number of inventors in 2009

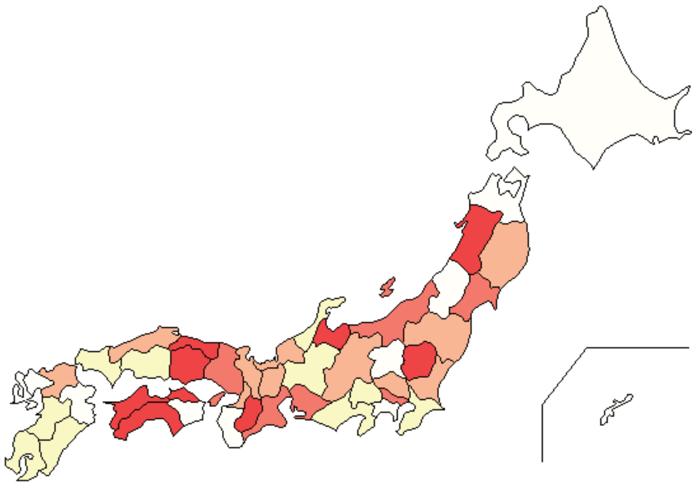


Legend	Classification	The number of prefectures
	5.00% or over ～	4
	2.00% ～ under 5.00%	6
	1.00% ～ 2.00%	5
	0.50% ～ 1.00%	7
	～ 0.50%	25

Top 5	Share	Low rank 5	Share
Tokyo	33.80%	Okinawa	0.04%
Osaka	13.28%	Aomori	0.06%
Kanagawa	10.25%	Saga	0.07%
Aichi	8.97%	Kochi	0.08%
Saitama	3.63%	Oita	0.08%

Source: Japan Patent Office, "Japan Patent Office Annual Report"

Chart 7-2: The share increase rate of the number of inventors
A comparison of the values for 2005 and those for 2009



Legend	Classification	The number of prefectures
	1.15 or over ～	9
	1.05 ～ under 1.15	6
	0.95 ～ 1.05	11
	0.85 ～ 0.95	10
	～ 0.85	11

Top 5	Growth rate	Low rank 5	Growth rate
Tottori	1.59	Okinawa	0.60
Akita	1.40	Yamagata	0.68
Tochigi	1.28	Oita	0.69
Okayama	1.28	Nagasaki	0.69
Toyama	1.22	Tokushima	0.73

Source: Japan Patent Office, "Japan Patent Office Annual Report"

[Key Points]

- Regarding addresses when patents are applied for, there are many cases where applicant companies write down the addresses of the headquarters as the address of applicants. However, it is generally considered that the addresses of the inventors themselves are written down as the address of inventors. Comparing the status of patent applications, which are a result of intellectual production activities, with the distribution of shares of the number of applications (Chart 6-1) and the distribution of shares of actual inventors (Chart 7-1), it can be seen that prefectures with large shares of inventors, are widely distributed around the prefectures with the largest shares of patent applications.
- The prefectures with large shares of inventors and relatively high rates of increase in 2005 and 2009 were Tokyo and Aichi Prefectures. Both were among the top three prefectures in terms of number of patent applications. There were 21 prefectures whose shares decreased and whose share increase rate was less than 0.95 in 2009 (Chart 7-2).

Table 7: The number of inventors

Prefectures	The number of inventors (Unit: people)		Share		
	2005	2009	2005 (A)	2009 (B)	The growth rate (B)/(A)
Hokkaido	3,503	2,192	0.44%	0.34%	0.768
Aomori	629	408	0.08%	0.06%	0.797
Iwate	774	620	0.10%	0.10%	0.984
Miyagi	4,348	3,953	0.55%	0.61%	1.116
Akita	816	927	0.10%	0.14%	1.395
Yamagata	1,518	835	0.19%	0.13%	0.676
Fukushima	2,175	1,751	0.27%	0.27%	0.989
Ibaraki	26,312	21,413	3.31%	3.31%	0.999
Tochigi	7,154	7,473	0.90%	1.16%	1.283
Gunma	8,514	5,272	1.07%	0.82%	0.760
Saitama	28,292	23,482	3.56%	3.63%	1.019
Chiba	19,699	14,466	2.48%	2.24%	0.902
Tokyo	247,803	218,499	31.22%	33.80%	1.083
Kanagawa	98,900	66,241	12.46%	10.25%	0.823
Niigata	4,101	3,742	0.52%	0.58%	1.121
Toyama	2,572	2,548	0.32%	0.39%	1.217
Ishikawa	2,319	1,638	0.29%	0.25%	0.867
Fukui	1,938	1,545	0.24%	0.24%	0.979
Yamanashi	2,452	1,807	0.31%	0.28%	0.905
Nagano	20,098	15,936	2.53%	2.47%	0.974
Gifu	3,326	2,467	0.42%	0.38%	0.911
Shizuoka	23,255	16,621	2.93%	2.57%	0.878
Aichi	66,501	57,962	8.38%	8.97%	1.070
Mie	6,072	5,347	0.76%	0.83%	1.081
Shiga	10,906	8,973	1.37%	1.39%	1.010
Kyoto	15,537	12,749	1.96%	1.97%	1.008
Osaka	109,008	85,852	13.73%	13.28%	0.967
Hyogo	21,727	18,723	2.74%	2.90%	1.058
Nara	2,121	2,021	0.27%	0.31%	1.170
Wakayama	3,089	2,046	0.39%	0.32%	0.813
Tottori	979	1,266	0.12%	0.20%	1.588
Shimane	984	796	0.12%	0.12%	0.993
Okayama	3,408	3,549	0.43%	0.55%	1.279
Hiroshima	11,228	7,811	1.41%	1.21%	0.854
Yamaguchi	4,652	3,579	0.59%	0.55%	0.945
Tokushima	1,690	1,007	0.21%	0.16%	0.732
Kagawa	1,624	1,579	0.20%	0.24%	1.194
Ehime	5,620	5,549	0.71%	0.86%	1.213
Kouchi	527	519	0.07%	0.08%	1.209
Fukuoka	10,295	8,458	1.30%	1.31%	1.009
Saga	758	480	0.10%	0.07%	0.778
Nagasaki	1,469	823	0.19%	0.13%	0.688
Kumamoto	1,148	803	0.14%	0.12%	0.859
Oita	936	523	0.12%	0.08%	0.686
Miyazaki	763	550	0.10%	0.09%	0.885
Kagoshima	1,779	1,367	0.22%	0.21%	0.944
Okinawa	534	263	0.07%	0.04%	0.605
Whole	793,853	646,431	100.00%	100.00%	-

Note: 1) The number of people is the total numbers of people who are abstracted from "Applicants" who were written on one application.
2) Excluding international applications (PCT applications)
Source: Japan Patent Office, "Patent Administration Annual Report"

Statistical Reference A　Population of the main countries

(Unit: thousand people)

Year	Japan	U.S.	Germany	France	U.K.	China	Korea	EU-15	EU-27
1981	117,902	229,966	61,682	55,419	56,357	1,000,720	38,723	341,070	-
1982	118,728	232,188	61,638	55,751	56,291	1,016,540	39,326	341,786	-
1983	119,536	234,307	61,423	56,049	56,316	1,030,080	39,910	342,292	-
1984	120,305	236,348	61,175	56,321	56,409	1,043,570	40,406	342,773	-
1985	121,049	238,466	61,024	56,600	56,554	1,058,510	40,806	343,382	-
1986	121,660	240,651	61,066	56,886	56,684	1,075,070	41,214	344,125	-
1987	122,239	242,804	61,077	57,192	56,804	1,093,000	41,622	344,843	-
1988	122,745	245,021	61,450	57,519	56,916	1,110,260	42,031	345,962	-
1989	123,205	247,342	62,063	57,859	57,076	1,127,040	42,449	347,427	-
1990	123,611	250,132	63,254	58,171	57,237	1,143,330	42,869	349,511	-
1991	124,101	253,493	79,984 a	58,459	57,439	1,158,230	43,296	367,264 a	-
1992	124,567	256,894	80,594	58,745	57,585	1,171,710	43,748	368,865	-
1993	124,938	260,255	81,179	58,995	57,714	1,185,170	44,195	370,342	-
1994	125,265	263,436	81,422	59,210	57,862	1,198,500	44,642	371,367	-
1995	125,570	266,557	81,661	59,419	58,025	1,211,210	45,093	372,313	477,893
1996	125,859	269,667	81,896	59,624	58,164	1,223,890	45,525	373,285	478,680
1997	126,157	272,912	82,052	59,831	58,314	1,236,260	45,954	374,225	479,425
1998	126,472	276,115	82,029	60,047	58,475	1,247,610	46,287	375,044	480,050
1999	126,667	279,295	82,087	60,315	58,684	1,257,860	46,617	376,103	480,932
2000	126,926	282,407	82,188	60,725	58,886	1,267,430	47,008	377,952	482,631
2001	127,291	285,339	82,340	61,163	59,113	1,276,270	47,357	379,665	483,754
2002	127,435	288,189	82,482	61,605	59,323	1,284,530	47,622	381,671	485,579
2003	127,619	290,941	82,520	62,038	59,557	1,292,270	47,859	383,906	487,628
2004	127,687	293,609	82,501	62,491	59,846	1,299,880	48,039	386,273	489,851
2005	127,768	296,329	82,464	62,958	60,238	1,307,560	48,138	388,643	492,110
2006	127,770	299,157	82,366	63,382	60,587	1,314,480	48,297	390,740	494,099
2007	127,771	302,045	82,263	63,758	60,975	1,321,290	48,456	393,080	496,375
2008	127,692	304,906	82,120	64,120	61,350	1,337,410	48,607	395,372	498,690

Note: a: Break in series with previous year for which data is available.
<Germany> Until 1990, data is for the former West Germany. After 1991, data is for the unified Germany.
Source :<Japan> Ministry of Internal Affairs and Communications, Statistics Bureau "Population Estimates" Annual Report (Web site).
<U.S..>The Executive Office of the President, "Economic Report of the President 2010" (Web site).
<Germany, France, U.K., China, Korea, EU>OECD, "Main Science and Technology Indicators 2010/2".

Statistical Reference B　Labor force population of the main countries

(Unit: thousand people)

Year	Japan	U.S.	Germany	France	U.K.	China	Korea	EU-15	EU-27
1981	56,610	108,670	28,305	23,466	26,740	-	14,683	146,760	-
1982	57,770	110,204	28,558	23,672	26,678	-	15,032	147,829	-
1983	58,070	111,550	28,605	23,725	26,610	-	15,118	148,714	-
1984	58,650	113,544	28,298	23,846	27,235	-	14,997	149,616	-
1985	58,710	115,461	28,434	23,910	27,486	-	15,592	150,411	-
1986	59,550	117,834 a	28,768	24,042	27,491	-	16,116	151,483	-
1987	60,610	119,865	29,036	24,159	27,943	-	16,873	153,788	-
1988	61,360	121,669	29,220	24,291	28,345	-	17,305	155,474	-
1989	62,630	123,869	29,624	24,460	28,764	-	18,023	156,888	-
1990	63,680	125,840 a	30,771	24,632	28,909	651,322	18,539	159,458	-
1991	65,040	126,346	39,577 a	24,714	28,545	658,432	19,109	168,241 a	-
1992	65,660	128,105	39,490	24,823	28,306	665,159	19,499	167,946	-
1993	66,070	129,200	39,557	24,811	28,103	672,281	19,806	166,619 a	-
1994	65,870	131,056 a	39,492	25,398	28,052	679,314	20,353	167,430	-
1995	66,100	132,304	39,376	25,451	28,024	685,846	20,845	167,891	217,685
1996	66,630	133,943	39,550	25,705	28,134	695,028	21,288	169,103	218,253
1997	67,260	136,297 a	39,804	25,901	28,252	703,968	21,782	170,333	219,320
1998	67,170	137,673 a	40,131	26,239	28,223	712,080	21,428	172,186	220,987
1999	67,150	139,368 a	39,614	26,680	28,508	719,690	21,666	173,357	222,183
2000	67,380	142,583 a	39,533	26,931	28,740	726,800	22,134	175,246	224,094
2001	66,990	143,734	39,686	27,213	28,774	737,060	22,471	176,191	225,016
2002	66,220	144,863	39,641	27,466	29,030	745,100	22,921	177,931	225,784
2003	66,070	146,510 a	39,507	27,656	29,235	752,320	22,957	179,355	226,351
2004	65,760	147,401 a	39,948	27,812	29,369	760,270	23,417	181,250	228,414
2005	65,800	149,320 a	41,040	28,005	30,062	766,640	23,743	184,554	231,876
2006	65,980	151,428 a	41,521	28,278	30,575	772,470	23,978	187,216	234,745
2007	66,270	153,124 a	41,685	28,423	30,721	778,200	24,216	189,013	236,570
2008	66,010	154,287 a	41,777	28,415	31,118	794,221 b	24,216	190,957	238,786
2009	65,390	-	41,866 b	28,622 b	31,466 b	-	24,347 b	-	-

Note: a: Break in series with previous year for which data is available.
b: Calculated estimates of OECD based on the materials of each country.
Source: <Japan>Ministry of Internal Affairs and Communications, average labor force population from Labor Force Survey (Web site)
<U.S.>Bureau of Labor Statistics, U.S. Department of Labor, Current Population Survey (Web site)
<Germany, France, U.K., China, EU, Korea>OECD, "Main Science and Technology Indicators 2010/2

Statistical Reference C　Gross Domestic Product (GDP) of the main countries

(A) National Currencies

Year	Japan (Billion yen)	U.S. (Billion dollar)	Germany (Billion euro)	France (Billion euro)	U.K. (Billion pound)	China (Billion yuan)	Korea (Billion won)	EU-15 (Billion dollar)	EU-27 (Billion dollar)
1981	264,641.7	3,126.8	825.8	500.8	256.3	489.2	50,739.4	3,445.8	-
1982	276,162.8	3,253.2	860.2	574.4	281.0	532.3	58,087.8	3,690.3	-
1983	288,772.7	3,534.6	898.3	636.6	307.2	596.3	68,342.8	3,901.5	-
1984	308,238.4	3,930.9	942.0	693.1	329.9	720.8	78,316.3	4,149.7	-
1985	330,396.8	4,217.5	984.4	743.9	361.8	901.6	87,630.5	4,384.7	-
1986	342,266.4	4,460.1	1,037.1	802.4	389.1	1,027.5	102,276.1	4,608.9	-
1987	362,296.7	4,736.4	1,065.1	845.2	428.7	1,205.9	120,054.5	4,871.5	-
1988	387,685.6	5,100.4	1,123.3	911.2	478.5	1,504.3	142,933.6	5,254.4	-
1989	415,885.2	5,482.1	1,200.7	980.5	525.3	1,699.2	161,324.6	5,653.9	-
1990	451,683.0	5,800.5	1,306.7	1,033.0	570.3	1,866.8	194,618.2	6,045.3	-
1991	473,607.6	5,992.1	1,534.6 [a]	1,070.0	598.7	2,178.1	235,604.4	6,496.7	-
1992	483,255.6	6,342.3	1,646.6	1,107.8	622.1	2,692.3	268,460.5	6,723.9	-
1993	482,607.6	6,667.4	1,694.4	1,114.7	654.2	3,533.4	303,018.4	6,855.5	-
1994	489,378.8	7,085.2	1,780.8	1,154.7	693.0	4,819.8	354,654.3	7,196.9	-
1995	497,740.0	7,414.7	1,848.5	1,194.6	733.3	6,079.4	415,773.3	7,535.6	8,342.9
1996	509,095.8	7,838.5	1,876.2	1,227.3	781.7	7,117.7	467,644.9	7,832.6	8,689.8
1997	513,612.9	8,332.4	1,915.6	1,267.4	830.1	7,897.3	511,989.6	8,197.2	9,095.1
1998	503,324.1	8,793.5	1,965.4	1,323.7	879.1	8,440.2	504,659.0	8,571.6	9,508.5
1999	499,544.2	9,353.5	2,012.0	1,368.0	928.7	8,967.7	551,983.5	8,921.9	9,893.1
2000	504,118.8	9,951.5	2,062.5	1,441.4	976.5	9,921.5	603,236.0	9,530.2	10,558.8
2001	493,644.7	10,286.2	2,113.2	1,497.2	1,021.8	10,965.5	651,415.3	10,045.3	11,149.5
2002	489,875.2	10,642.3	2,143.2	1,548.6	1,075.6	12,033.3	720,539.0	10,448.3	11,631.9
2003	493,747.5	11,142.1	2,163.8	1,594.8	1,139.7	13,582.3	767,113.7	10,711.8	11,960.3
2004	498,490.6	11,867.8	2,210.9	1,660.2	1,200.6	15,987.8	826,892.7	11,236.8	12,593.6
2005	503,186.7	12,638.4	2,242.2	1,726.1	1,252.5	18,321.7	865,240.9	11,762.6	13,204.4
2006	510,899.0	13,398.9	2,325.1	1,806.4	1,321.9	21,192.4	908,743.8	12,441.3	14,017.7
2007	515,822.8	14,077.6	2,428.2	1,894.6	1,400.5	24,953.0	975,013.0	13,153.1	14,885.7
2008	497,678.7	14,441.4	2,495.8	1,950.1	1,442.9	-	1,023,937.7	13,439.4	15,298.7
2009	-	-	2,417.7 [b]	1,944.2 [b]	1,406.8 [b]	-	1,084,089.2	13,183.1 [b]	15,014.7 [b]

(B) OECD Purchasing Power Parity Equivalent

Year	Japan (Billion yen)	U.S. (Billion yen)	Germany (Billion yen)	France (Billion yen)	U.K. (Billion yen)	China (Billion yen)	Korea (Billion yen)	EU-15 (Billion yen)	EU-27 (Billion yen)
1981	264,641.7	682,971.5	170,397.5	126,768.2	111,738.1	62,403.8	26,648.4	752,653.1	-
1982	276,162.8	684,109.6	173,354.7	132,628.9	116,516.6	69,498.1	29,212.1	776,023.0	-
1983	288,772.7	731,917.7	180,244.4	137,387.6	123,594.9	78,843.7	33,124.9	807,884.8	-
1984	308,238.4	809,586.1	191,253.8	143,881.7	130,950.2	93,769.2	36,952.9	854,657.2	-
1985	330,396.8	862,211.3	200,227.1	149,720.9	138,797.5	108,950.9	40,378.3	896,383.3	-
1986	342,266.4	906,811.9	208,225.6	155,952.3	146,776.1	120,684.1	45,411.6	937,055.5	-
1987	362,296.7	939,788.7	211,747.9	160,284.1	153,910.6	135,186.1	50,598.1	966,599.5	-
1988	387,685.6	985,918.6	221,273.8	168,933.7	162,889.1	151,555.9	56,409.7	1,015,684.4	-
1989	415,885.2	1,044,531.1	235,203.2	180,030.0	170,451.5	160,970.4	61,604.3	1,077,262.0	-
1990	451,683.0	1,089,642.3	253,519.3	189,235.0	175,912.5	169,268.0	68,862.1	1,135,620.8	-
1991	473,607.6	1,119,562.0	297,313.9 [a]	196,772.0	178,558.7	190,270.3	77,543.4	1,213,842.0	-
1992	483,255.6	1,177,201.3	308,886.0	202,712.5	181,735.5	220,830.3	83,437.8	1,248,025.6	-
1993	482,607.6	1,216,159.3	308,031.4	201,924.4	186,758.2	253,081.1	89,024.9	1,250,464.4	-
1994	489,378.8	1,266,841.3	316,507.6	206,588.3	194,931.4	286,498.1	96,713.6	1,286,818.0	-
1995	497,740.0	1,292,711.3	320,866.0	209,898.3	199,850.3	316,125.1	105,049.0	1,313,783.4	1,454,533.4
1996	509,095.8	1,333,450.8	321,801.0	211,430.1	207,560.7	345,762.7	111,762.6	1,332,443.8	1,478,269.2
1997	513,612.9	1,402,533.7	325,847.3	219,140.2	220,214.7	380,182.4	117,661.1	1,379,774.3	1,530,908.0
1998	503,324.1	1,464,326.9	331,335.7	227,984.0	226,989.1	409,962.1	109,629.3	1,427,378.2	1,583,384.4
1999	499,544.2	1,515,601.3	334,409.9	230,926.0	230,581.2	435,431.3	118,481.8	1,445,668.3	1,603,036.3
2000	504,118.8	1,541,916.3	330,063.9	237,510.2	237,598.2	461,183.2	124,818.9	1,476,632.7	1,636,017.5
2001	493,644.7	1,537,147.1	330,525.4	243,595.1	243,678.2	493,321.5	128,581.4	1,501,140.3	1,666,150.1
2002	489,875.2	1,530,088.2	327,150.3	246,021.7	246,385.8	526,877.0	134,578.7	1,502,203.0	1,672,368.2
2003	493,747.5	1,556,342.8	329,419.8	237,535.4	248,419.6	575,064.9	134,668.2	1,496,235.8	1,670,634.4
2004	498,490.6	1,594,080.7	331,469.3	237,411.9	255,146.7	626,335.1	139,836.0	1,509,324.8	1,691,563.6
2005	503,186.7	1,637,329.4	335,090.3	242,182.7	255,063.4	688,486.0	142,084.9	1,523,872.2	1,710,661.1
2006	510,899.0	1,665,911.3	336,774.9	243,866.1	257,147.9	760,631.2	148,535.0	1,546,854.1	1,742,848.2
2007	515,822.8	1,691,230.0	340,618.8	249,954.9	260,366.7	826,803.9	156,203.3	1,580,164.8	1,788,312.3
2008	497,678.7	1,682,811.8	341,157.5	246,456.0	256,321.8	-	158,247.8	1,566,048.3	1,782,711.8
2009	-	-	327,422.2 [b]	243,218.1 [b]	247,107.7 [b]	-	162,902.4	1,516,730.8 [b]	1,727,449.4 [b]

Note: <Japan>Fiscal year.
<Germany>Until 1990, data is for the former West Germany.　After 1991, data is for the unified Germany.
<China>FY data.
a: Continuity of these data with the previous fiscal year is impaired.
b: Estimate/calculation by OECD Secretariat based on national source materials

Source :<Japan>Cabinet Office, Economic and Social Research Institute " System of National Accounts (93SNA)" (Web site).
<U.S.>Bureau of Economic Analysis, "National Economic Accounts" (Web site).
<Germany, France, U.K., China, Korea, EU>OECD, "Main Science and Technology Indicators 2010/2".

Statistical Reference D　Gross Domestic Product (GDP) deflator of the main countries

Year	Japan	U.S.	Germany	France	U.K.	China	Korea
1981	82.8	58.9	66.9	53.1	44.7	-	33.0
1982	84.6	62.4	70.0	59.5	48.0	-	35.2
1983	86.6	64.9	71.9	65.1	50.6	-	37.4
1984	89.3	67.4	73.4	69.8	52.9	-	39.6
1985	91.4	69.4	74.9	73.7	56.0	-	41.5
1986	92.9	71.0	77.2	77.6	57.9	-	43.8
1987	93.2	73.0	78.2	79.8	61.0	-	46.3
1988	93.9	75.6	79.5	82.2	64.9	-	49.8
1989	96.1	78.4	81.8	84.9	69.6	-	52.7
1990	98.4	81.5	84.6	87.2	75.0	52.8	58.2
1991	101.3	84.4	87.2 a	89.4	79.8	56.4	64.4
1992	102.9	86.4	91.5	91.3	82.8	60.3	69.3
1993	103.5	88.3	94.9	92.7	85.2	70.9	73.7
1994	103.6	90.1	97.2	94.0	86.6	85.3	79.5
1995	103.0	92.0	99.0	95.2	88.9	96.8	85.4
1996	102.4	93.7	99.5	96.7	92.1	103.2	89.8
1997	103.1	95.4	99.8	97.7	94.7	104.0	93.9
1998	103.1	96.5	100.3	98.6	96.8	102.2	99.4
1999	101.8	97.9	100.7	98.6	98.8	99.9	99.3
2000	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2001	98.8	102.3	101.2	102.0	102.1	101.9	103.9
2002	97.2	103.9	102.6	104.4	105.3	103.1	107.2
2003	95.7	106.2	103.9	106.4	108.5	106.3	111.0
2004	94.7	109.2	104.8	108.1	111.2	113.4	114.4
2005	93.5	112.8	105.5	110.3	113.7	121.2	115.2
2006	92.7	116.5	106.1	112.9	116.7	128.3	115.0
2007	92.0	119.8	108.1	115.7	120.0	127.8	117.4
2008	91.2	122.4	109.7	118.6	122.8	137.0 b	120.6
2009	91.2 b	123.9 b	110.8 b	119.8 b	124.1 b	132.7 b	124.0 b

Note: <Germany>Until 1990, data is for the former West Germany.　After 1991, data is for the unified Germany.
a: This data has impaired continuity with the data for the previous fiscal year.
b: Calculated estimates of OECD Secretariat based on the materials of each country.
Source: OECD, "Main Science and Technology Indicators 2010/2"

Statistical Reference E　Purchasing Power Parity of the main countries

Year	Japan	U.S.	Germany	France	U.K.	China	Korea
	[yen／yen]	[yen／dollar]	[yen／euro]	[yen／euro]	[yen／pound]	[yen／yuan]	[yen／wan]
1981	1.0000	218.4251	206.3448	253.1537	436.0017	127.5744	0.5252
1982	1.0000	210.2882	201.5260	230.8817	414.6142	130.5533	0.5029
1983	1.0000	207.0723	200.6573	215.8073	402.3180	132.2292	0.4847
1984	1.0000	205.9544	203.0295	207.5952	396.9233	130.0896	0.4718
1985	1.0000	204.4366	203.3980	201.2676	383.6749	120.8412	0.4608
1986	1.0000	203.3165	200.7709	194.3660	377.1721	117.4521	0.4440
1987	1.0000	198.4184	198.8001	189.6486	359.0464	112.1075	0.4215
1988	1.0000	193.3022	196.9872	185.3981	340.4089	100.7496	0.3947
1989	1.0000	190.5349	195.8949	183.6042	324.5002	94.7313	0.3819
1990	1.0000	187.8532	194.0179	183.1852	308.4652	90.6737	0.3538
1991	1.0000	186.8397	193.7403	183.8951	298.2620	87.3541	0.3291
1992	1.0000	185.6111	187.5879	182.9847	292.1418	82.0215	0.3108
1993	1.0000	182.4038	181.7970	181.1470	285.4775	71.6255	0.2938
1994	1.0000	178.8011	177.7354	178.9057	281.2916	59.4421	0.2727
1995	1.0000	174.3444	173.5865	175.7059	272.5481	51.9996	0.2527
1996	1.0000	170.1156	171.5193	172.2794	265.5160	48.5781	0.2390
1997	1.0000	168.3229	170.1037	172.9019	265.2889	48.1408	0.2298
1998	1.0000	166.5238	168.5861	172.2383	258.2056	48.5724	0.2172
1999	1.0000	162.0357	166.2077	168.8097	248.2758	48.5555	0.2146
2000	1.0000	154.9431	160.0310	164.7807	243.3079	46.4834	0.2069
2001	1.0000	149.4378	156.4129	162.7021	238.4728	44.9884	0.1974
2002	1.0000	143.7742	152.6471	158.8718	229.0759	43.7850	0.1868
2003	1.0000	139.6813	152.2413	148.9424	217.9605	42.3394	0.1756
2004	1.0000	134.3198	149.9251	143.0030	212.5169	39.1757	0.1691
2005	1.0000	129.5520	149.4471	140.3089	203.6426	37.5775	0.1642
2006	1.0000	124.3319	144.8432	134.9989	194.5349	35.8918	0.1635
2007	1.0000	120.1362	140.2763	131.9270	185.9064	33.1345	0.1602
2008	1.0000	116.5269	136.6926	126.3822	177.6409	30.6296	0.1545
2009	1.0000	115.0507	135.4286	125.1025	175.6579	31.6171	0.1503

Note: The value of China for 2010 is calculated estimates of OECD Secretariat based on the materials of each country.
Source: OECD, "Main Science and Technology Indicators 2010/2"

A List of Science and Technology Indicators

1991 First edition The Japanese Science and Technology Indicator System:
Analysis of Science and Technology Activities NISTEP REPORT No. 19

1995 Second edition Science and Technology Indicators: 1994
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- Data Updated in 2007 for 5th edition - Research Materials - 140

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- Data Updated in 2008 for 5th edition –
Research Materials - 155

2009 Science and Technology Indicators 2009 Research Materials - 170

2010 Science and Technology Indicators 2010 Research Materials - 187

2011 Science and Technology Indicators 2011 Research Materials - 198

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