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Japanese Science and Technology

Indicators 2012

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Research Unit for Science and
Technology Analysis and Indicators

National Institute of Science and Technology Policy
(NISTEP)
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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. "Science and Technology Indicators 2012" has been enhanced with the addition of two new indicators, i.e., the percentage of Japanese researchers with doctorates and charts showing the flow of R&D funding in various countries from sectors that bear the costs to sectors that use the funds.

Science and Technology Indicators 2012 sees a number of changes in indicators compared with the previous year. Total research and development expenditure in Japan declined in FY 2010, as it did in FY 2008 and 2009. Growth in the number of researchers in Japan has been stagnant in recent years. New hires of researchers declined in both 2010 and 2011. The number of people enrolling in doctoral programs has also been trending downwards since peaking in 2002.

Looking at the number of academic papers produced in Japan (average for 2009–2011), Japan was fifth in terms of "degree of participation in the production of papers in the world (whole counting method)." As for the adjusted number of papers among the top 10% of the world's most cited papers (average for 2009–2011), Japan ranked seventh in terms of "degree of participation in high impact papers in the world (whole counting method)."

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Summary

1. R&D expenditure

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

- Japan's total R&D expenditure was approximately 17.1 trillion yen in FY 2010. This is a decrease of 0.79% from the previous year, following decreases in FY 2008 and 2009. The ratio to GDP was 3.6%, a decrease from the FY 2008 peak.
- The business enterprises 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 enterprises sector's share has been growing. In recent years, it has accounted for approximately 70% of the whole. In Korea, it accounted for about 80%.
- Looking at the flow of R&D expenditure from funding sectors to performing sectors in each country, in most countries the share funded by government flows to the public organizations sector and the universities and colleges sector. Countries in which there is a larger flow to the universities and colleges sector are Japan, Germany, France and the U.K. In almost all the countries, the flow from government to the business enterprises sector is small, but it is large in the U.S.
- The U.K. has a large share of funding from the foreign countries sector. It is relatively large in France and Germany as well. In all three of those countries, there is a notably large flow to the business enterprises sector.

(2) Government budgets

- With regard to the GBAORD (government budget appropriations or outlays for Science & Technology; real values; 2005 national currency basis), average annual growth during the first half of the 2000s was flat in Germany and France. It was positive in the other selected countries, and especially high in China. During the second half of the 2000s, the growth rate was flat in Japan and the U.K., negative in the U.S. and France, and high in Germany, China, and Korea.
- Japan's initial government budget (the government budget appropriation for S&T) in FY 2011 was 3.7 trillion yen. Including subsequent supplemental budgets, the final budget was 4.2 trillion yen.

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

- R&D expenditure during FY 2010 in the business enterprises sector in Japan was 12 trillion yen. The growth rate was almost flat at 0.22%, failing to recover from a big drop during FY 2009. Japan's ratio of R&D expenditure to GDP in the sector has been among the highest since FY 1990, but it continuously decreased during FY 2009 and FY 2010. It was 2.51% of GDP during the most recent available year.
- With regard to direct fund distribution (direct aid) and R&D tax incentives (indirect aid) to the business enterprises sector by the government in each country, the former accounts for a large

proportion in the U.S. and the U.K., while the latter accounts for a large proportion in Canada and Japan. France and Korea have high levels of both direct and indirect aid.

(4) R&D expenditure in the universities and colleges sector

- R&D expenditure in Japan's universities and colleges sector during FY 2010 was 3.4 trillion yen, a year-on-year decrease of 3.3%. Labor costs multiplied by FTE factor were 2.1 trillion yen (FY 2009).
- Looking at the most recent three-year average for the share of university and college R&D expenditure covered by governments, France is highest at 89.9%, while Japan is lowest at 49.5%. Compared with 2003–2005, Korea showed the largest increase, while the U.S. showed the largest decrease.
- As for the most recent three-year average for the share of university and college R&D expenditures borne by businesses in the selected countries, China was well ahead of the pack at 34.7%. France had the lowest share at 1.9%. Japan was the next lowest, at 2.6%. Germany showed the largest increase compared with 2003–2005, while Korea showed the largest decrease.

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

- As for Japan's FY2010 R&D expenditures by type, basic research accounted for 14.7% of the total. The universities and colleges sector accounted for 49.7% 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 26% 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 universities and colleges sector accounted for the highest share in France, the U.S. and Japan, the public organizations sector had the highest share in China, and the business enterprises sector was highest in Korea.

2. R&D Personnel

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

- In 2011, the number of researchers in Japan was about 660,000 when the number of researchers working at universities and colleges is calculated using the FTE method. Using the head count method, the number was about 890,000. The number of FTE researchers has changed little in recent years.
- The number of researchers in China increased rapidly after 2000, but in 2009 that country began using the definitions in the OECD's Frascati Manual to count researchers. This resulted in a big drop from the 2008 figure.
- Looking at the percentage of Japanese researchers who hold doctoral degrees, in 2011 it was 20.3% for all researchers. By sector, it was highest in the universities and colleges sector, at 59.3% in 2011. The next highest sector was the public institutions sector, at 43.5%. Both sectors

showed a rising trend. The percentage for the business enterprises sector was 4.2%. The growth rate has been flat, showing little change.

- Among Japanese researchers, the number of new graduates employed has declined after peaking in 2009. The business enterprises sector has shown the sharpest decline in recent years.

(2) Researchers by sector

- The number of researchers in the business enterprises 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 universities and colleges 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, the number of research assistants in the universities and colleges sector is smaller than in other sectors in Japan, Germany, France, the U.K. and China. The number of research assistants in the universities and colleges sector is large in Korea. Over time, growth has been flat or has declined in almost all the countries, but it has been increasing in Korea since 2000.
- 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 FY 2011 it decreased by 1% versus the previous year, to 613,000. 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 FY 2010 it increased by 5.4% over the previous year. In FY 2011, however, it decreased by 3.6%, to 79,000. 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 FY 2010. In 2011, however, it decreased by 4.8%, 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, during the 1980s generally about 80% of those receiving bachelor's degrees obtained employment. However, that percentage dropped sharply during the 1990s. In FY 2011, only 46.6% of them obtained employment, while 39.4% proceeded to further higher education.
- As for the career paths of those obtaining master's degrees in natural sciences and engineering, about 80% have been obtaining employment. This percentage had further increased since entering the 2000s. In 2010, however, the percentage decreased slightly. In 2011, 83.8% obtained employment.
- Turning to the career paths of those obtaining doctoral degrees in natural sciences and engineering, the percentage obtaining employment began dropping significantly around 2000, but in recent years it has been climbing again. The percentage obtaining employment in 2011 was 66.6%.
- About 30% of those obtaining doctoral degrees in natural sciences and engineering have been obtaining employment in manufacturing industries. In 2011, the figure was 30.9%. During the 1980s, 40 to 50% obtained employment in education (employed by schools, etc.), but in 2011 the percentage was 32.7%. In 2001, 12.9% obtained employment in research (employed by academic or research institutions, etc.).
- Looking by industrial classification at graduates of undergraduate, master's, and doctoral courses in natural sciences and engineering who obtain employment, the majority have become professional and technical workers. In the case of those with master's or doctoral degrees, they have accounted for almost 90% of those obtaining employment. For those with bachelor's degrees, the long-term trend has been downwards. In recent years, their percentage has been in the 70s.

(3) International comparison of degree recipients

- 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) Foreign Students

- Looking at the state of foreign graduate students in Japan and the U.S., Japan had 16,000 foreign graduate students in 2011. Chinese graduate students accounted for the largest number, 8,000, which was half the total. In the U.S., there were 176,000 foreign graduate students in 2010. Indian students accounted for the largest number, with 62,000.

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 2009–2011), 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, Germany and the U.K.. 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 Germany in fourth place and the U.K. 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 2011 was 52% for Germany, 54% for the U.K. and 54% for France, while the U.S. was 35% and Japan was 27%.

(2) Patents

- The number of world patent applications declined sharply in 2009 amidst the recession following the "Lehman Brothers shock," but it began rising again in 2010. The number of applications is approaching 2 million annually.
- 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 since the mid-2000s. The number of applications to the U.S. (about 490,000 annually) has been flat for the past few years, but there was an approximately 7% increase from 2009 to 2010. In 2010, there were about 390,000 patent applications to China, more than there were to the Japan Patent Office.

- As for patent applications from Japan, the U.S., China and Korea, more are directed within each country than are directed to other countries. Out of all patent applications from Japan, about 60% are to Japan (the JPO). China is increasing the volume of its domestic patent applications, but at only 14,000, its number of patent applications to other countries remains low.
- 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. As for applications by technical field, Japan's a share in Renewable energy has been on a downward trend.

5. Science, technology and innovation

(1) Technology trade

- Japan’s technology trade balance as a ratio was 4.6 in 2010. Its export surplus has continued since 1993.
- Looking at technology trade exclusive of that between parent companies and subsidiaries, Japan's technical trade balance in 2010 was 1.7. It has had an export surplus since 2006. In the U.S., the balance was 3.9.
- Looking at Japan's amount of technology exports by industry classification, "Transportation equipment manufacturing" had the largest amount during FY 2010. At 1.3 trillion yen, it accounted for 52.7% of all industries. It was followed by "Drugs and medicines" with 0.3 trillion yen (12.8% of all industries). The industry with the largest amount of technology imports during FY 2010 was "Information and communication electronics equipment." With 0.2 trillion yen, it accounted for 39.3% of technology imports in all industries.
- Transactions among parent companies and subsidiaries amounted to 80% in “Transportation equipment manufacturing.” In the case of "Drugs and medicines," the percentage has remained around 50%. With transactions among parent companies and subsidiaries so common in Japan's technology exports, "Drugs and medicines" can be considered an industry with more international technology transfer.

(2) The High Technology Industry Trade

- World high-technology trade had consistently increased, but it fell about 10% in 2009 compared with 2008. "Radio, Television and Communication Equipment" accounts for the largest share at about 40%.
- By country, the scale of U.S. trade was large and has been rising. However, China has increased its trade amount rapidly during recent years, and the value of its exports has surpassed that of the U.S. Germany's trade amount has also rapidly expanded. Japan is behind Germany in fourth place. High-technology trade declined in each country in 2009, but increased again in 2010.
- Japan's high-technology trade balance ratio has been on a long-term downward trend since peaking in 1984. Japan was passed by Korea in 2003 and by China in 2009. However, its

high-technology trade balance ratio has never fallen below 1.

- Japan's "Radio, Television and Communication Equipment" industry and "Medical, Precision and Optical Instruments" industry have export surpluses. In the U.S., the "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft" industries have export surpluses. In Germany, the "Pharmaceuticals," "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft" industries have export surpluses.

(3) Trademark applications and trilateral patent families

- Looking at the number of transnational trademark applications and trilateral patent families (patents with the same content submitted in Japan, the U.S. and Europe) per 1,000,000 population, in 2007–2009, Japan, Germany and 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.

(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, innovation related to new services is realized at a lower rate than innovation related to products and process innovation, regardless of the size of R&D expenditures. This is true for the U.S. as well, although the difference is not as large as it is for Japan.

(5) Total Factor Productivity (TFP)

- Total Factor Productivity (TFP) is used as an indicator that shows the contribution of technological progress to economic growth. Although Japan had the lowest TFP growth rate of any of the selected developed countries during the 1990s, since 2001 it has had a relatively high growth rate. However, the TFP growth rate has been falling in all those countries, including Japan, since the late 2000s.

Notes concerning Science and Technology Indicators 2012

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 17.1 trillion yen in FY 2010. This is a decrease of 0.79% from the previous year, following decreases in FY 2008 and 2009. The ratio to GDP was 3.6%, a decrease from the FY 2008 peak.

○The business enterprise sector accounted for the highest usage ratio of total 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 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 remains flat.

○Looking at the flow of R&D expenditure from funding sectors to performing sectors in each country, in most countries the share funded by government flows to the public organization sector and the university and college sector. Countries in which there is a large flow from the university sector are Japan, Germany, France and the U.K. In almost all the countries, the flow from government to the business enterprise sector is small, but it is large in the U.S.

○The U.K. has a large share of funding from the foreign countries sector. It is relatively large in France and Germany as well. In all three of those countries, there is a notably large flow to the business enterprise sector.

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. In principle, 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

(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.

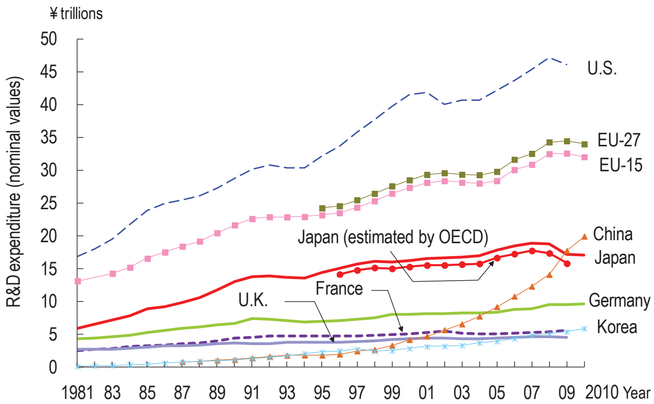
in the university and college sector. Strict separation of expenditures for research and for education in the university and college sector is difficult. Thus, in the Survey of Research and Development, expenditures in the university and college sector include faculty personnel expenses for non-research 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, 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 2005). (C) and (D) are the nominal values and real values (on 2005 base) represented by the national currencies of each country respectively.

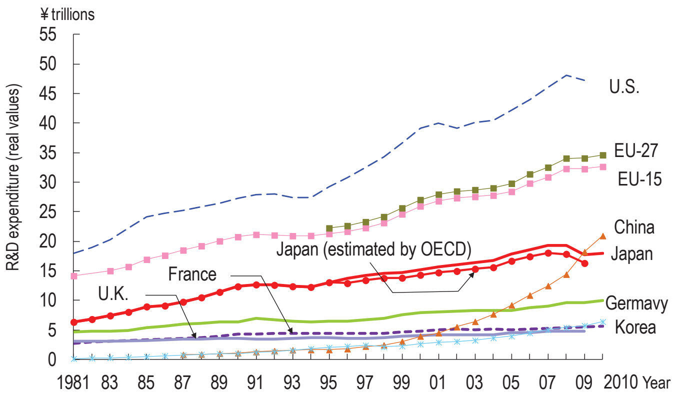
Japan's total R&D expenditure was approximately 17.1100 trillion yen in FY 2010[(2)]. This is a decrease of 0.79% from the previous year, following decreases in FY 2008 and 2009. The business sector had a large impact on the FY 2009 decline, but in FY 2010 there was also a decrease in R&D expenditures in the university and college sector. Looking at the most recent year for each country (Chart 1-1-1(A)), the U.S. has an overwhelming lead. China passed Japan in 2009. Those three countries are followed by Germany. Then come France, the U.K. and Korea, all roughly at an equivalent level. The U.S., Japan and the E.U. each experienced a decrease in the most recent year, but other countries continued to increase. Those trends hold for real values (Chart 1-1-1(B)) as well.

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

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



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



(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 (C) shows a comparison of the investment status of each country in terms of the annual average growth rate of R&D expenditure during the first half of the 2000s (2000–2005) and the second half of the 2000s (2005 to the latest available year) on the basis of each national currency.

Comparing the annual average growth rate of R&D expenditure (nominal values) between the first and second halves of the 2000s, the growth rate was higher in the second half for the U.S., Germany, France, China and Korea. The growth rate increased the most rapidly in China. The growth rate was worse in the second half of the 2000s for Japan and the U.K. Japan actually posted a negative annual growth rate.

Chart 1-1-1 (D) shows annual average growth rates in (real) R&D expenditures on a 2005 base in order to eliminate the influence of price fluctuations. Growth was higher during the second half of the 2000s than in the first half in the U.S., Germany, France and Korea. Japan and the U.K. showed higher growth during the second half of the decade in real terms.

(C) Nominal values (national currency)

National currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	16.3	17.8	17.1	1.84%	-0.84%
Japan (estimated by OECD) (¥ trillions)	15.3	16.7	15.8 (2009)	1.73%	-1.31% (2009)
U.S. ($ billions)	268	325	400 (2009)	3.93%	5.36% (2009)
Germany (€ billions)	50.6	55.7	69.8	1.95%	4.60%
France (€ billions)	31.0	36.2	43.6	3.20%	3.79%
U.K. (£ billions)	17.7	22.1	25.9 (2009)	4.50%	4.00% (2009)
China (¥ billions)	89.6	245	706	22.3%	23.6%
Korea (₩ trillions)	13.8	24.2	43.9	11.8%	12.7%

(D) Real values (2005 base; national currency)

National currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	15.2	17.8	18.0	3.22%	0.19%
Japan (estimated by OECD) (¥ trillions)	14.3	16.7	16.3 (2009)	3.10%	-0.56% (2009)
U.S. ($ billions)	302	325	365 (2009)	1.47%	2.94% (2009)
Germany (€ billions)	53.4	55.7	66.8	0.87%	3.68%
France (€ billions)	34.1	36.2	40.1	1.21%	2.05%
U.K. (£ billions)	20.1	22.1	23.3 (2009)	1.89%	1.35% (2009)
China (¥ billions)	105	245	557	18.5%	17.9%
Korea (₩ trillions)	15.9	24.2	39.0	8.66%	10.0%

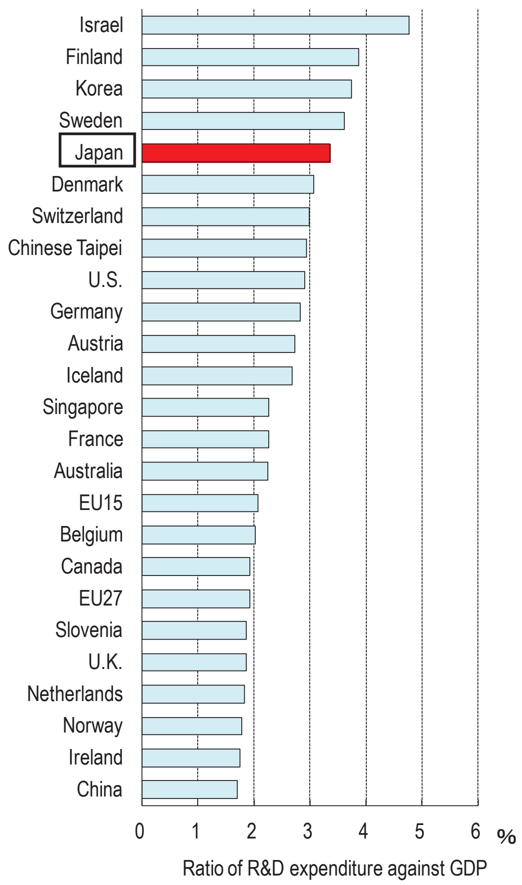
Note: 1) The total R&D expenditure is the sum of each sector's expenditure, and the definition of each sector occasionally differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected country.
2) R&D expenses include the fields of social science and humanities (in the case of Korea, only natural sciences until 2006).
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, "Science and Engineering Indicators 2012"
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2011/2" for information since 2008
<Japan (estimated by the OECD), France and EU> OECD, "Main Science and Technology Indicators 2011/2"
<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 2010 (website)
<Korea> National Science and Technology Information Service (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).

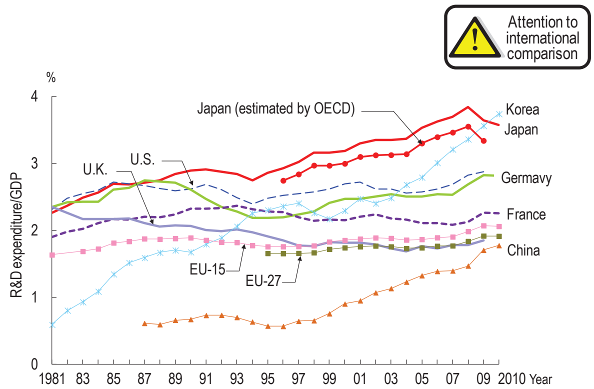
The ratio of total R&D expenditures to GDP in Japan was fifth among the listed countries and regions and stands at a relatively high level.

Chart 1-1-2: Ratio of the total R&D expenditure against GDP in each country (2009)



Note: 1) The value for Iceland is from 2007; those for Israel, Switzerland and Austria are from 2008.
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) Figures for the U.K. and Ireland are national estimates or projections.
Source: OECD, "Main Science and Technology Indicators 2011/2"

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



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 has been declining slowly since peaking at 3.84% in 2008. By 2010, the most recent available year, it fell to 3.57%. According to OECD estimates, the ratio in Japan also peaked in 2008. In 2009, it was 3.34%.

The value in Korea surpassed 3% in 2006. Its 2010 figure of 3.74% was higher than Japan's.

Each country exhibited a growth trend during the latter half of the 2000s. The U.S., Germany and France showed notable growth, although there was little movement in the most recent year.

In China, where industrial development has been remarkable, the ratio has been increasing since 1996. The gap between China and the other selected countries has shrunk markedly.

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

In order to understand national R&D systems, it is necessary to view by sector the institutions carrying out R&D activities in each country.

However, what is problematic in classification by sector and international comparison are the discrepancies among national R&D systems, methods of survey, and the scope of target organizations in each country. Consequently, comparison should be made in accordance with a correct understanding of the differences among each country.

In order to examine the structure of R&D funding, this section classifies by sector institutions in each country performing R&D activities.

(1) Definition of funding sectors and performing sectors for R&D expenditures

Chart 1-1-4 classifies institutions that perform R&D into four sectors based on the OECD's "Frascati Manual."(3) It shows a simple breakdown of each country's R&D expenditure funding sectors (five sectors) and performing sectors (four sectors). Expressions used in the chart are the same as those used in each country's R&D statistics or in OECD data, but the unified expressions are those used in a set of Japanese R&D statistics, the Survey of Research and Development of the Ministry of Internal Affairs and Communications.

Chart 1-1-4: Definitions of funding and performing sectors in R&D expenditure in selected countries

(A) Funding sectors

Country	Business enterprises	Universities and colleges	Governments	Non-profit institutions	Foreign countries
Japan	・ Companies ・ Special corporations orindependent administrativecorporations (for-profit)	・ Private universities (including junior colleges, university-affiliated research institutes, etc.)	• National government and local governments • Research institutions (including JSPS, NEDO, JST, etc.) at national, public and semi-governmental corporations and independent administrative agencies (not for profit) • National and public universities (including junior colleges, university-affiliated research institutes, etc.)	・ Corporations, organizations, and individuals not included in another category	Foreign organizations
U.S.	・ Companies and others	・ University & Colleges (organizations which each conduct R&D equivalentto $150,000 or more)	Federal government (however, some R&D funds used by universities and colleges are provided by state governments)	・ Other non-profit institutions	
Germany	・ Enterprises ・ Public research institutes (IfG)	*Not considered a funding source	Government (federal, state and district governments) (Includes federal government commissions and subsidies, and in some cases repayable grants from public organizations. Does not include funds received from the federal government within the economic sector's R&D human resources development program or the industrial and economic sectors' measures on the promotion of cooperative research.)	Domestic organizations that are not part of the economic sector, such as universities and private NPOs (nonprofit organizations)	• Corporate groups • Funds from E.U. promotion programs • Other funds from foreign countries
France	・ Enterprises	・ National Science and Research Center (CNRS) ・ Grandes ecoles (not administered by Ministèrede l'éducation nationale (MEN)) ・ Higher education institutions (administered byMinistère de l'éducation nationale (MEN))	• Public research institutions • Regional governments	・ Non-profit institutions	• Business enterprises (foreign business enterprises belonging to the same corporate group, unrelated foreign companies) • Foreign governments • Foreign nonprofit organizations • Foreign universities • E.U. • International organizations
U.K.	・ Enterprises	・ Universities	・ Central government (U.K) ・ Decentralized governments (Scotland, etc.) ・ Research councils ・ Higher Education Funding Councils * Local governments are not included	・ Non-profit institutions	・ Foreign countries
China	・ Enterprises	*Not considered a funding source	・ Government research institutes * Local governments are not included	・ Other non-profit institutions	・ Foreign countries
Korea	・ Enterprises ・ Government investment institution (organizations in which the government invests some or all of the funds needed to operate corporations: Korea Agricultural and Rural Infrastructure Corporation, Korea Industrial Promotion Corporation, etc.)	・ National or public universities ・ Private universities	• Government (national and public laboratories, local governments) • Government-contribution research institutions (organizations to which the government provides some or all of the funds needed to operate corporations: Korea Advanced Institute of Science and Technology, Korean Atomic Energy Research Institute, etc.)	・ Other non-profit institutions	• Business enterprises (foreign business enterprises belonging to the same corporate group, unrelated foreign companies) • Foreign governments • Foreign nonprofit organizations • Foreign universities • E.U. • International organizations

(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.

(B) Performing sectors

Country	Business enterprises	Universities and colleges	Public organizations	Non-profit institutions
Japan	・Companies ・Special corporations orindependent administrativecorporations (for-profit)	・University faculties (including advanced researchcources at graduate schools) ・Junior colleges ・University research institutes ・Others	・National research institutes ・Special corporations or independ entadministrative corporations (non-profit) ・Public research institutes	・Non-profit institutions
U.S.	・Companies and others	・University & Colleges (organizations which each conduct R&D equivalentto $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 Ministèrede l'éducation nationale (MEN)) ・Higher education institutions (administered byMinistère de l'éducation nationale (MEN))	・Scientific and technical research publicestablishment "Etablissement public a caracterescientifique et technologique" (other than CNRS) ・Commercial and industrial research publicestablishment "Etablissement public a caractereindustriel et commercial" ・Administrative research public establishment"Etablissement public a caractere administratif" (otherthan 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 (organizations in which the government invests some or all of the funds needed to operate corporations: Korea Agricultural and Rural Infrastructure Corporation, Korea Industrial Promotion Corporation, etc.)	・Universities and colleges offering majors in thefield of natural scienses and engineering (includingextention campuses and local campuses) ・University research institutes ・University hospitals (only if a school of medicineand its accounting are integrated)	・National or public research institutes ・Government-contribution research institutions (organizations to which the government provides some or all of the funds needed to operate corporations: Korea Advanced Institute of Science and Technology, Korean Atomic Energy Research Institute, etc.) ・National or public hospitals * Local governments are not included	・Private hospitals ・Other non-profit institutions

Note: 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. > 1) FFRDCs: Federally funded research and development centers
2)Funding sectors do not include "universities and colleges".
<Germany> 1) IfG : Institutions for co-operative industrial research and experimental development.
2) Funding sectors do not include "universities and colleges".
<China> Funding sectors do not include "universities and colleges".
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

(2) Funding sectors and performing sectors for R&D expenditures in selected countries

This section examines the flow of R&D funds from funding sectors to performing sectors in each country, how the funds are distributed, and which sectors use how much of them.

Chart 1-1-5 shows each country's R&D expenditures divided by sector and their flow. Chart 1-1-4 above provides some details of the funding and performing sectors. However, caution is required because there is variation among the countries in terms of systems, survey methods, and the scope of the institutions covered, for both the funding sectors and the performing sectors.

Looking at the flow of R&D funds from funding sectors to performing sectors in each country, the business enterprises sector accounted for a large percentage in each country, but the flow was almost entirely within that same sector. In Germany and China, however, the flow of R&D funds to the universities and colleges sector was relatively larger.

As for the governments sector, in most countries the flow was to the public organizations and universities and colleges sectors. Japan, Germany, France and the U.K. had a large flow from the universities and colleges sector. The flow from the governments sector to the business enterprises sector was small in most countries, although it is large in the U.S.

In the universities and colleges sector, even when it was the funding sector, the amount was quite small. Germany and China do not consider the universities and colleges sector to be a funding sector. In Japan, only private universities are considered a funding sector. Japan's universities and colleges sector accounts for a higher share of funding than the same sector does in the other countries. The main reason for this is that a portion of personnel costs for faculty at private universities is calculated as R&D expenditure.

The percentage of funding provided by the non-profit institutions sector was small in each country.

The foreign countries sector accounted for a large share in the U.K. and France. In both those countries, most of those funds flowed to the business enterprises sector. The U.S. does not classify foreign countries as a funding sector. Any such funds must be included in other categories.

Looking at each country, Japan had a large flow of R&D funds from the business enterprises sector to the business enterprises sector. There was almost no flow from that sector to other sectors. There was a large flow from the governments sector to the universities and colleges sector and to the public organizations sector as well. As a funding sector, the universities and colleges sector refers to private universities. All those funds flow to the universities and colleges sector as the performing sector. This flow means that R&D expenditure in private universities is almost entirely self-funded.

In the U.S., there was a large flow of R&D funds from the business enterprises sector to the business enterprises sector. There was also a large flow from the governments sector to the public organizations sector. The flow from that sector to the business enterprises sector was also large, exceeding the size of the flow to the universities and colleges sector. The foreign countries sector is not used as a funding sector classification.

In Germany, as in the other countries, the flow between the business enterprises sectors was the mainstream. Compared with the other countries, however, Germany had one of the larger flows of R&D funds to the university and college sector and the public organizations/non-profit institutions sector. It had the largest flow from the business enterprises sector to the universities and colleges sector of any of the selected countries. The share of funds accounted for by the foreign countries" sector was also among the largest.

In France, the business enterprises sector accounted for the largest share of funding, followed by the governments sector. France's governments sector accounted for 38.6% of funding, the highest percentage of any of the countries. The foreign countries sector's share of funding was also relatively large. Most of those R&D funds flowed to the business enterprises sector.

The U.K. is characterized by the relative evenness of the shares of its funding sectors compared to the other countries. Of course, the business enterprises sector was the largest funding sector at 45.4%, and the governments sector was also large at 30.7%, but the foreign countries sector's share was 17.7%, far ahead of the other countries. Most R&D funds from the foreign countries sector flowed to the business enterprises sector, but a large share also went to the universities and colleges sector.

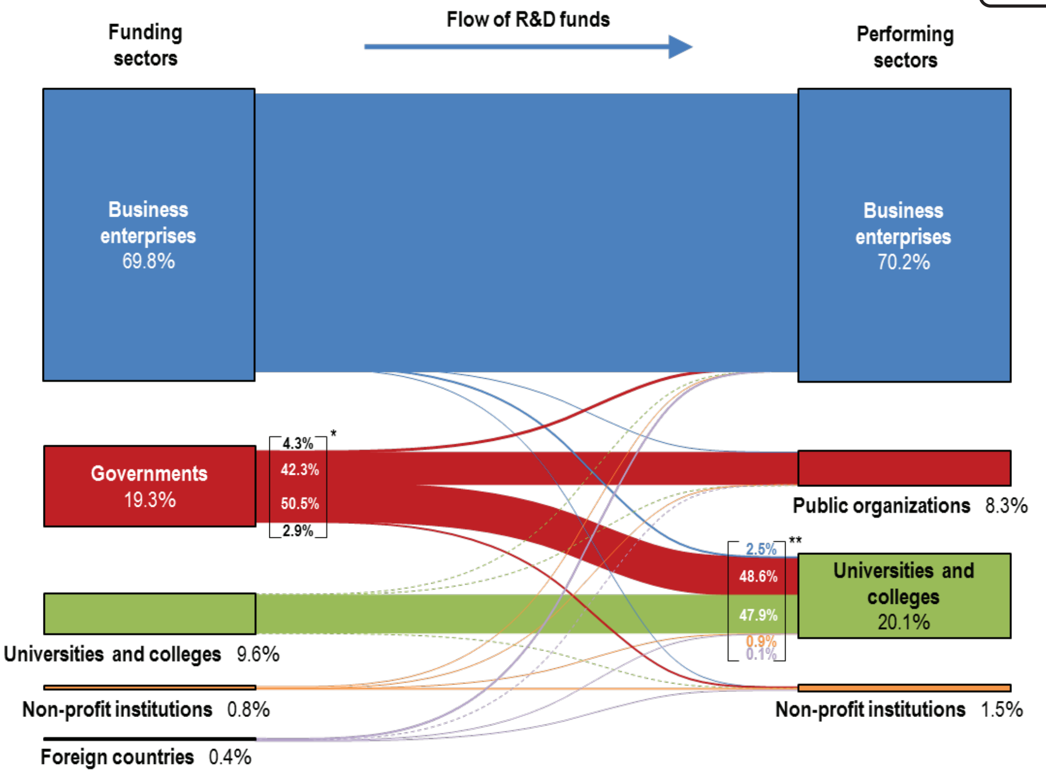
In China, the non-profit institutions sector comes under the classification “Other”. There was a large flow of R&D funds between the funding and performing business enterprises sectors. The largest share of R&D funding borne by the governments sector flowed to the public organizations sector.

In Korea, the business enterprises sector accounted for the largest share of funding at 71.8%. Most of that flowed to the business enterprises sector. The governments sector's share was large at 26.7%. About half of that went to the public organizations sector.

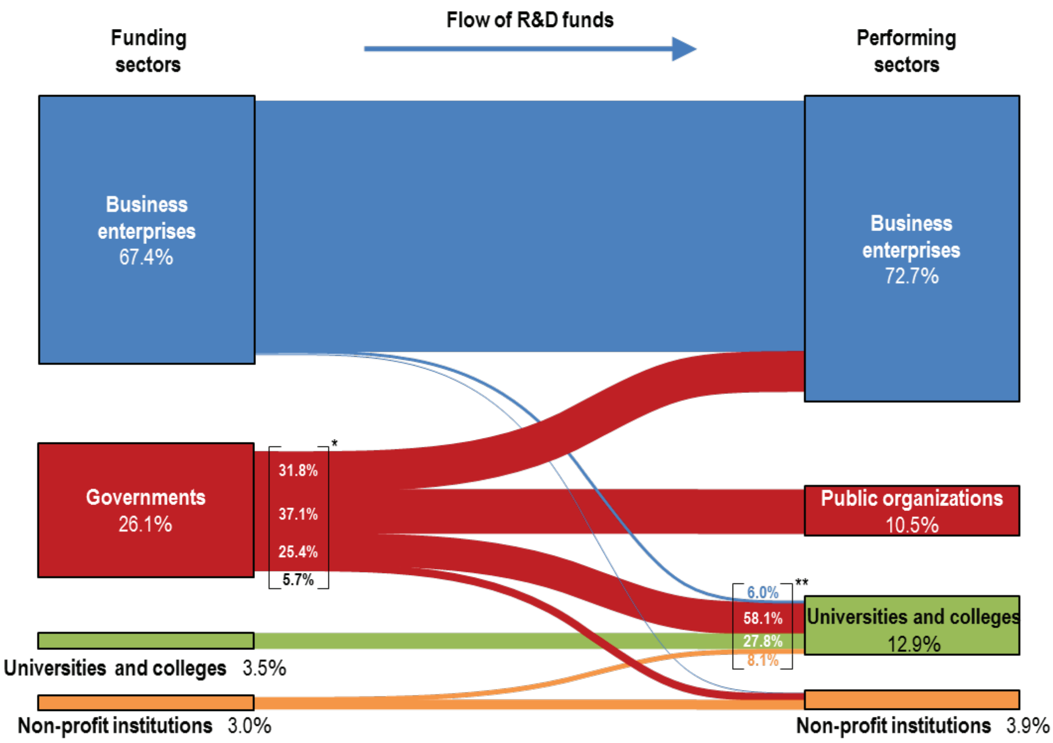
Chart 1-1-5: Flow of R&D funds from funding sectors to performing sectors in selected countries

Attention to international comparison

(A) Japan (FY 2010)

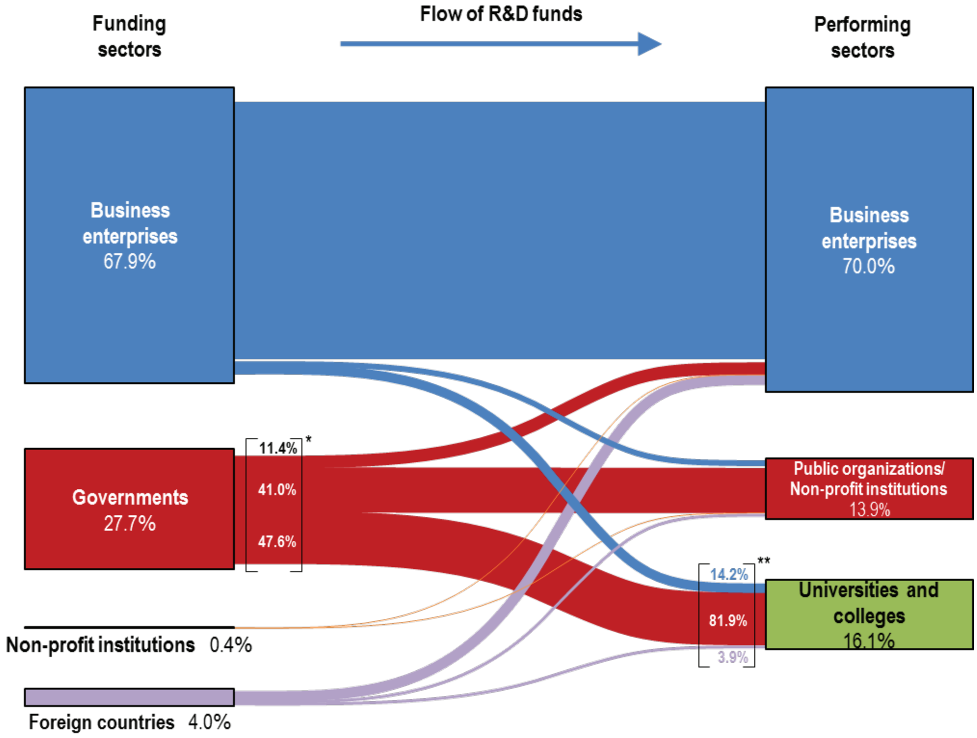


(B) U.S. (2009)

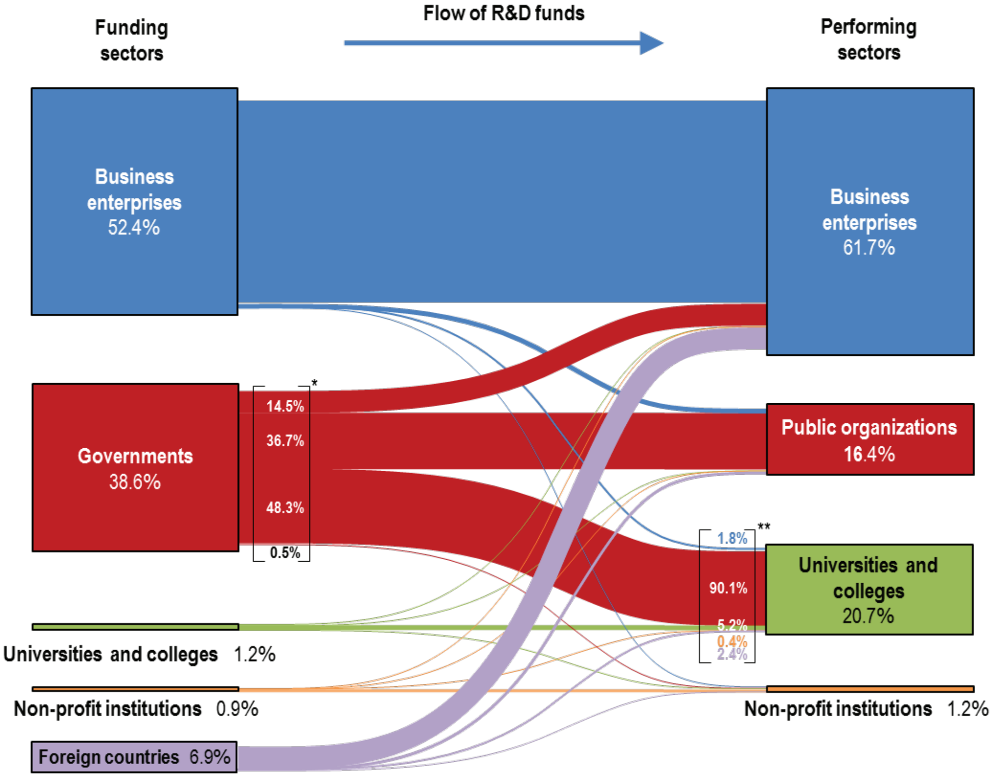


*U.S. funding sectors do not include "foreign countries."

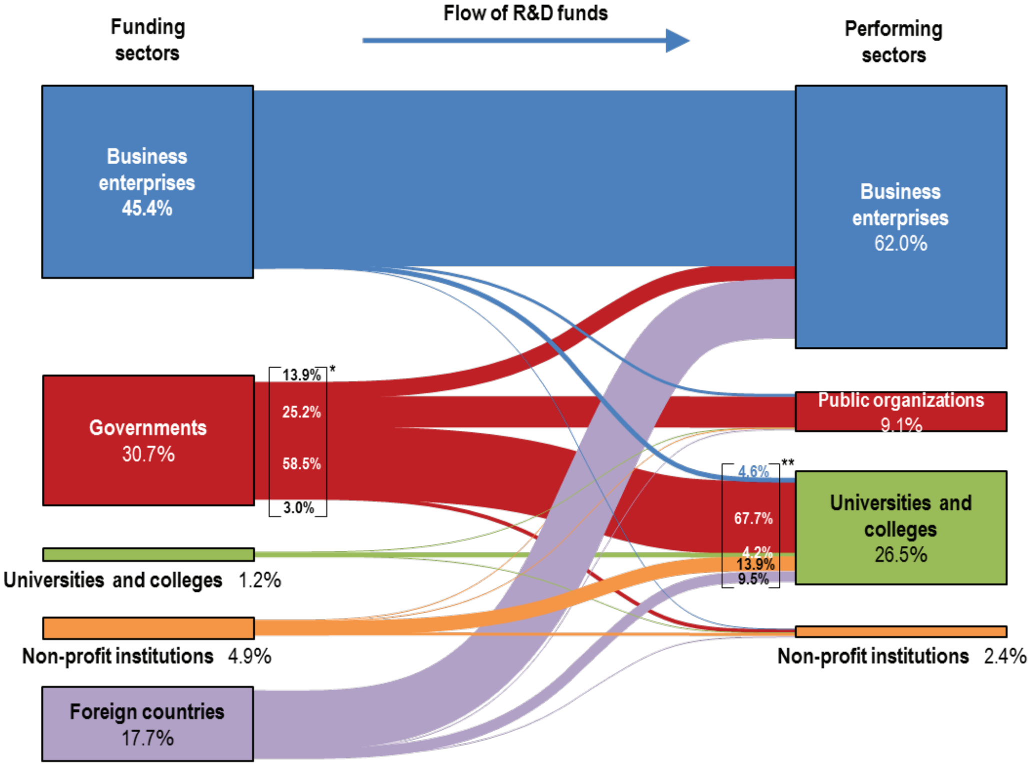
(C) Germany (2007)



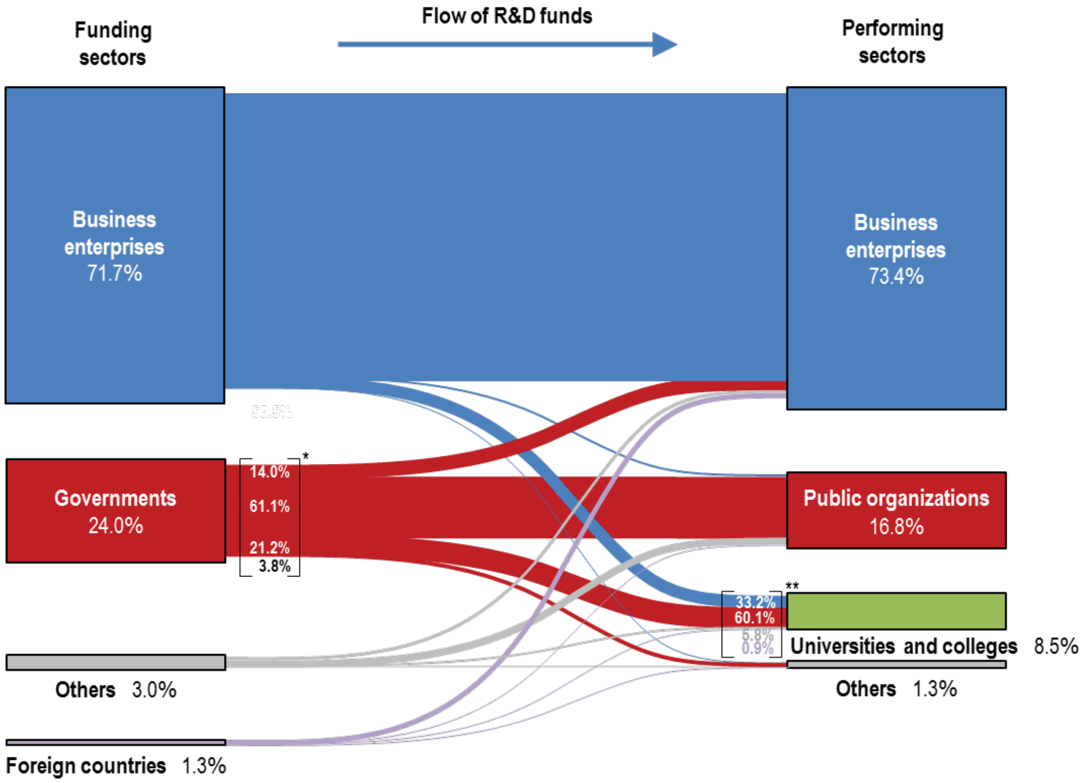
(D) France (2009)



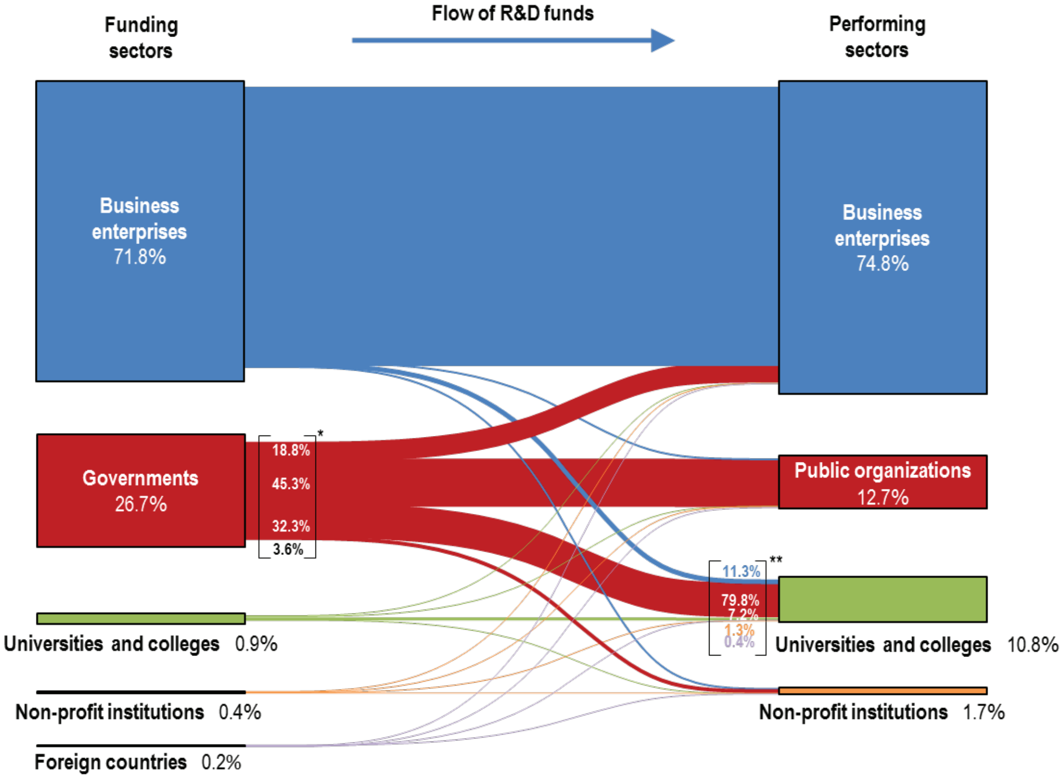
(E) U.K. (2009)



(F) China (2010)



(G) Korea (2010)



Note: See Chart 1-1-4 regarding funding and performing sectors.
*Analyzed in detail in Chart 1-2-5.
**Analyzed in detail in Chart 1-3-16.
Sources: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "Science and Engineering Indicators 2012"
<Germany> "Bundesbericht Forschung und Innovation 2010"
<U.K.> National Statistics website: www.statistics.gov.uk
<France, Korea> OECD, "Research & Development Statistics 2011"
<China>Ministry of Science and Technology of the People's Republic of China, "China Science and Technology Indicators"

(3) Changes in R&D expenditures in performing sectors in selected countries

In Chart 1-1-6, each selected country's total R&D expenditure is classified by sector, and changes in the proportions of each sector are shown. In each country, the business enterprises sector accounted for the largest proportion of total R&D expenditure: 70% in Japan, the U.S., Germany and Korea, and 60% in France and the U.K. On the other hand, the proportion used by the business enterprises 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 organizations sector has been decreasing while that used by the business enterprises sector had been increasing, but in the most recent year there has been a decline in the business enterprises sector as well. The significant decrease in the non-profit institutions 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 organizations sector has been on the decrease, while the non-profit institutions sector has been small but increasing. Over the long term, the proportion of the universities and colleges sector has tended to gradually increase, although recently it has shown little change.

In Germany, the data of public organizations sector and the non-profit institutions 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 universities and colleges sectors.

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

In the U.K., the proportion of the public organizations sector has decreased and that of the universities and colleges sector has increased, respectively since the 1990s.

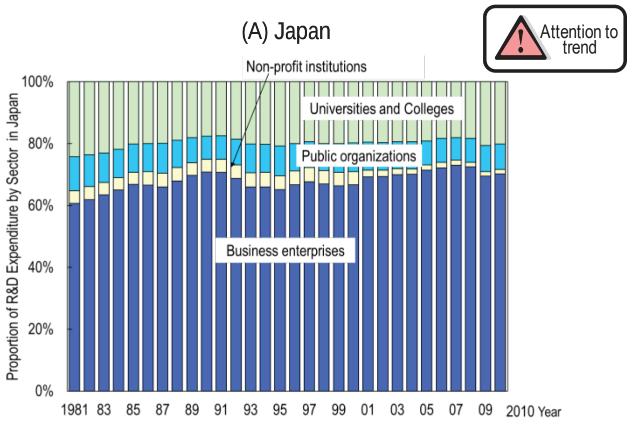
In China, the proportion of the public organizations sector is large compared to other (five) countries; however it has been decreasing since 1999. On the other hand, the proportion of the business enterprises sector is rising over time instead.

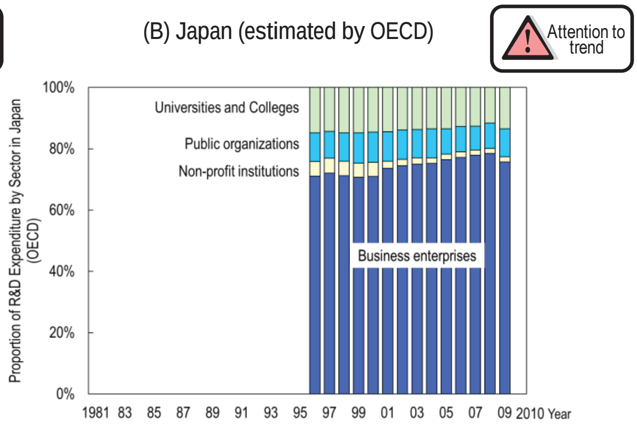
In Korea, the proportion of the public organizations sector is larger than the universities and colleges sector. In recent years, both the universities and colleges sector and the public organizations sector have exhibited little change.

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

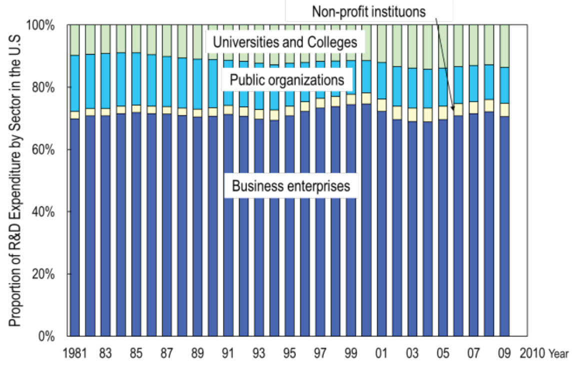
Attention to international comparison

Chart 1-1-6: Trends in the proportion of R&D expenditure by performing sector in selected countries

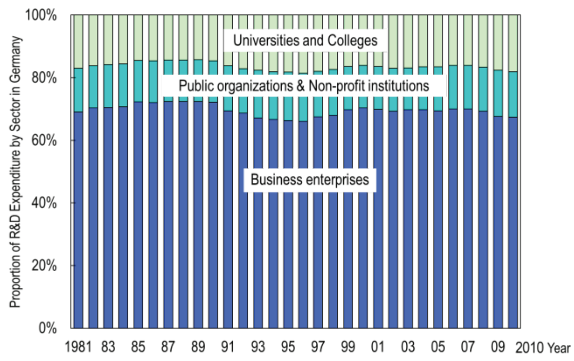




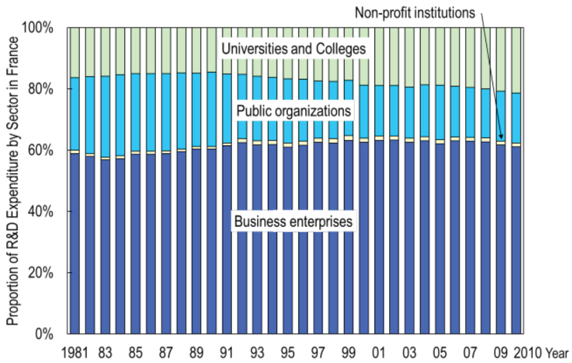
(C) U.S.



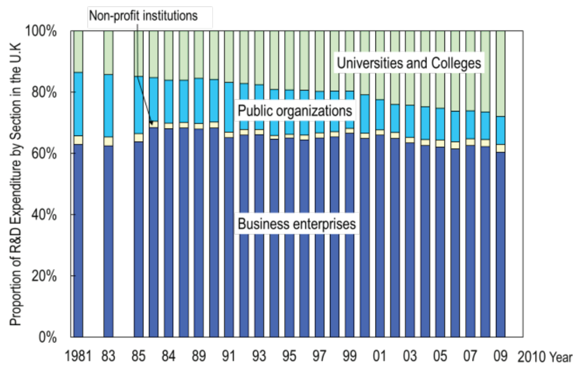
(D) Germany



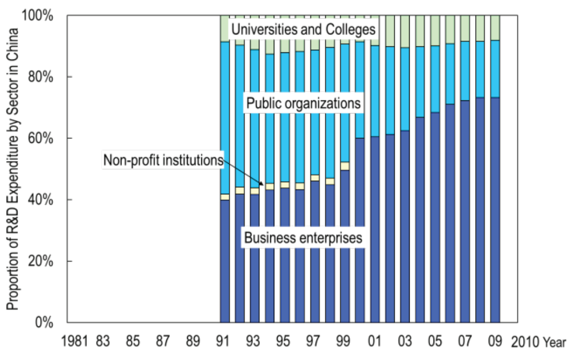
(E) France



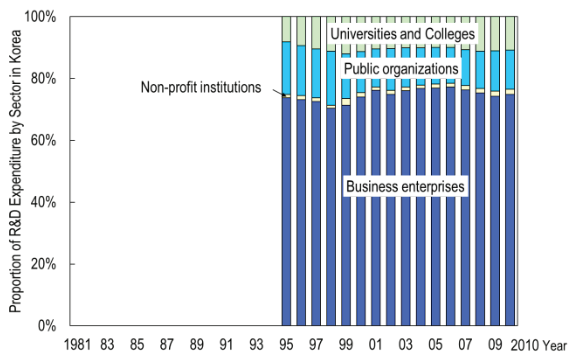
(F) U.K.



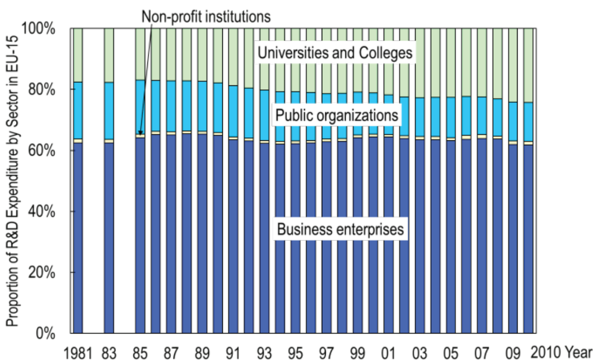
(G) China



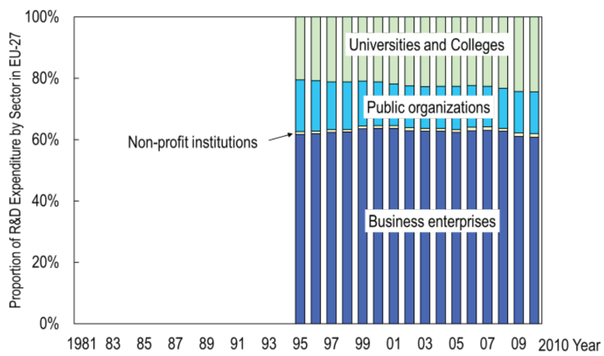
(H) Korea



(I) EU-15



(J) EU-27



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, only natural sciences until 2006).
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)> From 1996, figures corrected and estimated by the OECD (R&D expenditure in the universities and colleges sector comprising labor costs converted to FTE) are used, so caution is required when viewing changes over time.
<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, "Science and Engineering Indicators 2012 "
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004,2006"; "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2011/2" for 2008 or later
<U.K.> National Statistics website: www.statistics.gov.uk
<France, China, Korea and EU> OECD, "Main Science and Technology Indicators 2011/2"

1.2 Government budgets

Key points

○With regard to the GBAORD (government budget appropriations or outlays for Science & Technology; real values; 2005 national currency basis), average annual growth during the first half of the 2000s was flat in Germany and France. It was positive in the other selected countries, and especially high in China. During the second half of the 2000s, the growth rate was flat in Japan and the U.K., negative in the U.S. and France, and high in Germany, China, and Korea.

○Japan's initial government budget (the government budget appropriation for S&T) in FY 2011 was 3.7 trillion yen. Including subsequent supplemental budgets, the final budget was 4.2 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

Looking at total GBAORD (OECD purchasing power parity equivalent) in selected countries (Chart 1-2-1(A)), Japan's amount was 3.7 trillion yen, approximately one-fifth of the U.S.'s amount (2011). With regard to change over time, Japan's GBAORD growth rate became flat during the 2000s. In the case of the U.S., there has been a declining trend since special funds were allocated in 2009 under the American Recovery and Reinvestment Act of 2009 (ARRA). Growth in China has been remarkable since the start of the 2000s.

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 ratio of non-defense GBAORD to total GBAORD in Japan was 97.4% (2011[4]), a significant difference from the other selected countries. In the U.S., in contrast, the ratio was 42.8% (2011), less than half as much. No other country had as low a ratio of non-defense GBAORD.

From the perspective of change over time (Chart 1-2-1(C) on a national currency basis, average annual growth in total GBAORD was positive in each country during the first half of the 2000s (2000–2005). China and Korea posted especially high growth. During the second half of the 2000s (2005 through the most recent available year), average annual growth in GBAORD was flat in Japan and the U.S., positive in Germany, China and Korea and negative in France.

Furthermore, the change in real values, which reduces the influence of price fluctuations, shows that the average annual growth rate during the first half of the 2000s was flat in Germany and France and positive in the other selected countries. It was especially high in China. During the second half of the 2000s, the growth rate was flat in Japan and the U.K. and negative in the U.S. and France, but high in Germany, China, and Korea.

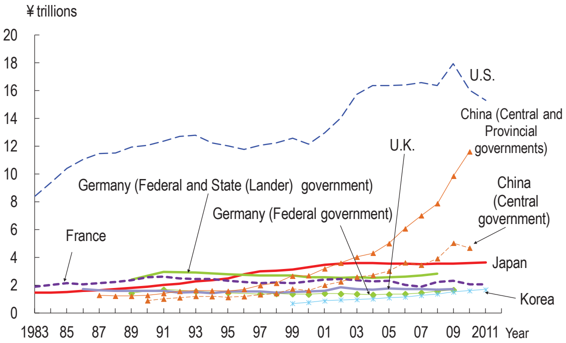
In nominal terms, only Germany had a higher growth rate during the second half of the 2000s than during the first half. In real terms, however, both Germany and China (central and provincial governments) had higher rates during the second half of the 2000s.

Since the beginning of the second half of the 2000s, the growth rate for defense-related budgets has been negative in most of the selected countries in both nominal and real terms. Only Germany and Korea have shown an increase.

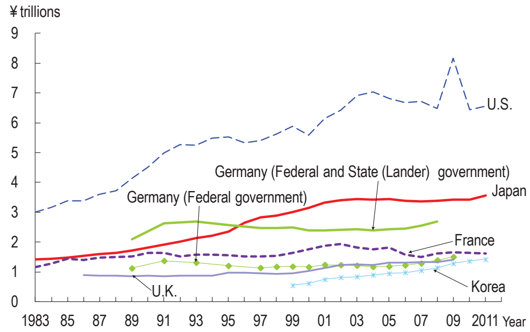
(4)This section uses "years" for international comparison, although in the case of Japan it is originally "fiscal years."

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	2000	2005	2011	Annual Average Growth Rate '00→'05	Annual Average Growth Rate '05→'11
Japan (¥ trillions)	Total	3.29	3.58	3.66	1.72%	0.40%
	Non-defense	3.15	3.43	3.57	1.74%	0.87%
	Defense	0.14	0.14	0.10	1.22%	-10.2%
U.S. ($ billions)	Total	78.7	127	143	9.98%	0.39%
	Non-defense	36.1	52.6	61.4	7.81%	1.74%
	Defense	42.6	74.0	82.0	11.7%	-0.55%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	16.3	17.2	19.8 ('08)	1.16%	4.77% ('08)
	Non-defense	15.0	16.2	18.6 ('08)	1.61%	4.68% ('08)
	Defense	1.27	0.99	1.19 ('08)	-4.80%	6.22% ('08)
Germany(Federal Govenment) (€ billions)	Total	8.47	9.03	12.7 ('10)	1.30%	7.07% ('10)
	Non-defense	7.28	7.95	11.5 ('10)	1.77%	7.71% ('10)
	Defense	1.19	1.09	1.19 ('10)	-1.83%	1.75% ('10)
France (€ billions)	Total	13.8	16.7	16.8	3.82%	-0.14%
	Non-defense	10.6	12.9	13.1	3.95%	1.23%
	Defense	3.24	3.82	3.67	3.39%	-4.17%
U.K. (£ billions)	Total	6.45	8.66	9.73 ('09)	6.06%	2.96% ('09)
	Non-defense	4.21	6.41	7.99 ('09)	8.78%	5.64% ('09)
	Defense	2.24	2.24	1.74 ('09)	0.03%	-6.12% ('09)
China (Central and Provincial governments) (¥ billions)	Total	57.6	133.5	411 ('10)	18.3%	9.77% ('10)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	35.0	80.8	166 ('10)	18.2%	5.27% ('10)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	3.75	6.74	13.0	12.4%	11.6%
	Non-defense	2.98	5.75	10.9	14.1%	11.3%
	Defense	0.77	0.99	2.12	5.05%	13.7%

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

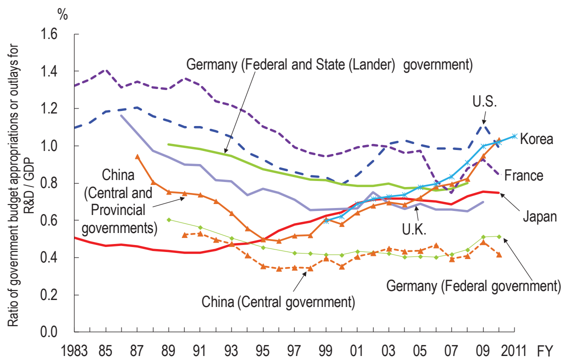
National Currencies	Government Budget Appropriations or Outlays for R&D	2000	2005	2011	Annual Average Growth Rate '00→'05	Annual Average Growth Rate '05→'11
Japan (¥ trillions)	Total	3.07	3.58	3.94	3.09%	1.61%
	Non-defense	2.95	3.43	3.83	3.12%	1.86%
	Defense	0.13	0.14	0.10	2.59%	-5.33%
U.S. ($ billions)	Total	88.7	127	126	7.38%	-0.02%
	Non-defense	40.7	52.6	54.2	5.26%	0.51%
	Defense	48.0	74.0	72.3	9.06%	-0.40%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	17.1	17.2	19.4 ('08)	0.09%	4.10% ('08)
	Non-defense	15.8	16.2	18.3 ('08)	0.53%	4.01% ('08)
	Defense	1.34	0.99	1.16 ('08)	-5.80%	5.27% ('08)
Germany(Federal Govenment) (€ billions)	Total	8.93	9.03	12.2 ('10)	0.23%	6.11% ('10)
	Non-defense	7.68	7.95	11.0 ('10)	0.70%	6.75% ('10)
	Defense	1.26	1.09	1.13 ('10)	-2.87%	0.85% ('10)
France (€ billions)	Total	15.3	16.7	15.2	1.82%	-1.53%
	Non-defense	11.7	12.9	11.9	1.95%	-1.30%
	Defense	3.57	3.82	3.32	1.40%	-2.33%
U.K. (£ billions)	Total	7.32	8.66	8.77 ('09)	3.41%	0.34% ('09)
	Non-defense	4.78	6.41	7.20 ('09)	6.06%	2.95% ('09)
	Defense	2.54	2.24	1.57 ('09)	-2.47%	-8.51% ('09)
China (Central and Provincial governments) (¥ billions)	Total	67.4	133	324.5 ('10)	14.7%	19.4% ('10)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	40.9	80.8	131 ('10)	14.6%	10.2% ('10)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	4.32	6.74	11.4	9.31%	9.11%
	Non-defense	3.43	5.75	9.52	10.9%	8.76%
	Defense	0.89	0.99	1.85	2.13%	11.1%

Note: <Japan> Data for all the fiscal years are of initial budget amounts.
<U.S.> The value for FY 2010 is a preliminary budget amount. The value for 2011 is the requested amount. The FY 2009 figure includes special funding allocated under the ARRA (American Recovery and Reinvestment Act of 2009).
<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> Ministry of Education, Culture, Sports, Science and Technology data
<U.S.> NSF, "Federal R&D Funding by Budget Function Fiscal Years 2009–2011"
<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 2011/2"
<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. Since the 2000s, growth in Korea and China (central and provincial governments) has been remarkable. Ratios in the other countries have been flat or have shown a declining trend.

The ratios for the latest available year were 0.75% in Japan, 0.99% in the U.S., 0.51% or 0.80% in Germany with or without including the local governments ("Lander governments") respectively, 0.84% in France and 0.70% in the U.K. Korea had the highest ratio at 1.05%. China's ratio was close to Korea's at 0.42% for the central government and 1.03% 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[5] 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 2010, the ratio of government expenditure in Japan was 19.3%.

The ratio decreased in almost all the countries until about 2000. It has tended to be flat since then.

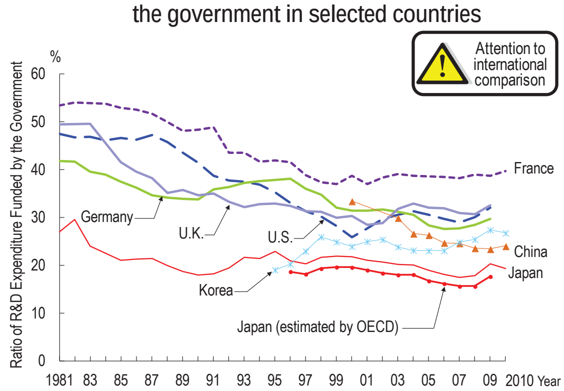
(5) Ordinarily, only the part of the S&T budget devoted to R&D (the R&D budget) should be studied, but there are no data on Japan's R&D budget. This report therefore uses S&T budget data. However, R&D accounts for most of Japan's S&T budget. R&D budget data are available for most countries other than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

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

Country	Government
Japan	• National government and local governments • Research institutions (including JSPS, NEDO, JST, etc.) at national, public and semi-governmental corporations and independent administrative agencies (not for profit) • National and public universities (including junior colleges, university-affiliated research institutes, etc.)
Japan (OECD)	• National government and local governments • Research institutions (including JSPS, NEDO, JST, etc.) at national, public and semi-governmental corporations and independent administrative agencies (not for profit)
U.S.	Federal government (however, some R&D funds used by universities and colleges are provided by state governments)
Germany	Government (federal, state and district governments)
France	• Public research institutions • Regional governments
U.K.	· Central government (U.K) · Decentralized governments (Scotland, etc.) · Research councils · Higher Education Funding Councils * Local governments are not included
China	· Government research institutes * Local governments are not included
Korea	• Government (national and public laboratories, local governments) • Government-contribution research institutions (organizations to which the government provides some or all of the funds needed to operate corporations: Korea Advanced Institute of Science and Technology, Korean Atomic Energy Research Institute, etc.)

Note: Same as Chart 1-1-4(B).
Sources: Same as Chart 1-1-4(B).

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 expenditures include humanities and social sciences (for Korea, only natural sciences until 2006).

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "Science and Engineering Indicators 2012"
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006"; "Bundesbericht Forschung und Innovation 2010"
Since 2008, OECD, "Research & Development Statistics 2011"
<Japan (OECD estimate), France and Korea> OECD, "Research & Development Statistics 2011"
<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 had been increasing, but in recent years it has been flat.

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.

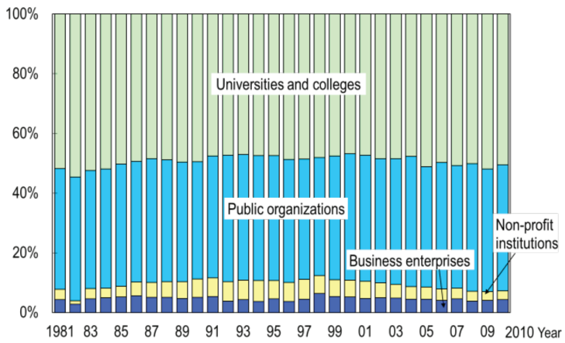
In summary, the ratio of government-funded R&D expenditure changed little in Japan. In Germany and the U.K., spending for the business sector decreased, but spending for the university and college sector increased relatively. France had been following the same trend as Germany and the U.K., but during 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

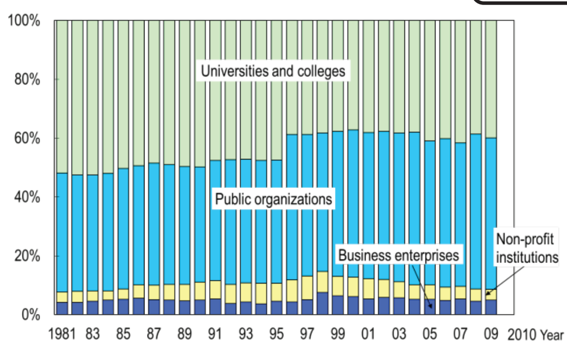
Attention to international comparison

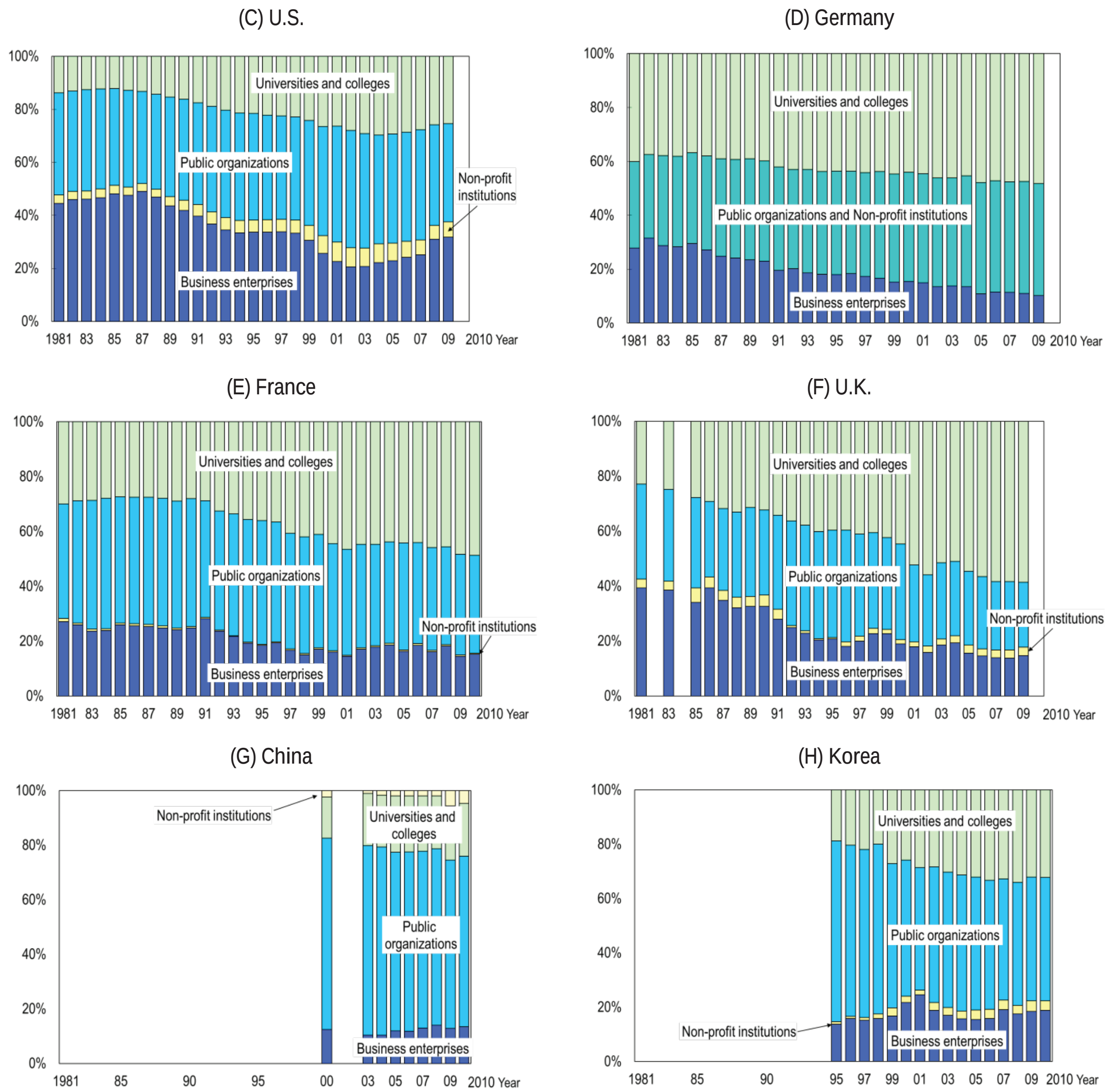
Attention to trend

(A) Japan



(B) Japan (estimated by OECD)





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

2) R&D expenses include the fields of social science and humanities (for Korea, only natural sciences until 2006).

<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 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, “Science and Engineering Indicators 2012”

<Germany> Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 2004, 2006”; “Bundesbericht Forschung und Innovation 2010” For Germany since 2008, OECD, “Research & Development Statistics 2011”

<Japan (OECD estimate), France, Korea> OECD, “Research & Development Statistics 2011”

< U.K.> OECD, “Research & Development 2011”; 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 ("Basic Plan") (Chart 1-2-6).

The First Science and Technology Basic Plan covered FY 1996-2000. 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. Actual (national) budgets during this period totaled approximately 18.8 trillion yen. Initial budgets increased slightly, with large supplemental budgets added in 2001 and 2002.

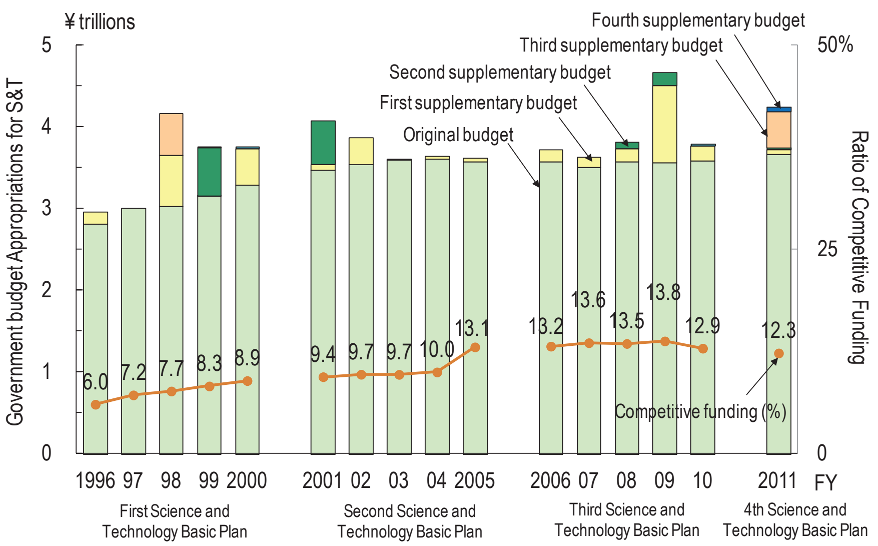
With the 2.3 trillion yen from local government budgets added in, the total was 21.1 trillion yen.

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 was 19.6 trillion yen. With local government budgets added, the total was 21.7 trillion yen.

The Fourth Science and technology Basic Plan covers the five years that began in 2011. It sets concrete goals for GBAORD. It calls for total GBAORD of about 25 trillion yen during the five years. (This is predicated on a ratio of GBAORD to GDP during the period of 1%, with an average nominal GDP growth rate of 2.8%.)The initial budget for GBAORD in FY 2011 is 3.7 trillion yen. With four supplemental budgets added, the final budget is 4.2 trillion yen. The preliminary figure for FY 2012 is 3.7 trillion yen.

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.

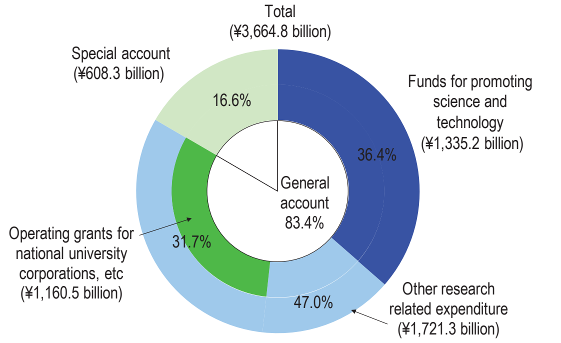
Some basic indexes regarding GBAORD are shown below.

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.

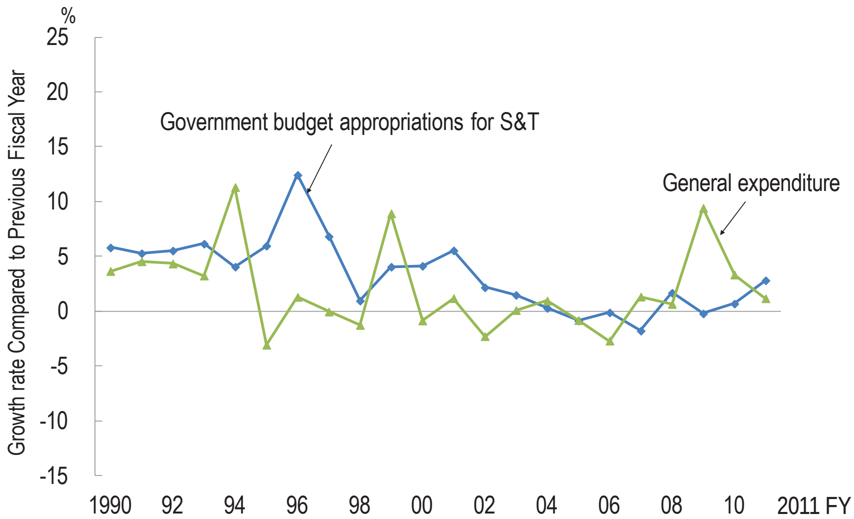
Chart 1-2-8: Breakdown of the Government appropriations for S&T (FY 2011)



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

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

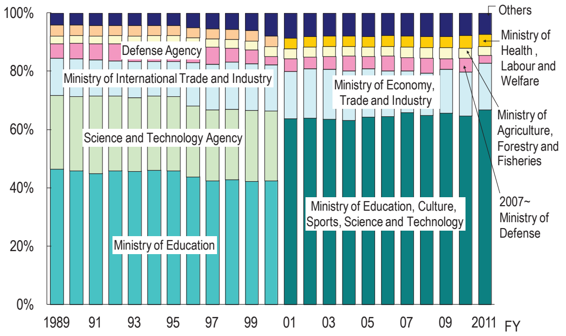


Note: 1) These are initial budgets.
2) The expenses covered were revised in FY 1996, FY 2001 and FY 2006 with the setting of the Science and Technology Basic Plans (First through Third).
3) The FY 2011 budget compilation does not use "general expenditures". Instead, it uses "expenditures subject to the 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)

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



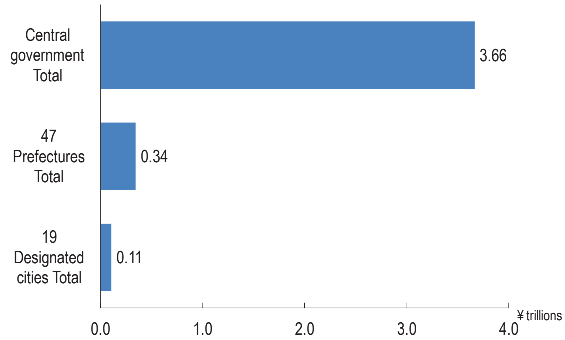
Note: 1) Data for each fiscal year is for initial budgets.
2) In accordance with the formulation of the science and technology basic plans (from the first to the third) , the range of targeted costs were reviewed in FY 1996, 2001 and 2006.
3) Until FY 2000, the expenditure on the Japan Key Technology 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 450.5 billion yen in FY 2011. This amount was the equivalent of 12.3% out of the original government budget appropriation for S&T allocated by the national government (approximately 3,664.8 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 2011)



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

○Japan's R&D expenditure in the public organization sector in FY 2010 was 1.42 trillion yen. Growth has been flat since the beginning of the 2000s.

○Looking at average annual growth rate in R&D expenditure (nominal values) on a national currency basis, Japan and the U.K. had growth rates below 1% during the latter half of the 2000s (2005 through the most recent available year). In contrast, the other countries showed growth, with China posting a particularly high rate of 19.4%.

(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.

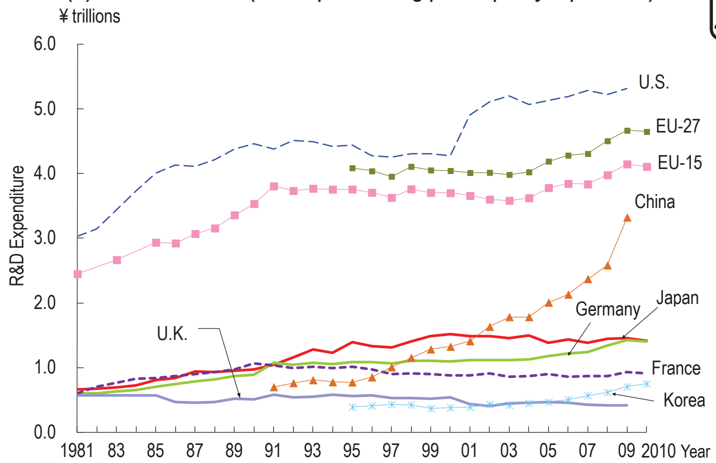
Chart 1-3-1(A) shows the trend of R&D expenditure (by OECD purchasing power parity equivalent) in the public organization sector for selected countries. The R&D expenditure in the public organization sector in Japan was approximately 1.42 trillion yen in FY 2010. Since the 2000s, the trend has been flat. Although R&D expenditure was flat in each country at the beginning of the 1990s, China started rapidly increasing its R&D expenditure during the middle of that decade, and its expenditure passed Japan's in 2002. And that of the U.S. has also been on the increase since the beginning of the 2000s.

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 first half of the 2000s (2000–2005), Japan posted negative growth while all the other countries showed positive growth. The growth rate in the U.K., however, was less than 1%. During the latter half of the 2000s (2005 through the most recent available year), Japan and the U.K. had growth rates below 1%. In contrast, the other countries showed growth, with China posting a particularly high rate of 19.4%. 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)), Japan and the U.K. showed negative growth in the first half of the 2000s, while all the other countries increased. The countries with high increases in growth rates from the first half to the second half of the 2000s were Japan, Germany, the U.K., China and Korea. In the case of the U.K., this was merely a slowing of negative growth rate.

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)

Attention to international comparison



(B) Nominal values (national currency)

National Currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	1.51	1.38	1.42	-1.80%	0.49%
U.S. ($ billions)	27.6	39.6	46.2 (2009)	7.48%	3.92% (2009)
Germany (€ billions)	6.87	7.87	10.2	2.74%	5.39%
France (€ billions)	5.36	6.44	7.14	3.73%	2.09%
U.K. (£ billions)	2.24	2.29	2.37 (2009)	0.43%	0.87% (2009)
China (¥ billions)	28.19	53.4	109 (2009)	13.6%	19.4% (2009)
Korea (₩ trillions)	1.84	2.87	5.56	9.21%	14.2%

(C) Real values (2005 base, national currency)

National Currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	1.42	1.38	1.49	-0.47%	1.54%
U.S. ($ billions)	31.1	39.6	42.1 (2009)	4.94%	1.54% (2009)
Germany (€ billions)	7.25	7.87	9.78	1.65%	4.46%
France (€ billions)	5.91	6.44	6.56	1.73%	0.37%
U.K. (£ billions)	2.54	2.29	2.14 (2009)	-2.08%	-1.69% (2009)
China (¥ billions)	33.0	53.4	90.7 (2009)	10.11%	14.2% (2009)
Korea (₩ trillions)	2.12	2.87	4.94	6.18%	11.5%

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) R&D expenses include the fields of social science 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.
<Japan (OECD estimate)> 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> 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 2011/2"
<U.S.>NSF, "Science and Engineering Indicators 2012"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010; OECD, "Main Science and Technology Indicators 2011/2" since 2008
<U.K.>National Statistics website: www.statistics.gov.uk
<France, Korea, and EU> OECD, "Main Science and Technology Indicators 2011/2"

(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.

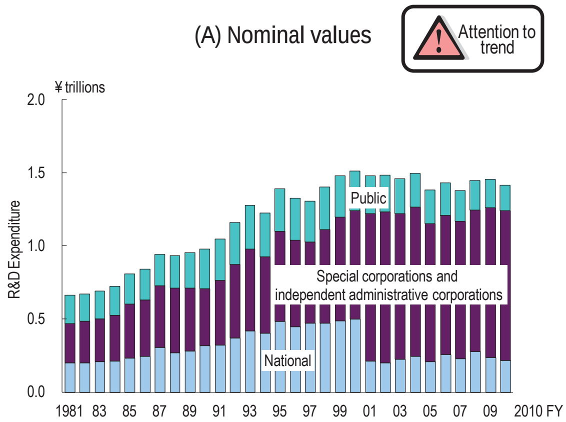
Chart 1-3-2(B) shows the trend in R&D expenditure for each of two types of institutes which compose the entire public organization sector, with the values on a 2000 base, which was adjusted considering the influence caused by price. One type of public institutes is run only by local governments, and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

From 1991 to 2005, the annual average growth rate of R&D expenditure in public institutes run by local governments showed a decrease of -0.89%, while that in the other public organizations showed an increase of 3.59%.

From 2005 to 2010, the annual average growth rate of R&D expenditure in public institutes run by local governments was -4.08%, showing further dwindling, while that in the other public organizations was 2.52%, 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 (2005 base)

(Unit: ¥ trillions)

FY	1991	2005	2010	Annual average growth rate 91→'05	Annual average growth rate 05→10
Public institutes (run by local government)	0.26	0.23	0.19	-0.89%	-4.08%
Public organizations other than public institutes	0.70	1.15	1.31	3.59%	2.52%
Total public organizations	0.96	1.38	1.49	2.61%	1.54%

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

- ○R&D expenditure during FY 2010 in the business enterprise sector in Japan was 12 trillion yen. The growth rate was almost flat at 0.22%, failing to recover from a big drop during FY 2009. Japan's ratio of R&D expenditure to GDP in the sector has been among the highest since FY 1990, but it decreased during FY 2009 and FY 2010. It was 2.51% of GDP during the most recent available 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 and Korea, while the latter accounts for a large proportion in France and Canada. France has a large percentage of both direct and indirect aid, as do both Korea and Slovenia.

(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 2010 [(6)] were 12 trillion yen, up by 0.22 %, virtually unchanged from the previous year. Recovery from the big drop in 2009 has not been made.

Examination of R&D expenditure in the business enterprise sector for selected countries with OECD purchasing power parity equivalents found that expenditure has been increasing in every country over the long term. In recent years, however, it has decreased in the U.S., Japan and the E.U. There have been no major changes in Germany, France or the U.K. China has grown rapidly since the beginning of the 2000s. It passed Japan in 2009.

Turning to annual average growth rates in each country's national currency (nominal values) (Chart 1-3-3(B)), the U.S., Germany, France and China had higher growth rates during the second half of the 2000s (2005 through the most recent available year) than during the first half (2000–2005). They were lower in all the other selected countries. Japan posted a negative growth rate during the latter half of the 2000s.

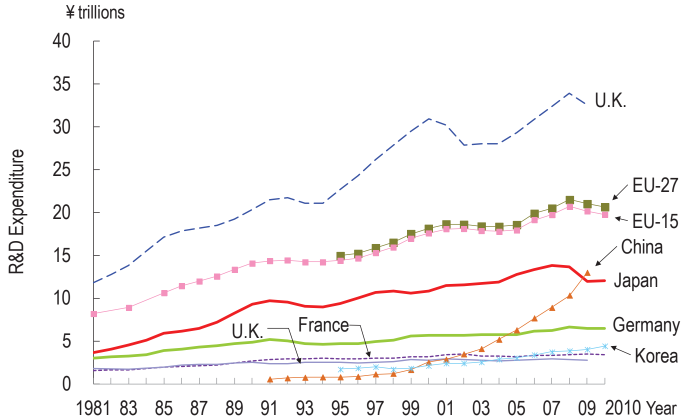
Annual average growth rates for real values (2005 base, national currency) adjusted in light of commodity price trends in each country (Chart 1-3-3(C)) show that The U.S., Germany and France had higher rates during the second half of the 2000s than during the first half.

China and Korea tended to have higher annual growth rates than the other countries, as well as smaller decreases.

Japan's growth rate was 4.65 % in the first half of the 2000s, but it declined to -0.15 % since the beginning of the second half of the 2000s.

(6) This section uses "years" for international comparison, although in the case of Japan it is originally "fiscal years."

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	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	10.9	12.0	12.0	3.25%	-1.18%
U.S. ($ billions)	200	226	282 (2009)	2.49%	5.71% (2009)
Germany (€ billions)	35.6	38.7	47.0	1.66%	3.98%
France (€ billions)	19.3	22.5	26.7	3.07%	3.47%
U.K. (£ billions)	11.5	13.7	15.6 (2009)	3.60%	3.28% (2009)
China (¥ billions)	53.7	167	425 (2009)	25.5%	26.2% (2009)
Korea (₩ trillions)	10.3	18.6	32.8	12.6%	12.1%

(C) Real values (2005 base, national currency)

National Currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
Japan (¥ trillions)	10.2	12.7	12.6	4.65%	-0.15%
U.S. ($ billions)	225	226	257 (2009)	0.07%	3.28% (2009)
Germany (€ billions)	37.5	38.7	44.9	0.58%	3.06%
France (€ billions)	21.3	22.5	24.5	1.08%	1.73%
U.K. (£ billions)	13.1	13.7	14.1 (2009)	1.00%	0.65% (2009)
China (¥ billions)	62.9	167	355 (2009)	21.6%	20.7% (2009)
Korea (₩ trillions)	11.8	18.6	29.1	9.47%	9.44%

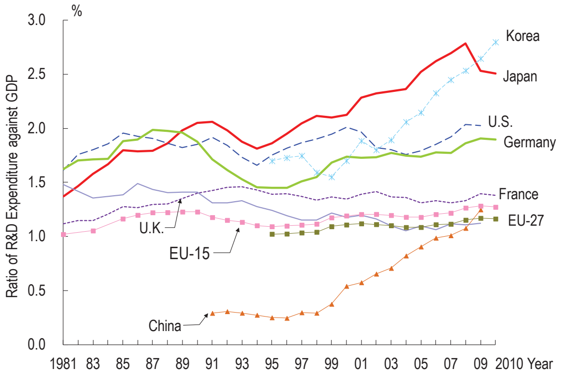
Note: 1) Refer to Chart 1-1-4 for the definition of the business enterprise sector in each country.
2) R&D expenses include the fields of social science and humanities (until 2006, only natural sciences in Korea)
3) Purchasing power parity equivalent is the same as Reference Statistics E.
4) Real values 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 2011/2"
<U.S.>NSF, "Science & Technology Indicators 2012"
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2010"; OECD, "Main Science and Technology Indicators 2011/2" since 2008
<U.K.> National Statistics website: www.statistics.gov.uk
<France, China, Korea and EU> OECD, "Main Science and Technology Indicators 2011/2"

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 declined in both 2009 and 2010. It was 2.5% of GDP in the most recent available year. Korea had maintained second position since 2002, and it surpassed Japan in 2009. In 2010, its ratio was high at 2.8%. 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



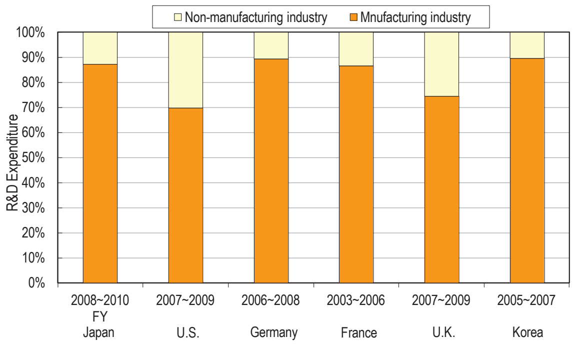
Note: 1) GDP is the same as Reference Statistics C.
2) Same as in Chart 1-3-3.
Source: Same as in Chart 1-3-3.

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

Looking at three-year averages for business sector R&D expenditure in manufacturing and non-manufacturing industries, manufacturing industries accounted for at least 90 percent of expenditure in Japan, Korea and Germany. The ratio was 80% in the U.K. and 70% in the U.S., giving them a higher proportion of R&D expenditure in non-manufacturing industries than seen in other countries (Chart 1-3-5).

Chart 1-3-5: Comparison of R&D expenditure in manufacturing industries vs. that in all industries in selected countries

Attention to international comparison



Note: 1) Since each country uses its own industrial classifications, care must be taken when making international comparisons.
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.
2) Fiscal year was used as a year scale.
<U.S.> Industrial classifications use NAICS.
<Germany> German industrial classification, 2003 edition, was used.
<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, “S&E Indicators 2010,2012”,"InfoBrife (NSF 12-309)”
<Germany> Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung und Innovation2010”
<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.

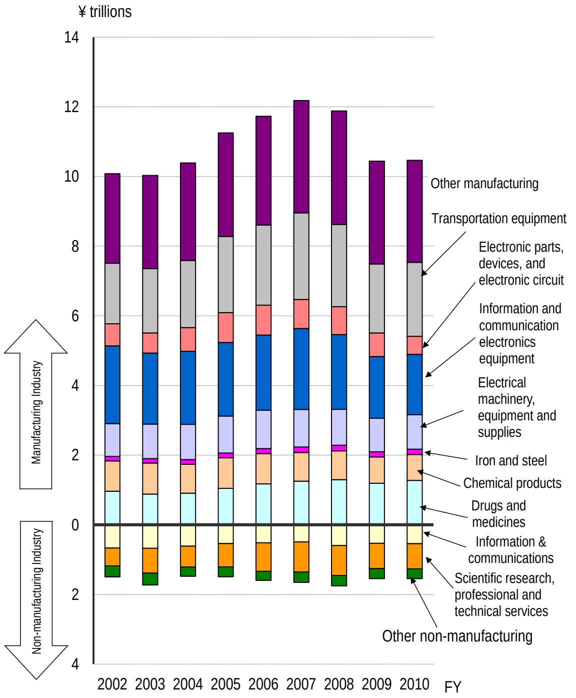
When the R&D expenditures of Japan, the U.S. and Germany are looked at in this way, in Japan the manufacturing industry accounts for a very large share and has a significant impact on the overall increase in R&D expenditures. On the other hand, no major changes were seen in R&D expenditures in non-manufacturing 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. Growth was flat during FY 2010. By type of industry, R&D expenditures fell in every industry during FY 2009. During FY 2010, the transportation equipment industry and the electrical machinery, equipment and supplies industry posted increases. Among non-manufacturing industries, the information and communications industry showed an increase.

In the U.S., non-manufacturing industries were quite large. Since 2004, however, manufacturing industries have also grown large. During 2008, figures were high for the computer, electronics, and chemical industries.

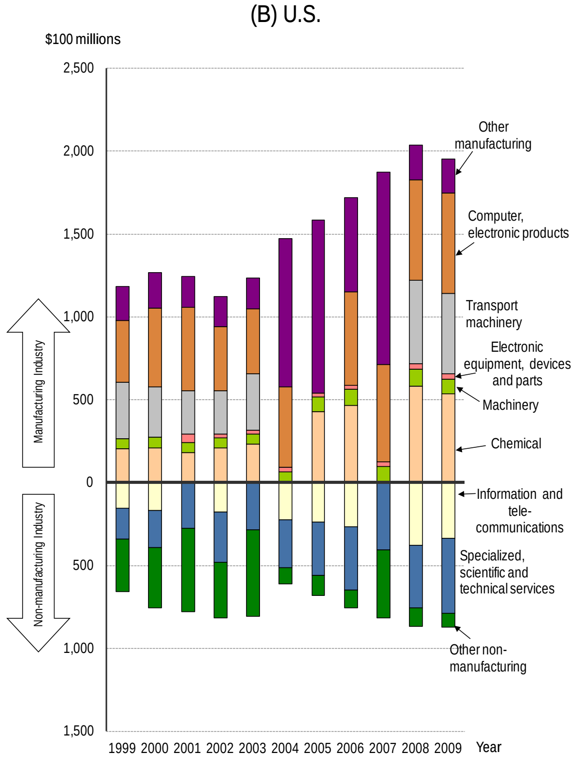
In Germany, both the manufacturing and non-manufacturing industries increased. In Germany's non-manufacturing industries, "software" and "R&D" are classed in the "real estate, leasing and business activities" category. Caution regarding such differences among countries' standard classifications is necessary.

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

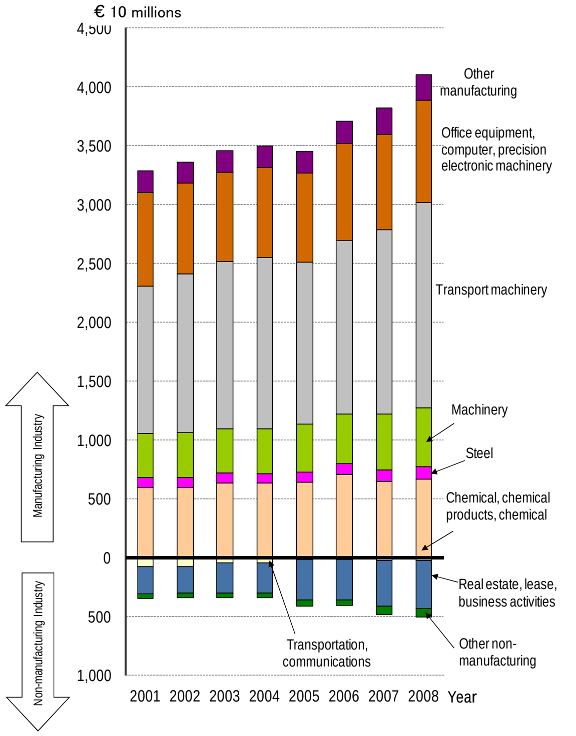
(A) Japan



(B) U.S.



(C) Germany



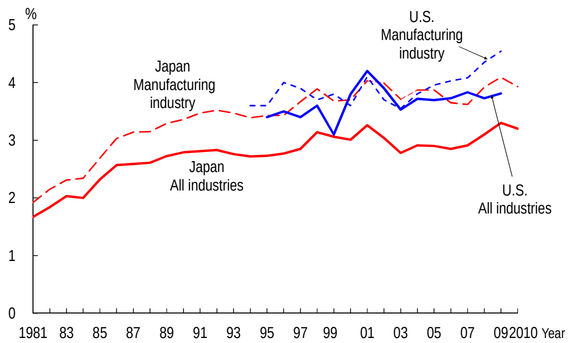
Note: See Chart 1-1-4 for definition of the business enterprise sector in each selected country.
<Japan> Industrial classification was made in accordance with the classification in the survey of research and development based on the Japan standard industry classification. In accordance with revisions of the classifications, classifications in the survey were changed in the 2002 and 2008 editions.
<U.S. >Industrial classifications are those in the NAICS. They were revised in 2003 and 2008. 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 "S&E Indicators 2012", InfoBrif (NSF 12-309)"
<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. Also in the U.S., intensity has been greater in manufacturing since 2000.

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



Note: Same as for Chart 1-3-6.
<Japan> R&D expenditure per turnover in All industries is the figure from FY2001 (All industries excluding finance and insurance industries)
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "R&D Industry"; various years, "InfoBrif (NSF 12-309)"

(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 Korea. Countries in which indirect support is large include France and Canada.

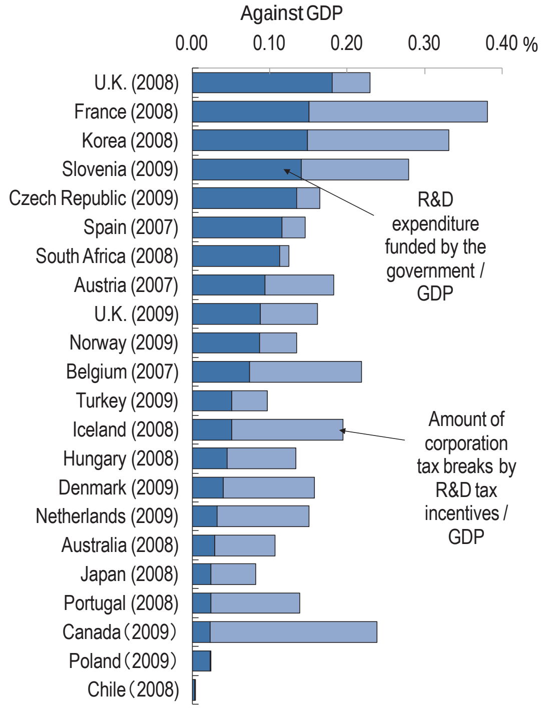
Both direct support and indirect support are large in France. This is true in Korea and Slovenia as well (Chart 1-3-8(A)).

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.

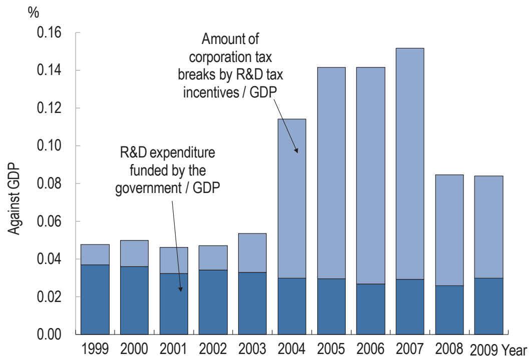
The sharp increase in indirect support in 2004 likely stems mainly from a tax credit for total experimental and research expenses that was adopted in 2003. The number of business enterprises utilizing them is thought to have increased in 2004. The decrease in 2008 is probably because of a decrease in total corporate taxes, which caused a decrease in deductions.

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

(A) Comparison of major countries



(B) Changes in Japan



Note: Values estimated by each country (in accordance with the survey for R&D tax incentives by NESTI). Preliminary budget values are also included.
Sources: OECD, "STI Scoreboard 2011," Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development," National Tax Agency, "Corporation Sample Survey"

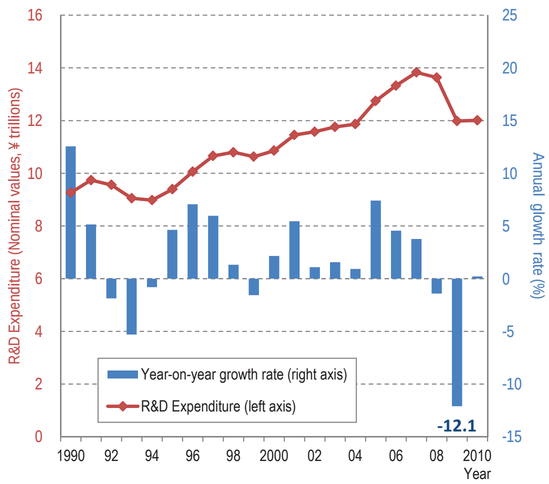
Column: R&D by Japanese businesses during the global economic crisis

R&D expenditures in the business enterprise sector in Japan and selected countries in Europe and North America declined during 2009[7] (see Chart 1-3-3 above). This is a noteworthy phenomenon, and Japan's decrease was especially large, so this column will focus mainly on Japan while providing indicators of the situation.

(1) The decrease in R&D expenditures during 2009

In Japan's business enterprise sector, R&D expenditures had been increasing since 2000. During the three years from 2005 through 2007 in particular, the average annual growth rate was above 5% (Chart 1-3-9). However, this shifted to a decline in 2008 and continued to a large year-on-year drop of 12.1% in 2009. This was an even larger decline than that which followed the collapse of the so-called bubble economy during the early 1990s. Indeed, it was the highest rate of decline since Japan began keeping R&D statistics in 1953. R&D expenditures increased slightly year-on-year in 2010, by 0.2%, but it would be difficult to call that a recovery from the 2009 decline.

Chart 1-3-9: Changes in R&D expenditures in Japan's business enterprise sector



Note: R&D expenditures are nominal values.
Sources: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

This large fall in R&D expenditures can be attributed to the impact of the global financial crisis triggered when the U.S. investment bank Lehman Brothers failed on September 15, 2008 (the so-called Lehman Shock). As shown in Chart 1-3-10, GDP growth was negative in the U.S., Germany and the U.K. in 2009, and R&D expenditures in the business enterprise sector fell. As in Japan, the worsening economic situation impacted corporate R&D.

Chart 1-3-10: Rate of year-on-year increases in statistical indicators in selected countries in 2009

	Annual GDP growth rate (%)		Annual growth rate of corporate R&D expenditures (%)	
	Nominal	Real	Nominal	Real
Japan	-3.20	-2.84	-12.11	-11.78
U.S.	-2.47	-3.49	-2.85	-3.87
Germany	-4.01	-5.13	-1.73	-2.87
France	-2.27	-2.73	2.25	1.78
U.K.	-3.50	-4.87	-2.51	-3.90
China	8.43	9.11	25.64	26.43
Korea	3.76	0.32	8.33	4.74

Note: Real value for GDP and R&D expenditures is calculated using the GDP deflator.
Sources: Same as for Chart 1-3-3. GDP is same as for Reference Statistics C. The deflator is the same as for Reference Statistics D.

Yet, among the selected countries, why was the Japanese decline so large? A variety of analyses are needed to explain this, but one likely reason is that, in Japan's case, the global drop in consumption and the rising yen heavily damaged exporters, especially in manufacturing industries, and that those industries account for a large share of corporate R&D expenditures.

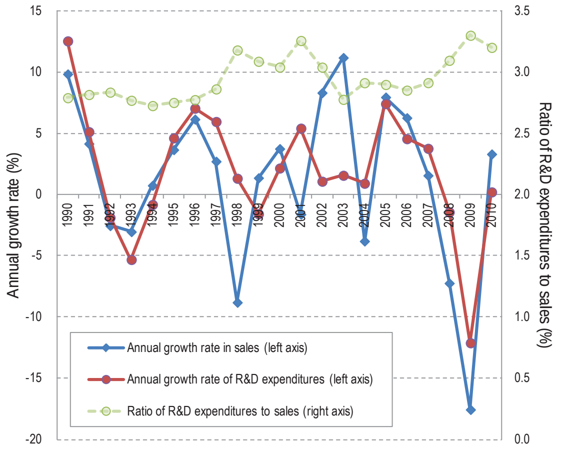
(2) The relationship between sales and R&D expenditures

Looking at changes in the R&D expenditures and sales of Japanese corporations (Chart 1-3-11), when sales declined, R&D expenditures usually declined also. There is an overall link between the two factors. This confirms that the 2009 decline in R&D expenditures was linked to the large drop in sales.

As for the ratio of R&D expenditures to sales, 2009 marked the highest level. The ratio of R&D expenditures to sales can be interpreted as an index of corporate commitment to R&D. In that sense, one may say that the commitment of Japanese corporations to R&D did not decline in 2009.

(7) According to FY 2009 amounts. In this column, Japanese monetary amounts will be based on fiscal year data, but will be referred to as "years" for comparison with personnel data, U.S. data, etc.

Chart 1-3-11: Year-on-year growth rate in sales and R&D expenditures in the Japanese business enterprise sector, and ratio of R&D expenditures to sales



Note: R&D expenditures and sales are both nominal values and based on figures of businesses engaged in R&D (excluding finance and insurance industries),
Sources: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

(3) What did corporations cut in 2009?

Looking at a breakdown by category of the cuts to R&D expenditures by Japanese corporations in 2009 (Chart 1-3-12), of the -12.1% decline, "Other expenditure" and "Materials" made a major contribution. Those two categories totaled -8.34%. On the other hand, the decline in "Labour costs," which accounts for a large percentage of total R&D expenditures, was relatively small at -1.95%.

Chart 1-3-12: Breakdown of rate of year-on-year change in R&D expenditures in Japan's business enterprise sector in 2009

R&D expenditure items	Rate of year-on-year change (%)
Labour costs	-1.95
Materials	-3.86
Expenditures on tangible fixed assets	-1.66
Lease fee	-0.15
Other expenditure	-4.48
Total	-12.11

Note: based on nominal value of R&D expenditures.
Sources: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development "

Year-on-year growth rates in statistical data other than R&D expenditures were almost universally negative in 2009 (Chart 1-3-13). However, of researchers, only the number of "People engaged mainly in research" increased slightly, by 0.1%. Research personnel and R&D expenditures cannot easily be compared, but these data suggest that although Japanese corporate R&D expenditures contracted overall, the contraction did not extend to a cut in the number of core researchers.

Chart 1-3-13: Year-on-year growth rates of R&D statistical indicators in Japan's business enterprise sector in 2009

R&D statistical variables	Year-on-year growth rate (%)
R&D expenditures	-12.1
No. of businesses engaged in R&D	-17.8
No. of employees of businesses engaged in R&D	-3.3
Gross sales of businesses engaged in R&D	-17.6
No. of people engaged in research (actual no.)	
Researchers	-0.9
People engaged mainly in research	0.1
People engaged partly in research	-7.8
Research support personnel	-4.8
Technicians	-7.5
Research office staff and related personnel	-2.5

Note: 1) Gross sales are value for corporations, not including the finance and insurance industries.
2) Of researchers, "People engaged mainly in research" are those who work full-time on research, and "People engaged partly in research" are those who carry out research while performing other work.
Sources: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

(4) Conclusion

During the worsening economic climate of 2009, Japanese corporations carried out unprecedented cuts to R&D expenditures. However, since the ratio of R&D expenditures to sales remained at a high level, overall corporations appear to have maintained their stance emphasizing R&D. Moreover, of R&D expenditures, items that can easily be temporarily contracted were cut, indicating that most of the corporations cutting R&D expenditures probably considered them temporary, at least in 2009.

Subsequently, events likely to impact corporations occurred, including the March 2011 Great East Japan Earthquake, the European financial/debt crisis and the soaring yen. The impacts of those events may appear in the statistical data. If the economy remains in the doldrums for some time, further cuts to corporate R&D may become inevitable. The situation will bear careful watching.

(Hiroyuki Tomizawa)

1.3.3 R&D expenditure in the university and college sector

Key points

- ○R&D expenditure in the university and college sector in Japan during FY 2010 was 3.4 trillion yen, a year-on-year decrease of 3.3%. R&D expenditure by universities and colleges in Japan was 2.1 trillion in FY 2009 (OECD estimate).
- ○With regard to the average annual growth rate of R&D expenditure by real value (2005 base, national currency), Japan, the U.S. and the U.K. showed a lower rise in the second half of the 2000s (2005 through the most recent available year) than in the first half of that decade (2000–2005).
- ○Looking at the most recent three-year average for the share of university and college R&D expenditure covered by governments, France is highest at 89.9%, while Japan is lowest at 49.5%. Compared with 2003–2005, Korea showed the largest increase, while the U.S. showed the largest decrease.
- ○As for the most recent three-year average for the share of university and college R&D expenditures borne by businesses in the selected countries, China was well ahead of the pack at 34.7%. France had the lowest share at 1.9%. Japan was the next lowest, at 2.6%. Germany showed the largest increase compared with 2003–2005, while Korea showed the largest decrease.
- ○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[8]. 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[9] 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)”.

(8)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.

(9) 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 [(10)], 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 1-3-14(A) shows the nominal values of R&D expenditure in the university and college sector. The figure for Japan in 2010 was 3.4340 trillion yen, a year-on-year decrease of 3.3%. R&D expenditure by universities and colleges in Japan was 2.1212 trillion yen in 2009 (OECD estimate).

With regard to other countries, the rise in the U.S. and the EU was remarkable.

Among E.U. countries, in Germany, France and the U.K., where R&D expenditure is large, the amount has gradually increased over the long term. R&D expenditure has steadily increased in China since 2000.

Turning next to the average annual growth rate (nominal values) of R&D expenditure by country in each country's national currency (Chart 1-3-14(B)), countries in which it was lower during the second half of the 2000s (2005 through the most recent available year) than during the first half (2000–2005) were Japan, the U.S., the U.K. and China. Countries with higher growth rates during the second half of the 2000s than in the first half were Germany, France and Korea.

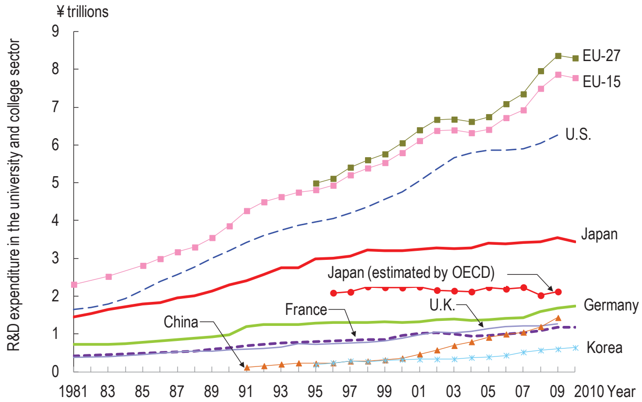
Looking at real values in light of prices (Chart 1-3-14(C)), countries with lower growth rates in the second half of the 2000s than in the first half were Japan, the U.S. and China. Countries with higher growth rates during the second half of the 2000s were Germany, France and Korea. China's average annual growth rate was high, but it decreased during the second half of the decade in both nominal and real terms.

(10) This section uses "years" for international comparison, although in the case of Japan it is originally "fiscal years."

Chart 1-3-14: Trend of R&D expenditure in the university and college sector for selected countries

Attention to international comparison

(A) Nominal values (OECD purchasing power equivalent)



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

National Currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
[Japan (¥ trillions)	3.21	3.55	3.43	1.21%	0.16%]
Japan (OECD) (¥ trillions)	2.22	2.23	2.12 (2009)	0.10%	-1.30% (2009)
U.S. ($ billions)	30.7	45.2	54.4 (2009)	8.04%	4.74% (2009)
Germany (€ billions)	8.15	9.22	12.6	2.51%	6.44%
France (€ billions)	5.80	6.82	9.30	3.28%	6.39%
U.K. (£ billions)	3.69	5.58	7.23 (2009)	8.62%	6.68% (2009)
China (¥ billions)	7.67	24.2	46.8 (2009)	25.9%	17.9% (2009)
Korea (₩ trillions)	1.56	2.40	4.75	8.96%	14.6%

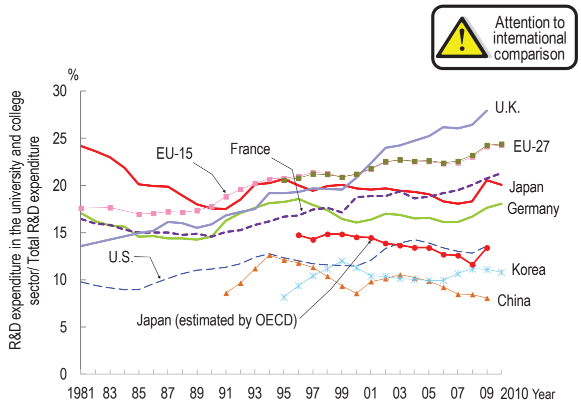
(C) Real values (2000 base; national currency of each country)

National Currency	2000	2005	2010	Annual average growth rate '00→'05	Annual average growth rate '05→'10
[Japan (¥ trillions)	3.00	3.41	3.62	2.58%	1.20%]
Japan (OECD) (¥ trillions)	2.08	2.23	2.19 (2009)	1.46%	-0.55% (2009)
U.S. ($ billions)	34.6	45.2	49.6 (2009)	5.48%	2.34% (2009)
Germany (€ billions)	8.59	9.22	12.1	1.43%	5.50%
France (€ billions)	6.40	6.82	8.54	1.29%	4.60%
U.K. (£ billions)	4.19	5.58	6.52 (2009)	4.81%	2.88% (2009)
China (¥ billions)	8.98	24.2	39.1 (2009)	22.0%	12.7% (2009)
Korea (₩ trillions)	1.80	2.40	4.22	5.92%	11.9%

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) R&D expenses include the fields of social science and humanities (for Korea, only natural sciences until 2006)
<Japan (estimated by OECD)> Since 1996, values corrected 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

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 1-3-15. 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.) In 2010, however, there was a decrease of 0.5 percentage points, to 20.1%. 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 has likely been influenced by a rise in R&D expenditure in the university and college sector and a fall in that in the public sector. In the U.S. and Germany, the ratio has repeatedly gone up and down over the long term but recently has been flat.

Chart 1-3-15: 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 1-3-16 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 most recent three-year average for the share of university and college R&D expenditure covered by different sectors (Charts 1-13-16(A), (i), (ii)), France had the highest share covered by government at 89.9%, while Japan had the lowest at 49.5%. Compared with 2003–2005, Korea showed the largest increase, while the U.S. showed the largest decrease. As for the most recent three-year average for the share borne by businesses in the selected countries, China was well ahead of the pack at 34.7%. France had the lowest share at 1.9%. Germany showed the largest increase compared with 2003–2005, while Korea showed the largest decrease.

By country, during 2008–2010 the share of costs borne by the Japanese government was 49.5%, while that borne by business enterprises was 2.6%. Compared with 2003–2005, the government share decreased by 0.8 percentage points, while the business enterprise share decreased by 0.2 percentage points.

In the U.S., the government’s share of the cost for all universities and colleges was 65.6% during 2007–2009, while the business enterprise sector’s share was 5.8%. This was a 3.6 percentage point decrease for government and a 0.7 percentage point increase for business compared with 2003–2005.

In Germany, government and non-profit institution bear large percentages of the costs. In 2005–2007, they accounted for 81.3% of the whole. The business enterprise sector also accounts for a large share relative to the other countries at 14.6%. Compared with 2003–2005, the share borne by government and non-profit institutions fell by 2.4 percentage points, while that of business enterprises rose by 1.3 percentage points.

The government’s share in France is also large. During 2008–2010, it accounted for 89.9%, 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 0.8 percentage points, and the business enterprise share decreased by 0.1 percentage points compared with 2003–2005.

In the U.K., government’s percentage of costs is large as well, at 68.4% in 2007–2009. The business enterprise share is 4.3%. Compared with 2003–2005, the government share of costs rose 0.2 percentage points, while the business enterprise share fell 0.5 percentage points.

In China during 2008–2010, the government's share of the costs was 58.2%, while that borne by business enterprises was 34.7%, the highest among the selected countries. Compared with 2003–2005, the government share increased by 3.6 percentage points, while the business enterprise share decreased by 1.9 percentage points.

In Korea during 2008–2010, the government's share was 79.1%, while that of business was 11.5%. Compared with 2003–2005, the government share rose rapidly, by 6.3 percentage points. In contrast, the business share fell by 1.9 percentage points.

Next, the percentage of R&D expenditure by the government and business enterprise sectors that goes to universities and colleges is examined (Chart 1-3-16(A), (iii), (iv)).

The highest share of government R&D expenditures that go to the university and college sector is 58.5%, in the U.K. In Japan, Germany and France, the figure is about 50%. About 30% goes to universities and colleges in the U.S. and Korea. China has the smallest percentage, at 20.4%. Only a small percentage of the business enterprise sector’s R&D expenditures go to universities and colleges in any of the selected countries. China and Germany have relatively large percentages at about 4.0%. In contrast, Japan, the U.S. and France are around 1%.

Comparing 2003–2005 to the most recent available year, with a 6.1 percentage point increase, the U.K. had the largest increase in the share of government R&D expenditure that went to universities and colleges. On the other hand, there was little if any growth from the business enterprise sector in any country. As shown in Charts 1-3-16(B)–(G), the share borne by foreign countries was small. The largest share, 9.4%, was in the U.K.

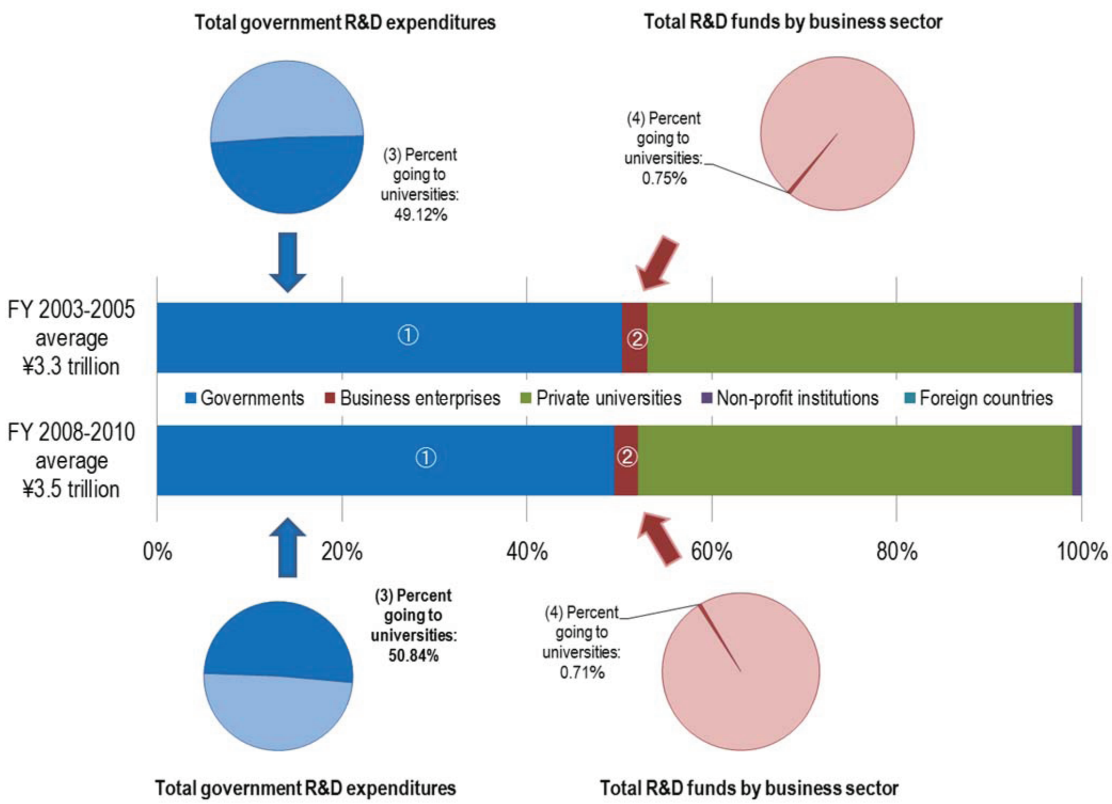
Chart 1-3-16: Changes in the cost-sharing structure for universities and colleges research funding in selected countries

Attention to international comparison

(A) Table

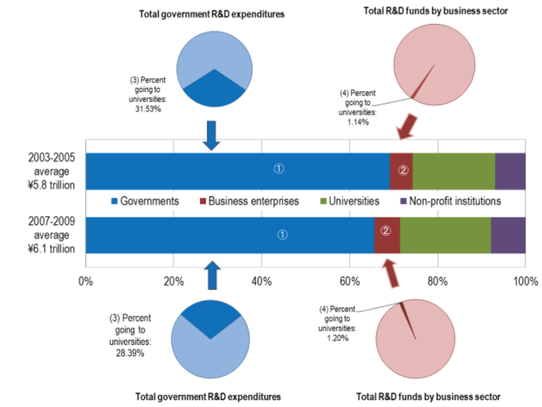
Country / Most recent year (3-year average)	Total university research expenditures (OECD purchasing power	Break down of university research expenditures: (1) Percentage received from government	Change from 2003–2005	(2) Percentage received from business sector	Change from 2003–2005	(3) Percentage of total government R&D expenditures going to universities	Change from 2003–2005	(4) Percentage of total business sector R&D expenditures going to	Change from 2003–2005
Japan '08-10	¥3.5 trillion	49.5%	△0.8%	2.6%	△0.2%	50.8%	1.7%	0.7%	0.0%
Japan (OECD) '07-09	¥2.1 trillion	52.0%	1.1%	2.9%	0.0%	40.0%	1.0%	0.5%	0.0%
U.S. '07-09	¥6.1 trillion	65.6%	△3.6%	5.8%	0.7%	28.4%	△3.1%	1.2%	0.1%
Germany '07-09	¥1.6 trillion	81.3%	△2.4%	14.6%	1.3%	47.8%	1.4%	3.7%	0.3%
France '08-10	¥1.1 trillion	89.9%	△0.8%	1.9%	△0.1%	47.6%	3.3%	0.8%	0.0%
U.K. '07-09	¥1.2 trillion	68.4%	0.2%	4.3%	△0.5%	58.5%	6.1%	2.5%	△0.2%
China '08-10	¥1.4 trillion	58.2%	3.6%	34.7%	△1.9%	20.4%	0.2%	4.0%	△1.7%
Korea '08-10	¥0.6 trillion	79.1%	6.3%	11.5%	△3.5%	32.7%	1.4%	1.8%	△0.3%

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

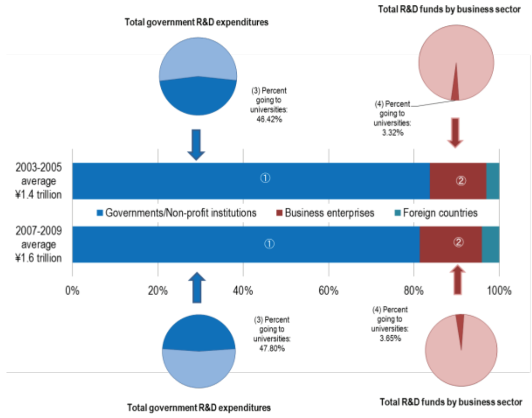


For the Japanese statistics, of R&D expenditures used at universities and colleges, the share of costs borne by universities and colleges refers to funding by private universities and colleges. Most of that is R&D expenditures self-funded by the private universities and colleges.

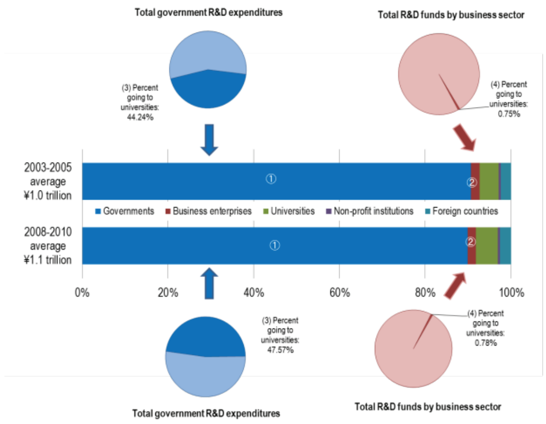
(C) Cost-sharing structure for universities and colleges R&D expenditures in the U.S.



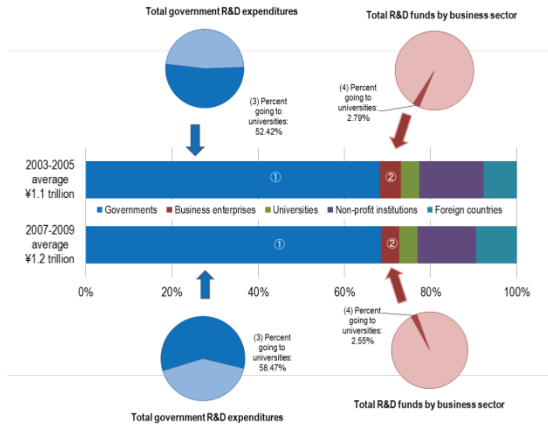
(D) Cost-sharing structure for universities and colleges R&D expenditures in Germany



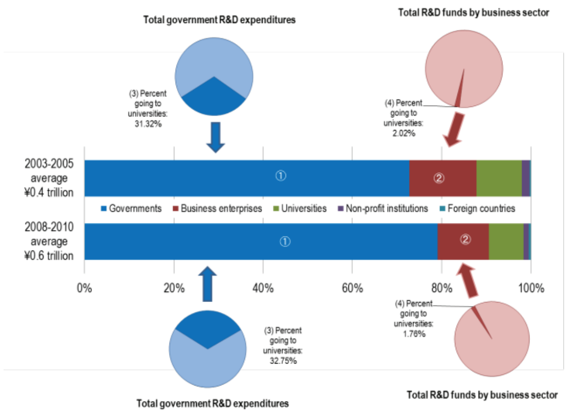
(E) Cost-sharing structure for universities and colleges R&D expenditures in France



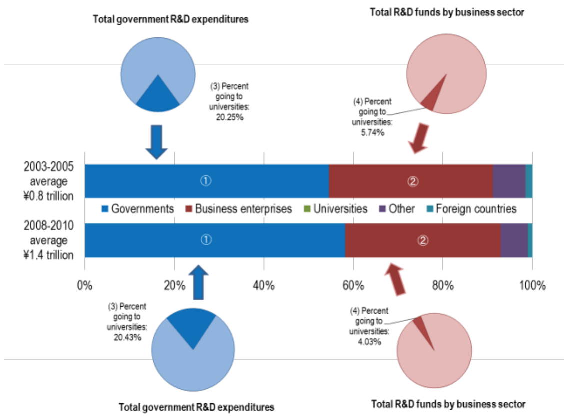
(F) Cost-sharing structure for universities and colleges R&D expenditures in the U.K.



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



(H) Cost sharing structure for universities and colleges R&D expenditures in China



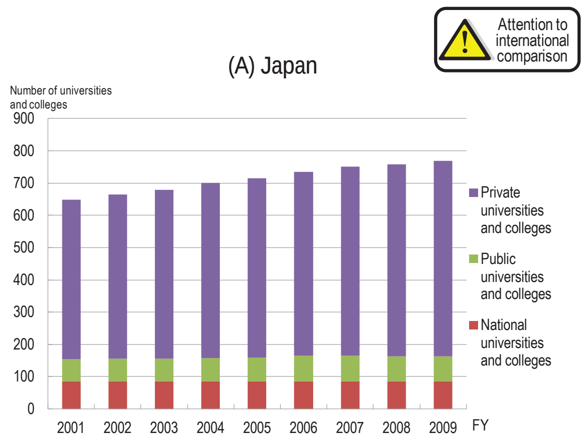
Note: 1)Three-year averages are used. For example, 2008–2010 refers to the average value for the years 2008 through 2010
2)Numbers by the arrows refer to the percentage of funds from each sector's R&D expenditures going to the university and college sector. For example, during FY 2008–2010 in Japan, of costs borne by government, 50.84% 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.

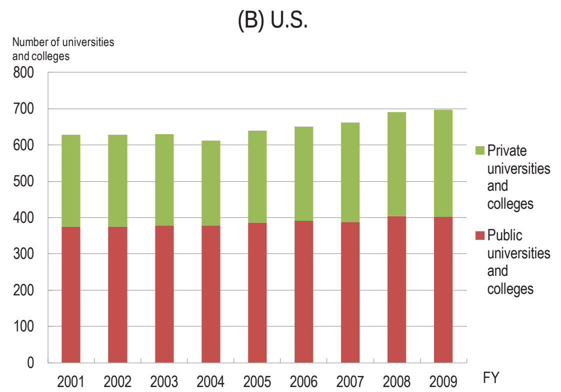
(3) Funding structure for universities and colleges R&D expenditures by form of institution in Japan and the U.S.

Chart 1-3-17 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 607 private universities. Looking at trends, the number of private universities is increasing. In the U.S., there are 403 state universities and 294 private universities. The number of private universities is increasing.

Chart 1-3-17: 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.

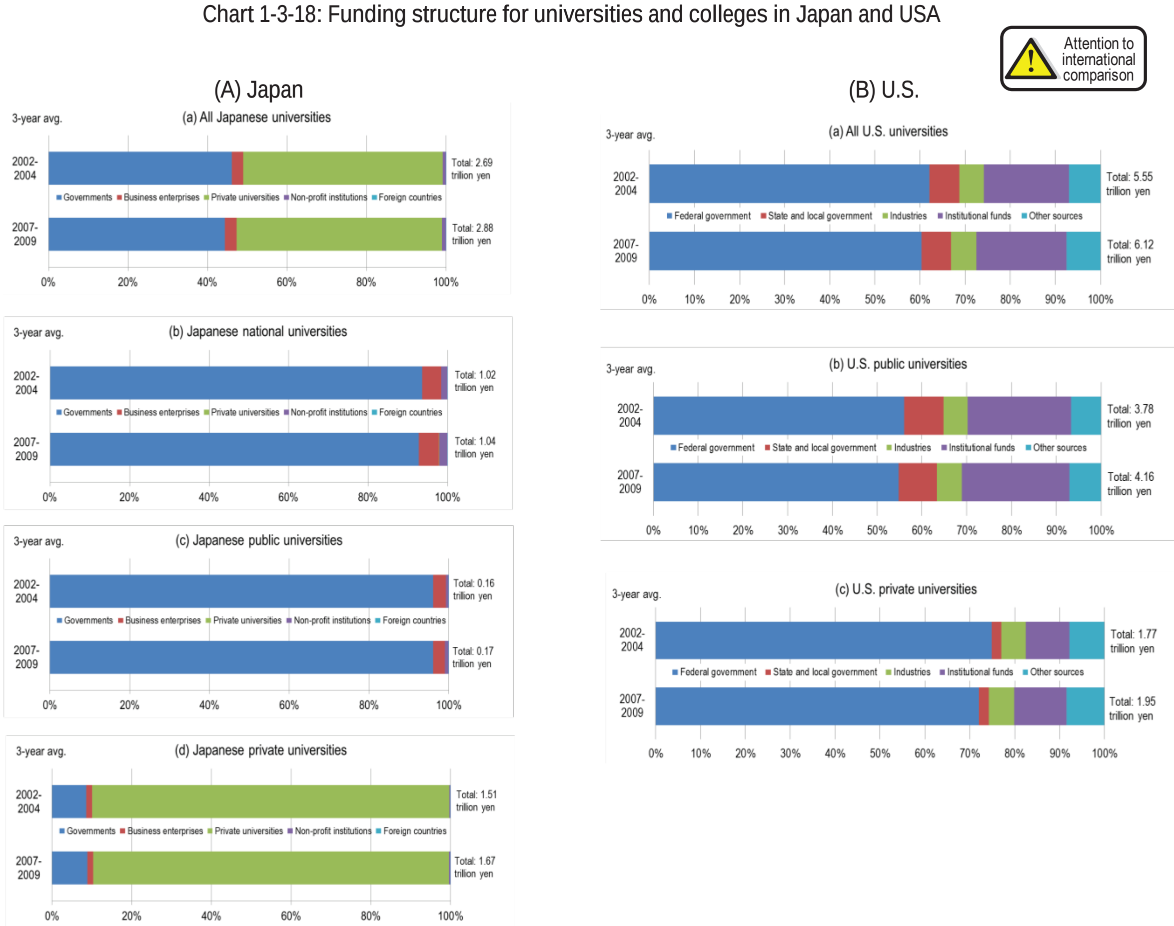
Chart 1-3-18(A) shows the funding structures for Japanese universities (four-year universities) according to type, i.e., national, public and private universities. At national and public universities, more than 90 % of funding comes from government. Little funding comes from business enterprises or other sectors.

Looking at the share for national universities in 2007–2009, government funding accounted for 92.7% of funding. This was almost unchanged, a decrease of only 0.8 percentage points from 2002–2004. There was little funding from the business enterprise sector, which accounted for only 5.1%. As for private universities in 2007–2009, 89.3% of funding for R&D expenditures came from private universities, indicating that their R&D is mostly self-funded. Funds from government accounted for 8.9% during 2007–2009, an increase of 0.3 percentage points from 2002–2004. At 1.4%, there was even less funding from the business enterprise sector than there was for national universities.

Chart 1-3-18(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, 63.4% at public universities and colleges and 74.3% 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 (23.9%) than at private universities and colleges (11.7%).

Chart 1-3-18: Funding structure for universities and colleges in Japan and USA



Note: See Chart 1-3-16 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”

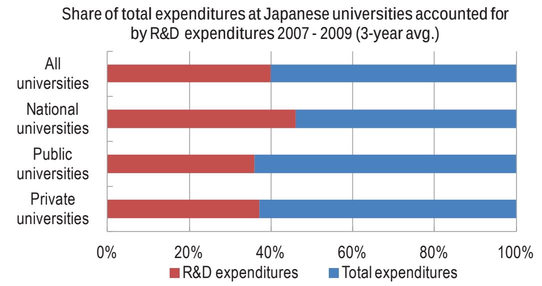
(4) Comparison of share of R&D expenditures in total operating costs at Japanese and U.S. universities and colleges

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 2007 through 2009 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 1-3-19, R&D expenditures accounted for 39.9% of total expenditures at all universities. By type of university, the highest share was at national universities with 46.1%, while public universities are at 36% and private universities at 37.2%.

Chart 1-3-19: Share of total expenditures at Japanese universities accounted for by R&D expenditures

(A) Percentage



(B) Amount

2007-2009 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥7.2 trillion	¥2.9 trillion	39.9%
National universities	¥2.3 trillion	¥1.0 trillion	46.1%
Public universities	¥0.5 trillion	¥0.2 trillion	36.0%
Private universities	¥4.5 trillion	¥1.7 trillion	37.2%

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”

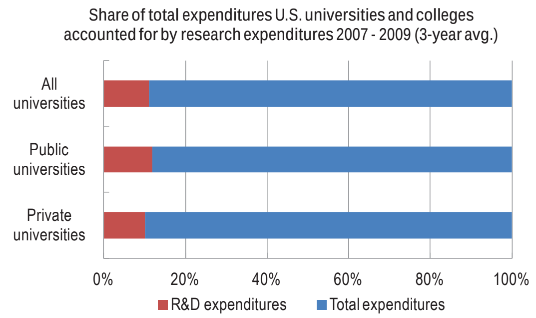
In the case of the U.S., the NSF's R&D statistics do not include total operating costs (total expenditures) at universities and colleges, so National Center for Education Statistics (NCES) IPEDS data was used. IPEDS is a database on postsecondary education (including higher education) in the U.S. It 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 1-3-20, 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 1-3-20: Share of total expenditures at U.S. universities and colleges accounted for by research expenditures (IPEDS data)

(A) Percentage



(B) Amount

2007-2009 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥44.4 trillion	¥5.0 trillion	11.2%
Public universities	¥26.3 trillion	¥3.1 trillion	11.9%
Private universities	¥18.3 trillion	¥1.8 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.

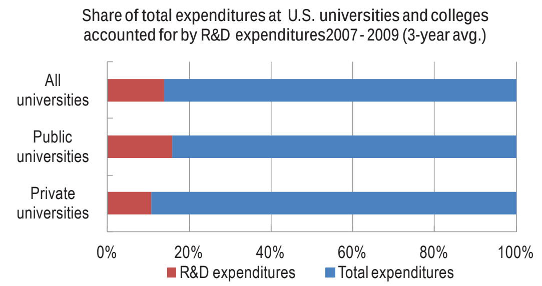
The NSF's R&D statistics cover universities and colleges with annual R&D expenditures of at least 150,000 dollars. There are a little under 700 such universities and colleges in the U.S. The NSF total is still about 1 trillion yen higher than for IPEDS' research expenditures, which cover about 2,780 universities and colleges (including about 678 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 1-3-21 in this case, the share of total expenditures at all universities and colleges accounted for by R&D expenditures is 13.8%. By type of institution, the share is 15.9% at public universities and colleges and 10.7% 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 1-3-21: Share of total expenditures at U.S. universities and colleges accounted for by R&D expenditures (NSF data)

(A) Percentage



(B) Amount

2007-2009 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥44.4 trillion	¥6.1 trillion	13.8%
Public universities	¥26.3 trillion	¥4.2 trillion	15.9%
Private universities	¥18.3 trillion	¥2.0 trillion	10.7%

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 1-3-22).

Chart 1-3-22: 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"

(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 1-3-23).

R&D expenditure for the entire university and college sector in Japan in FY 2010 was approximately 3,434.0 billion yen, which was composed of approximately 2,183.8 billion yen for the field of natural sciences and engineering and approximately 1,250.2 billion yen for the field of social sciences and humanities, respectively.

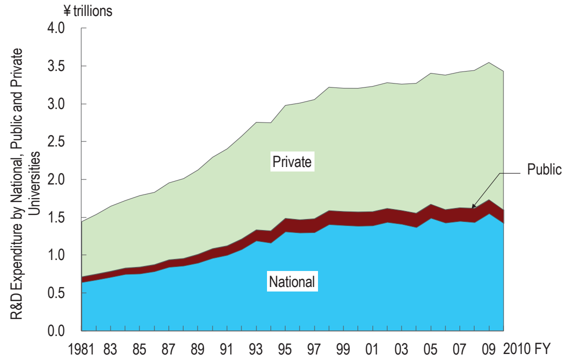
Compared to the previous year, there was an overall decline of 3.3%. The drop was larger in the natural sciences, where expenditure fell by 4.6%, versus 0.8% in the humanities and social sciences.

The shares of R&D expenditure by type of university versus the total in FY 2010 were 41.1% for national, 5.2% for public and 53.4% for private universities. Looking only at the field of natural sciences and engineering, the figures were 53.6% for national, 5.8% for public and 40.6% for private universities. For the field of social sciences and humanities, the shares were 20.2% in national, 4.1% for public and 75.7% for private universities.

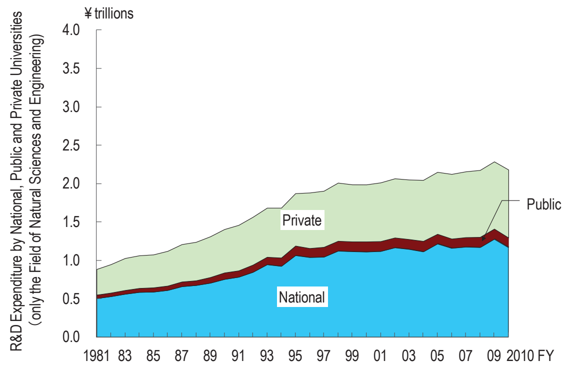
In summary, it was found that national universities accounted for large proportion of R&D expenditure in the field of natural sciences and engineering (natural sciences, engineering, agricultural sciences, medical sciences). On the other hand, private universities accounted for large proportion of R&D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

Chart 1-3-23: R&D expenditure by national, public and private universities

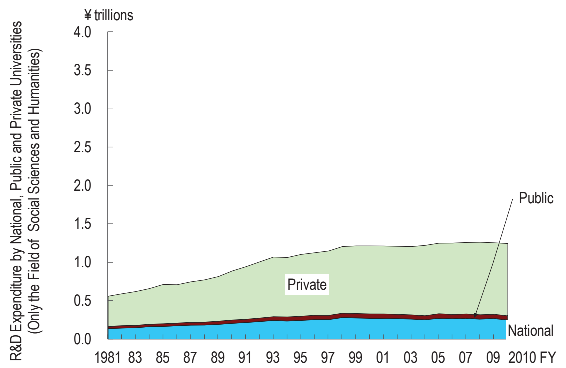
(A) All fields



(B) Field of natural sciences and engineering



(C) Field of social sciences and humanities



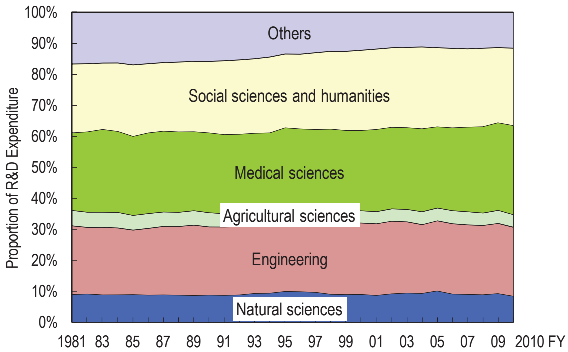
Note: "Social sciences and humanities" includes "Other."
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

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 1-3-24 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.

Over the long term, however, the shares of natural sciences, engineering and agricultural sciences are declining, while those of medical sciences and social science and humanities are increasing.

Chart 1-3-24: Trend of the proportion of R&D expenditure by field of study in universities and colleges

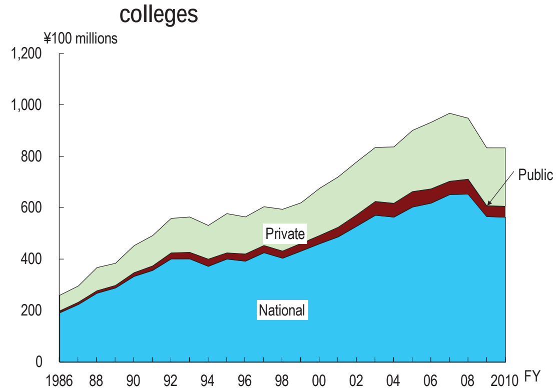


Note: Classification into the field of study represents a classification into the element of the organization, such as the faculty.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

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 1-3-25). R&D expenditures received by universities and colleges from the business enterprise sector showed a sharp increase beginning in FY 1999, but peaked in FY 2007 and began falling. In FY 2010, they were 83.2 billion yen. During that year, they accounted for only 2.4% of the total intramural R&D expenditure of universities (approximately 3.433 trillion 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 1-3-25: 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"

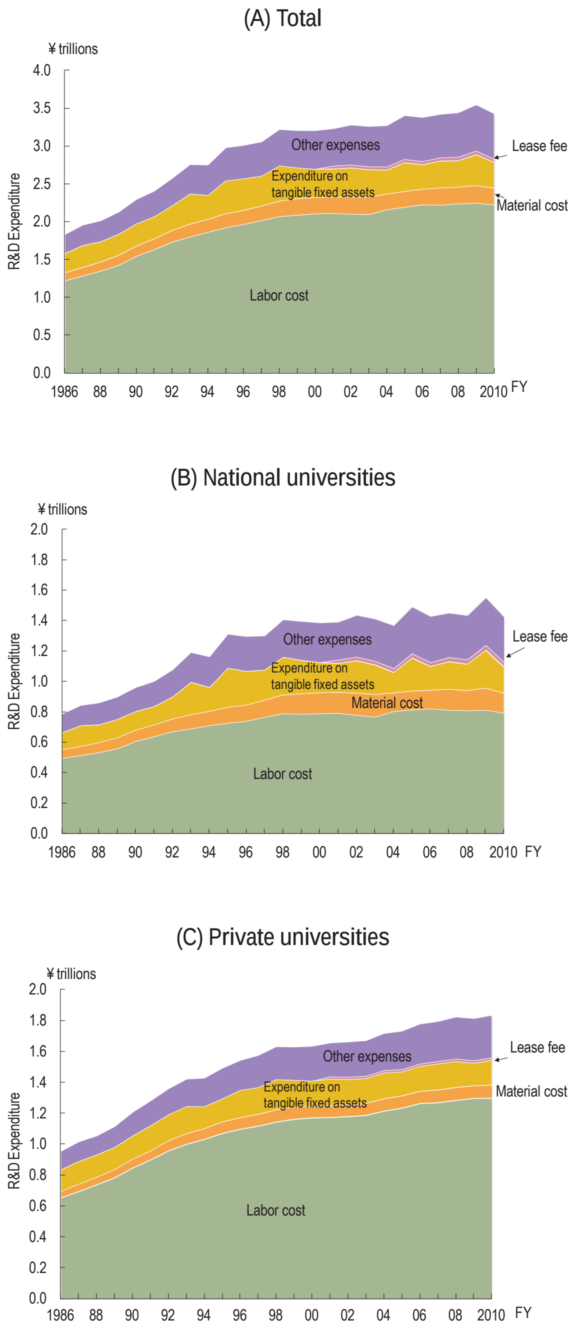
(6) R&D expenditure by item of expense in the university and college sector for Japan

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 2010 was approximately 2,221.8 billion yen at 64.7% of the total (Chart 1-3-26).

Comparing national and private universities, labor costs in FY 2010 at national universities were 792.4 billion yen. The growth rate has been flat since the beginning of the 2000s. This was about 55.7% of total R&D expenditures. Over the long term, the percentage has been decreasing.

Labor costs in FY 2010 at private universities continued to increase, reaching 1.2986 trillion yen. They account for 70.8% of total R&D expenditures. Over the long term, the percentage has been gradually increasing.

Chart 1-3-26: R&D expenditure by item of expense in universities and colleges



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 2010 for Japan, the proportion of that for basic research was 14.7%, and a large proportion, or 49.7%, 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 26%. 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 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(11) measures only the field of natural science and engineering, not total R&D expenditures. The same was true of Korea through 2006, but since 2007, all fields have been covered.

Chart 1-4-1 shows the proportion of development by type of R&D. Basic research accounted for 14.7% of all R&D expenditures by type in Japan during FY 2010(12). Over the long term, there has been little change.

U.S. ratios for basic research, applied research, and development are similar to those of Japan. Over the long term, there has been an increase in the ratio of basic research.

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(11) 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.
(12)This section uses "years" for international comparison, although in the case of Japan it is originally "fiscal years."

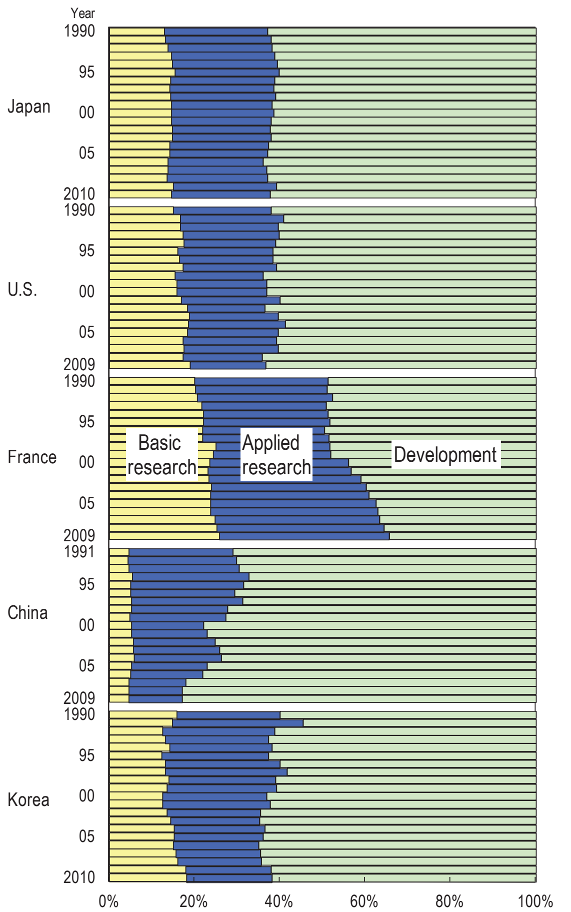
In France, basic research accounts for the largest share at 26% for the most recent available year. The ratio of development, on the other hand, has been declining.

In China, basic research accounts for a small share at 4.7%. On the other hand, development accounts for a large and increasing share.

In Korea, the percentage accounted for by basic research has been growing since 2000. The share of applied research has been shrinking, as has that of development in recent years.

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: 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 that for the field of natural sciences and engineering and for social sciences and humanities. Therefore it is necessary to be careful when an international comparison is being made.

<Japan> Fiscal year is used as a year scale.

<U.S.> R&D expenditures by type do not add up to total R&D expenditures for 1998 and 1999.

Source: <Japan> The Ministry of Internal affairs and communications, "Report on the Survey of Research and Development".
<U.S.> NSF, "Science and Engineering Indicators 2012"
<France, China> OECD, "Research & Development Statistics 2010"
<Korea> National Science and Technology Information Service (website)

1.4.2 Basic research in each country

Next, we examine which sector is in charge of basic research in each country. Basic research provides low return on investment over the short term, but it builds intellectual capital in science and technology and is important in constructing foundations for the future.

Looking at the trend of the proportion of basic research expenditure by performing sector (Chart 1-4-2), the universities and colleges sector accounts for a large percentage in almost all the selected countries.

In Japan, the university and college sector accounted for a large share during the most recent available year, at 49.7%. The business enterprise sector also accounts for a relatively large share.

In the U.S., the percentage accounted for by the university and college sector is large. Over the long term, the shares of the university and college sector and the non-profit institution sector have been increasing. The shares accounted for by the business enterprise sector and the public sector, on the other hand, have been decreasing.

The university and college sector accounts for a large share of basic research expenditure in France. At 67.3% during the most recent available year, it was the highest of any of the selected countries. In the case of French data for the public organization sector, discrepancies were found in 1998 and 1999. This was caused by a change in the method for estimating and a change in survey response slips. The continuity of data during this period should be regarded as interrupted.

In China, the public organization sector had accounted for the largest share, but the university and college sector's share has increased in recent years. During the most recent available year, the latter sector accounted for a 53.8% share.

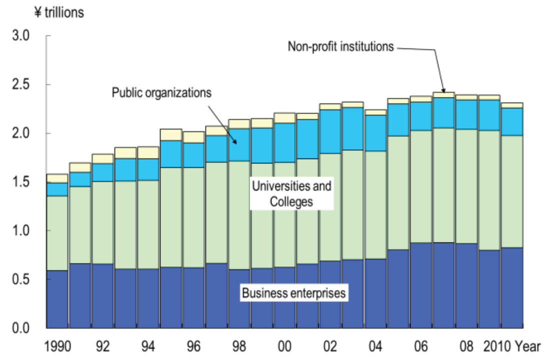
Even higher is Korea, where the business enterprise sector's share of basic research has increased rapidly, making it the leading sector.

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

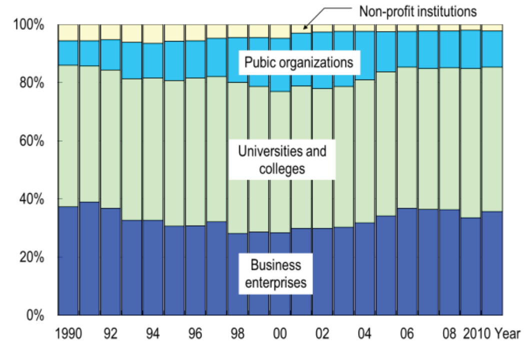
Attention to international comparison

(A) Japan

Expenditure (Yen PPP)

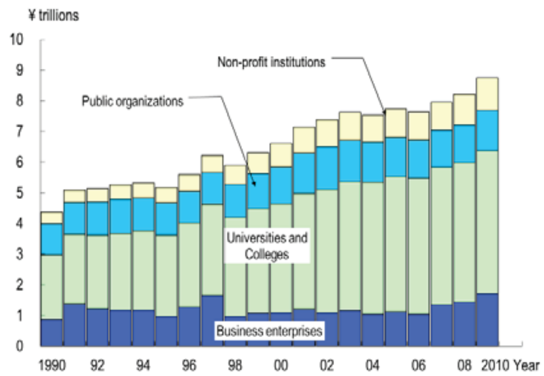


Proportion of expenditure by sector

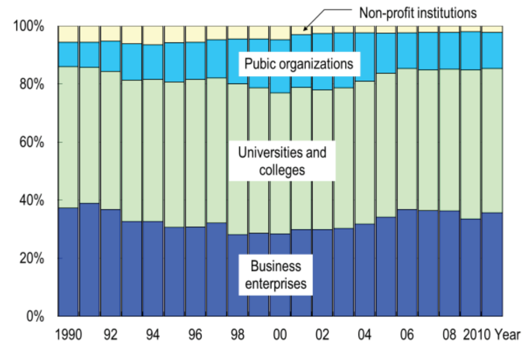


(B) U.S.

Expenditure (Yen PPP)

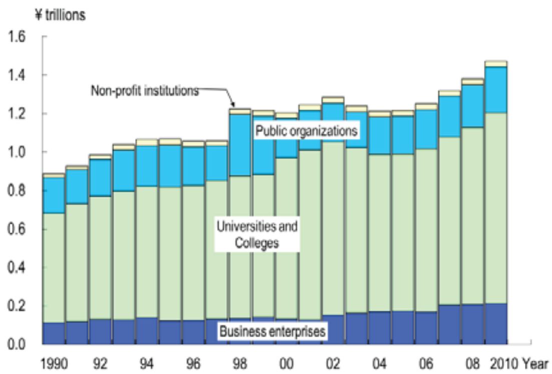


Proportion of expenditure by sector

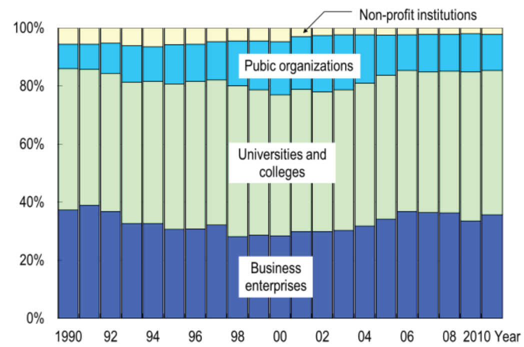


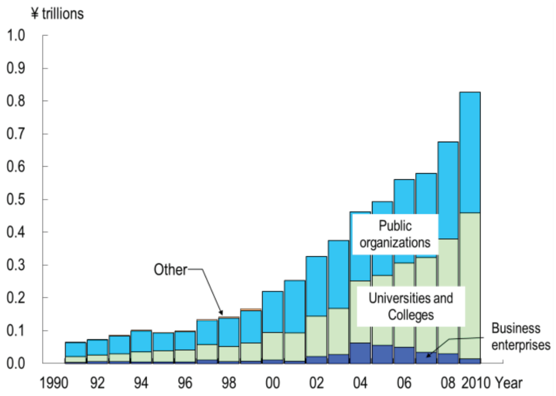
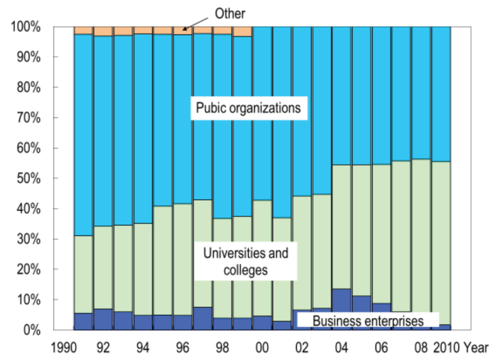
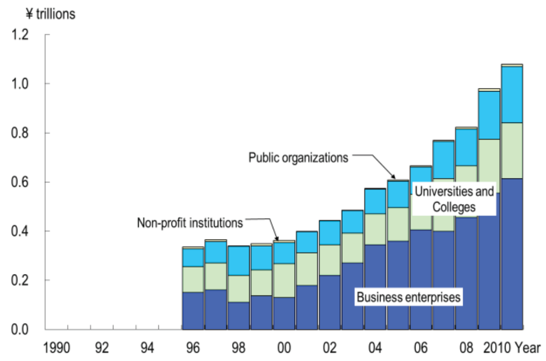
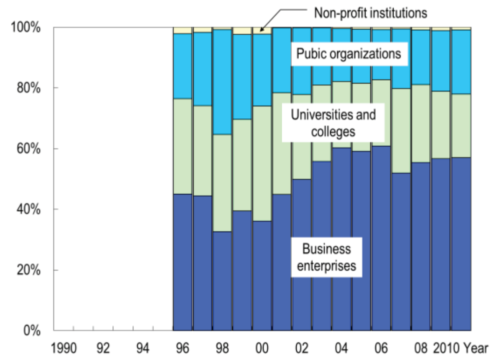
(C) France

Expenditure (Yen PPP)



Proportion of expenditure by sector



	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.

Source: <Japan> The Ministry of Internal Affairs and Communications. "Report on the Survey of Research and Development"
<U.S.> NSF, "Science and Engineering Indicators 2012"
<France, China and Korea> OECD, "Research & Development Statistics 2011"

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

○In 2011, the number of researchers in Japan was about 660,000 when the number of researchers working at universities and colleges is calculated using the FTE method. Using the head count method, the number was about 890,000.

○The number of researchers in China increased rapidly after 2000, but in 2009 that country began using the definitions in the OECD's Frascati Manual to count researchers. This resulted in a big drop from the 2008 figure.

○Comparing the number of researchers by sector, the business enterprises sector had the largest share in each country. In terms of female researchers by sector, on the other hand, the business enterprises sector accounted for only a small share in each country.

○Looking at the percentage of Japanese researchers who hold doctoral degrees, in 2011 it was 20.3% for all researchers. By sector, it was highest in the universities and colleges sector, at 59.3% in 2011. The next highest sector was the public organizations sector, at 43.5%. Both sectors showed a rising trend. The percentage for the business enterprises sector was 4.2%. The growth rate has been flat, showing little change.

○Turning to the percentages of postdoctoral fellows in Japan (in the universities and colleges sector and the public organizations sector) and the U.S. (universities and colleges sector) who were foreign nationals, in Japan it was 23.2%, while in the U.S. it was 53.1%.

○Among Japanese researchers, the number of new graduates employed has declined after peaking in 2009. The business enterprises sector has shown the sharpest decline in recent years.

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)]”.

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

(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.

(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/her working time to R&D activities on annual basis, the value for this person as a researcher would be “0.6 people”.

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 as one which measures the number of researchers by taking their activities into account while counting them.(3)

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 universities and colleges sector.

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.

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

(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.

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

Country	Business Enterprises Sector	Universities and Colleges Sector	Public Organizations Sector	Non-profit Institutions 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.			

Note: 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 universities and colleges sector in Japan represents those in the later term (the 3rd to 5th year).
4) With regard to the universities and colleges 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 organizations sector and the non-profit institutions sector are combined. With regard to the universities and colleges 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 counting method used through 1999 is applied.
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"

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		○

Note: 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 universities and colleges 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 2011 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. The continuity of FTE figures between 2007 and 2008 is therefore impaired.

The number of researchers in the U.S. was publicly announced only up to 1999 for the universities and colleges, and up to 2002 for the public organizations sector and the non-profit institutions 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 enterprises sector, the public organizations sector and the non-profit institutions sector. With regard to the universities and colleges 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. Because the 1990 unification of East and West Germany increased the number of researchers in 1991, data continuity is impaired.

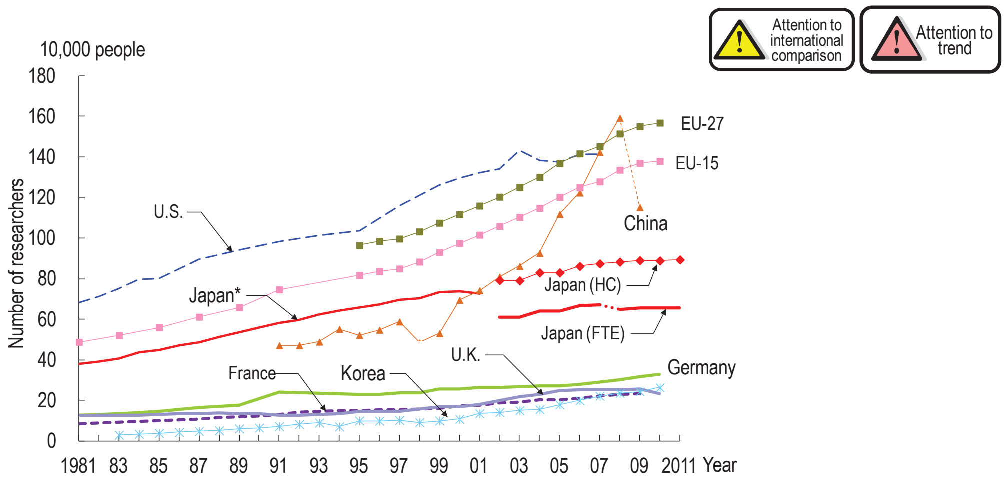
In France, the number of researchers is measured in accordance with statistical surveys for R&D which are conducted in all the sectors.

In the U.K., because no statistical survey for R&D is conducted in the universities and colleges 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. In 2009, it began using the definitions in the OECD's Frascati Manual to collect statistics. This resulted in a big drop from the 2008 figure.

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



Note: 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 universities and colleges 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 universities and colleges 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 enterprises sector, the public organizations sector and the non-profit institutions 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 institutions” 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. For 2010, OECD Secretariat estimate/projection based on each country's materials.
<U.K.> OECD secretariat estimate or projection based on national sources has been used since 1999. In 2005, the measurement method was changed. Estimated values have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards. Figures for 2010 are provisional.
<China> Through 2008, the definition of researcher used was not in complete accordance with the OECD. The measurement method was changed in 2009. Caution is therefore necessary when observing changes over time.
<EU> OECD Secretariat estimate/projection based on each country's materials. Figures for 2009 and 2010 are provisional.
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 2011/2” 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 2011/2” for the data since 2008
<France, U.K., China, EU> OECD, “Main Science and Technology Indicators 2011/2”
<Korea>KISTEP, Statistical DB (website)

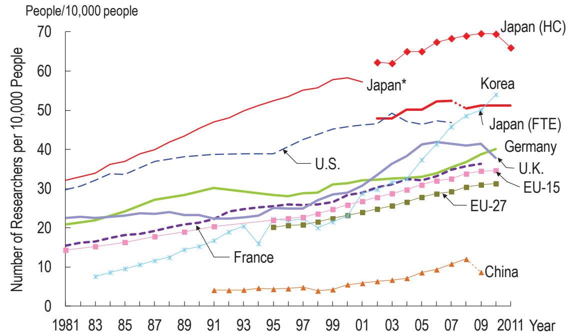
Next, an international comparison is conducted in which the influence of the size of each country is reduced by using the relative value of the number of researchers, in other words, the number of researchers per capita (Chart 2-1-4). As far as the period since 2002 is concerned, Japan’s values have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

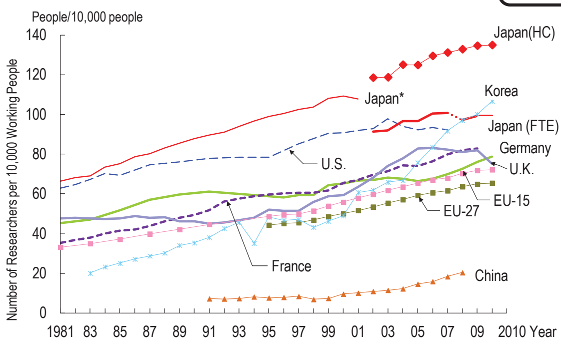
Attention to international comparison
Attention to trend



Note: 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

Attention to international comparison



Note: 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

(1) Breakdown of each country's researchers by sector

The situation and trend over time with regard to the number of researchers in each country are examined by sector, which are same as those in the classification of R&D expenditure, the “business enterprises sector”, the “universities and colleges sector”, the “public organizations sector” and the “non-profit institutions sector”.

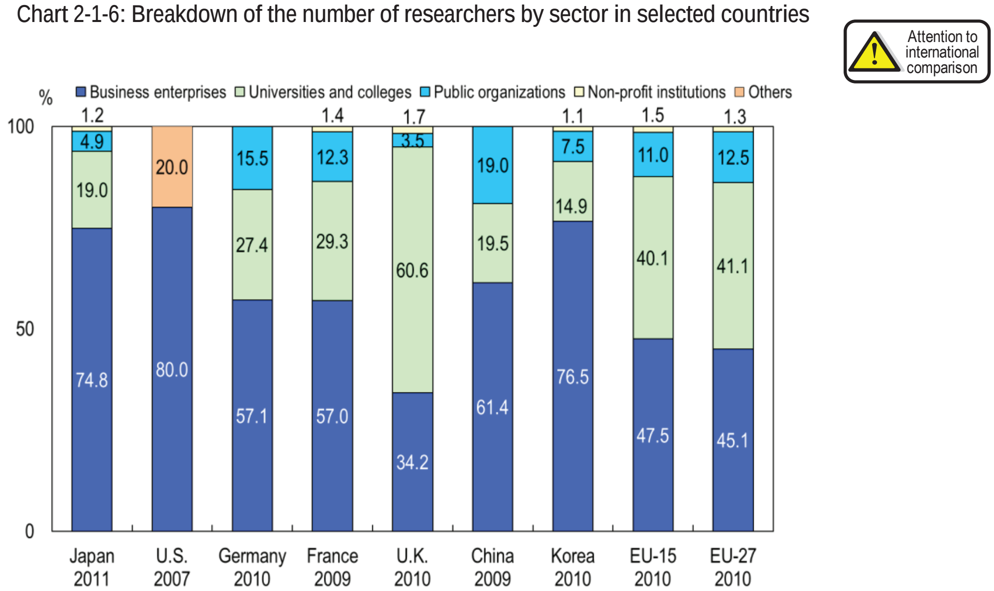
Although an international comparison of the number of researchers faces difficulties as mentioned in 2.1.1, in this section each country’s characteristics are examined using the data which is available at the present time.

In each country except the U.K., the number of researchers in the business enterprises sector accounts for the largest proportion of the total, followed by that in the universities and colleges sector, the public organizations sector and the non-profit institutions sector.

The proportion of researchers in the universities and colleges is generally large in the U.K. and relatively small in Korea (Chart 2-1-6).

Looking at changes in the number of researchers by sector (Chart 2-1-7), with the exception of the U.K., the number of researchers in the business enterprises sector was found to account for a large proportion in each country. The increase in the total number of researchers is largely due to the influence of the business enterprises sector. The rise in the number of researchers in the business enterprises sector is especially remarkable in emerging industrial countries such as China and Korea. In 2009, China began using the definitions in the OECD's Frascati Manual to collect statistics. This resulted in a big drop from the 2008 figure. On the other hand, in the U.K., the increase in the business enterprises sector is not significant when compared to other countries. In addition, the number of researchers in the public organizations sector is also reducing, which seems to be due to the transfer of a part of the public organizations sector into the business enterprises sector.

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

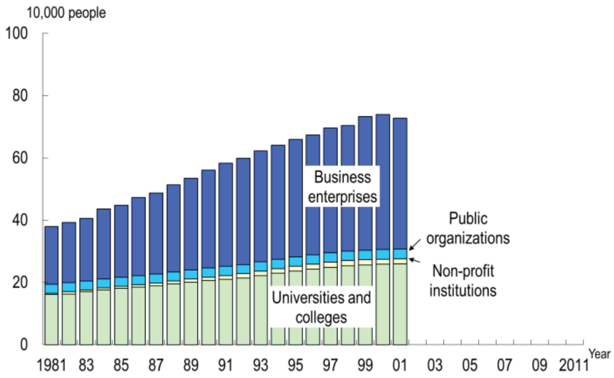


Note: 1) Values for each country are FTE, except Japan, which is HC.
2) Data of the field of social sciences and humanities were also included.
3) The values in the non-profit institutions sector for each country (other than Japan) were obtained by subtracting the number of researchers in the business enterprises sector, the universities and colleges sector and the public organizations sector from the total.
<U.S.> Years included are OECD Secretariat estimate/projection based on each country's materials.
<Germany> Public organizations include non-profit institutions. For the years included, estimated values have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards.
<U.K. and E.U.> Figures for years included are provisional.
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 2011/2”

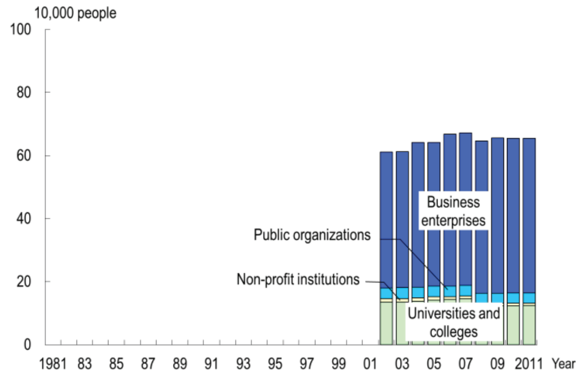
Chart 2-1-7: Trends in the number of researchers by sector

Attention to international comparison

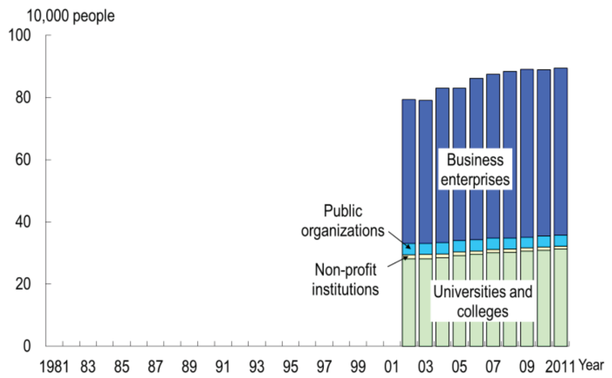
(A) Japan *



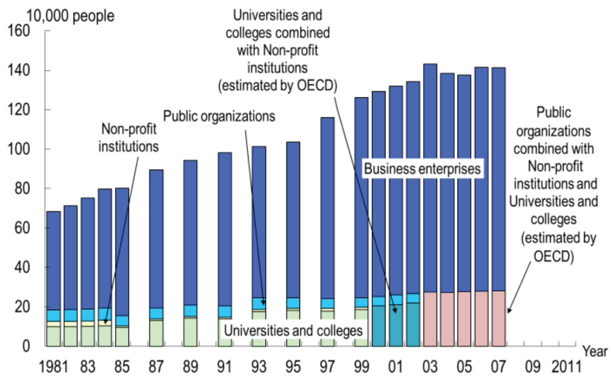
(B) Japan



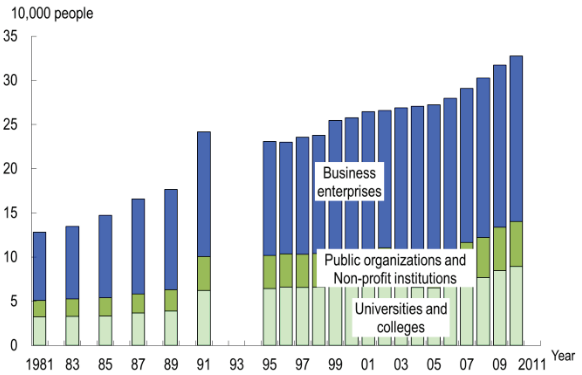
(C) Japan (HC)



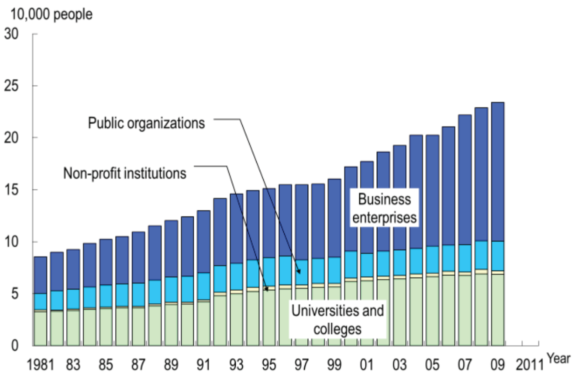
(D) U.S.



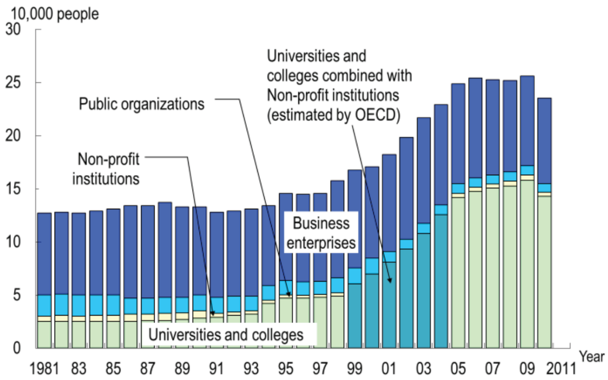
(E) Germany



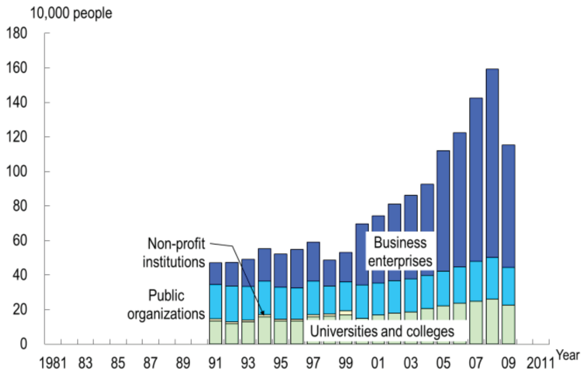
(F) France



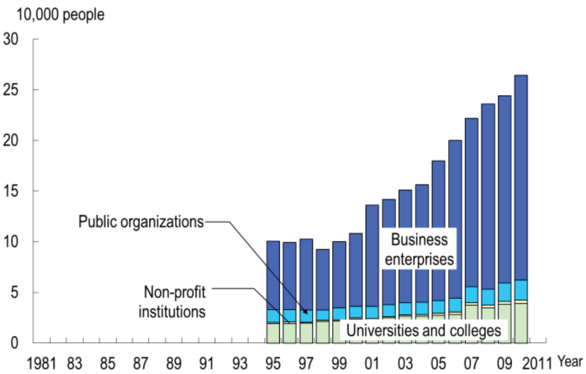
(G) U.K.



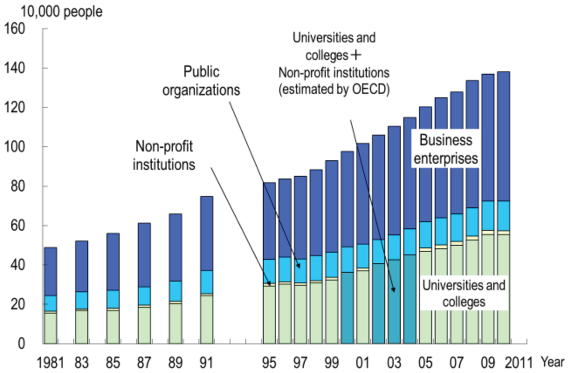
(H) China



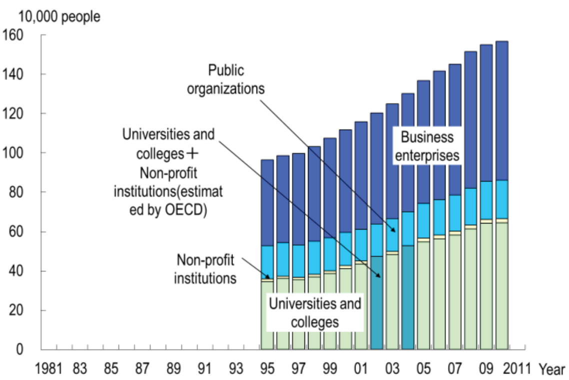
(I) Korea



(J) EU-15



(K) EU-27



Note: 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 universities and colleges sector combined with the non-profit institutions sector in the U.S. since 2000 was obtained by subtracting the number of researchers in both the business enterprises sector and the public organizations sector from the total.
6) Germany represents the former West Germany until 1990 and unified Germany since 1991 respectively. For the latest available year, estimated values have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards.
7) The number of researchers in the universities and colleges sector in France, the U.K., China, Korea and EU since 1999 was obtained by subtracting the number of researchers in the business enterprises sector; public organizations sector and the non-profit institutions sector form the total.
8) Through 2008, the definition of researcher used was not in complete accordance with the OECD. The measurement method was changed in 2009. Caution is therefore necessary when observing changes over time..
9) Figures for 2010 in the U.K. and those for 2010 and 2011 in the E.U. are provisional.

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 (2011/2)” 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 2011/2)” since 2008.
<France, U.K., China, Korea, and EU> OECD, “Main Science and Technology Indicators 2011/2”

(2) Researchers with doctoral degrees in Japan

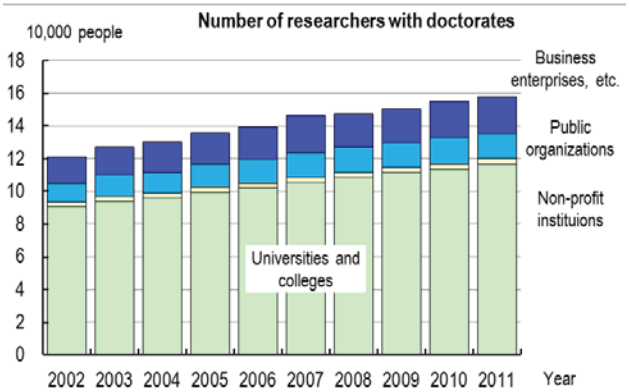
As discussed in 2.1.1 above, the definition of researcher does not require any special scientific qualifications. Depending on the country, however, the definition of researcher may include clear conditions such as "specialist knowledge at least equivalent to that of a holder of a doctoral or higher degree." Examination of the number of researchers with doctoral degrees may be one indicator for looking at the number of researchers with advanced knowledge.

Looking at the state of Japanese researchers with doctoral degrees (Chart 2-1-8(A)), they numbered 158,000 in 2011. By sector, the universities and colleges sector accounted for the largest number of these researchers. The trend in that sector is upward. The smallest number of such researchers was found in the non-profit institutions sector, but that sector has fewer researchers than the other sectors do. Numbers are also small in the public organizations sector and the business enterprises sector. The trend is flat in both those sectors.

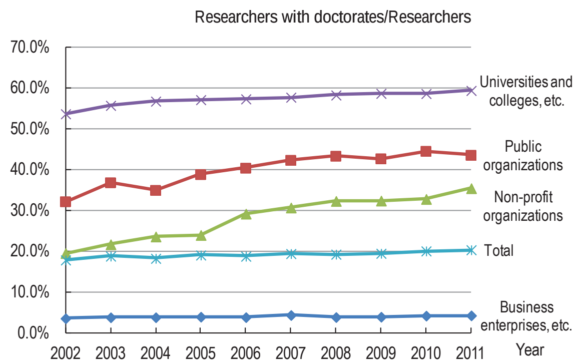
As for the percentage of researchers (not including current enrollees in doctoral courses) in each sector with doctoral degrees (Chart 2-1-8(B)), in 2011 the overall figure was 20.3%. By sector, the percentage was highest in the universities and colleges sector, at 59.3% in 2011. It was followed by the public organizations sector at 43.5%. The trend is rising in both sectors. There has also been significant growth in the non-profit institutions sector. The business enterprises sector has the lowest percentage of researchers with doctorates, at just 4.2% in 2011. The trend is flat, with little change since 2002.

Chart 2-1-8: State of researchers with doctorates in each sector (HC)

(A) Changes in the number of doctorate holders



(B) Percentage of researchers who hold doctorates



Note: The universities and colleges sector includes "teachers" and "medical staff and others." It does not include "doctoral course students in graduate schools."
Sources: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development.""

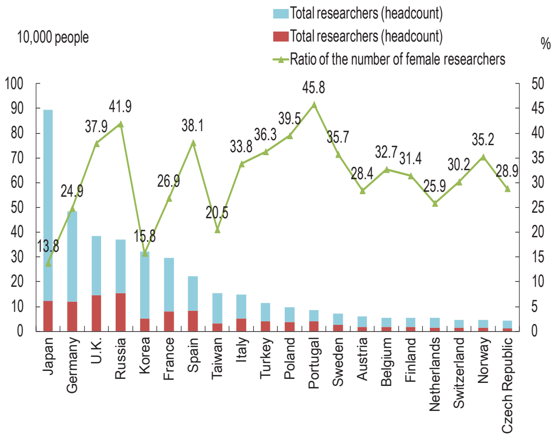
2.1.4 Female researchers in each country

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 13.8% in 2011. This ratio was the smallest among the surveyed countries, but the number place Japan third behind Russia and the U.K. (Chart 2-1-9).

Chart 2-1-9: Ratio of the number of female researchers against the total (comparison in HC values)



Note: 1) Data are for 2011 in Japan, 2008 in Switzerland and 2009 in the 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.
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 2011/2"

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 2-1-10).

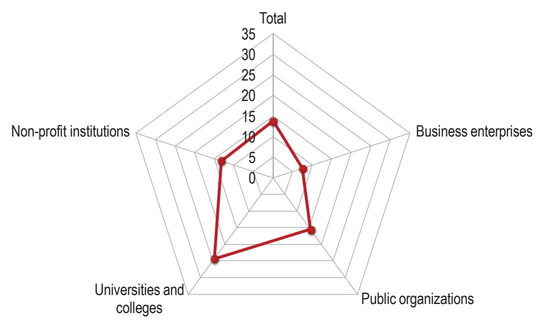
In Germany, data for the public organizations sector and for the non-profit institutions sector were combined.

In each country, the ratio of female researchers was smallest in the business enterprises sector. The ratio was relatively large in the universities and colleges sector in each country. The ratio in the non-profit institutions sector was remarkably large in France, the U.K. and Korea

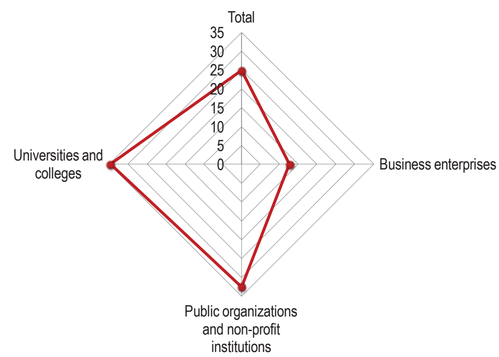
In Japan, the number of female researchers in the universities and colleges sector accounted for the largest proportion of the total at 24.3% in 2011. This value was larger than that of Korea. The number of female researchers in the business enterprises sector was lowest, accounting for 7.5% of the total. In this connection, positive activities by female researchers in the business enterprises sector are required in the future.

Chart 2-1-10: The ratio of the number of female researchers by sector for selected countries

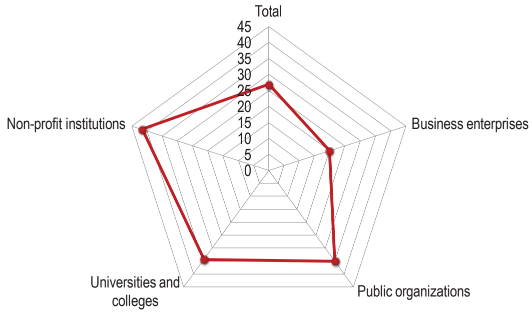
(A) Japan (2011)



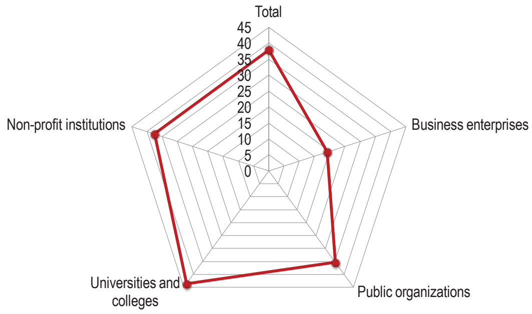
(B) Germany (2009)



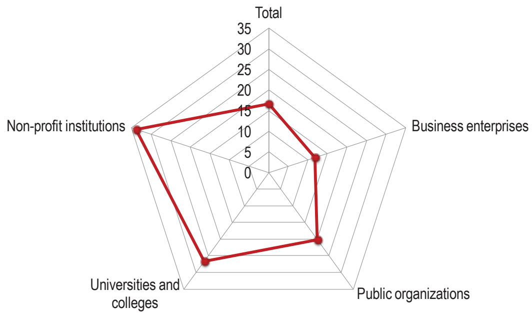
(C) France (2009)



(D) U.K. (2009)



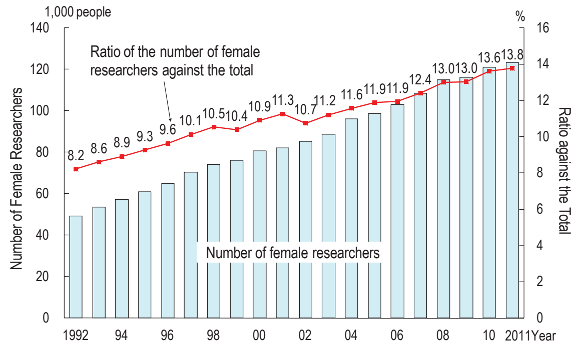
(E) Korea (2010)



Note: Figures for France's public organizations sector do not include defense-related research.
Figures for the U.K.'s business enterprises sector are national projections or estimated values.
Sources: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<Other countries> OECD, "Main Science and Technology Indicators 2011/2"

Next, the number of female researchers in Japan and their ratio to the total number of researchers was examined (Chart 2-1-11). The number of female researchers as of 2011 was 123,181. 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 2-1-11: The number of female researchers and their ratio against the total number of researchers



Note: 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 enterprises sector and the non-profit institutions sector, and those including external non-regular researchers in the universities and colleges 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 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.

(1) Birthplaces of Doctoral degree holders in the U.S.

The number of foreign researchers can be considered an indicator of researcher mobility and internationalism. However, Japan does not keep track of its number of foreign researchers. In the U.S., although there are data for the occupational category "scientists and engineers," there are no figures for researchers in the stricter sense. This section will therefore look at foreigners obtaining doctoral degrees in the U.S., a situation for which data exist.

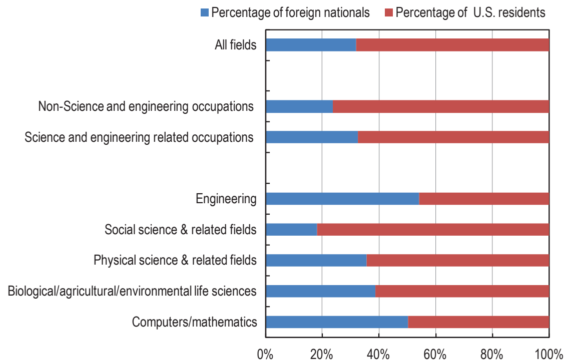
Of the 1.09 million people obtaining doctoral degrees in the U.S. in 2008, 350,000, 32%, were foreign nationals (Chart 2-1-12). The percentage was highest in science and engineering-related fields. Breaking those fields down further, engineering had the highest percentage at 54.2% among foreign nationals. Computer science and mathematics also had a high percentage.

Turning next to the countries and regions doctoral degree holders in the U.S. come from and the fields they are employed in (Chart 2-1-13), 26% of those employed come from outside the U.S. People from Asia are the most common, accounting for 17.1% of employment of holders of doctoral degrees.

By occupational classification, people from Asia were most common in computer and information science at 35.0% of the total. They also accounted for a large percentage in engineering at 34.7%.

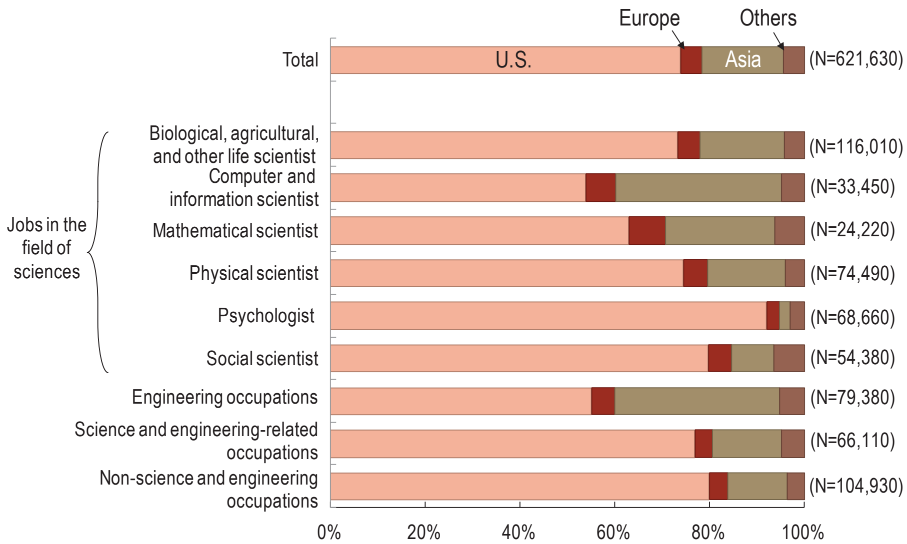
In the U.S., a large percentage of the people obtaining doctoral degrees in engineering and in computer science and mathematics are foreign nationals, and a large percentage is employed in the U.S.

Chart 2-1-12: Ratios of foreign-born doctoral degree recipients by specialized field of study (2008)



Sources: NSF, "SESTAT Public 2008" website.

Chart 2-1-13: Status of employment for doctoral degree holders by country or region of origin in each occupational field (2008)



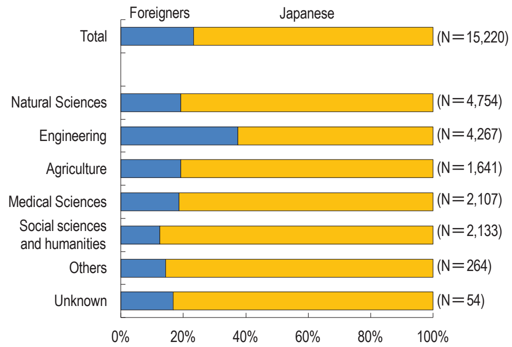
Source: NSF, “Characteristics of Doctoral Scientists and Engineers in the United States: 2006”

(2) Percentage of postdoctoral fellows who are foreign nationals

Next, the percentage of postdoctoral fellows who are foreign nationals is examined. Chart 2-1-14 shows the percentages of postdoctoral fellows in Japan's universities and colleges sector and public organizations sector who are foreign nationals. The fields discussed here refer to the primary research fields of the laboratories with which the postdoctoral fellows are affiliated.

The overall percentage of foreign nationals is 23.2%. By sector, engineering has the largest percentage at 37.5%, followed by the physical sciences and agriculture sectors at 19.1% each.

Chart 2-1-14: Employment status (percentage of foreign nationals) of postdoctoral fellows at Japanese universities and public organizations (as of November 2009)

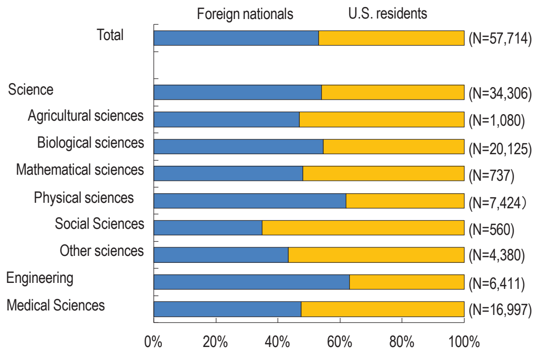


Note: 1) "Postdoctoral fellow" as used here refers to a person with a doctoral degree hired for a fixed term who 1) is engaged in research work in a research institution at a university, etc., but who does not have the status of Professor, associate professor, assistant professor, lecturer, etc., or 2) is engaged in research work in a research institution in an independent administrative agency, etc., but who is not a team leader, senior research fellow, etc., of his or her research group. (This includes so-called ABDs who have obtained the required number of credits and conditionally withdrawn from school.)
2) Research fields are the primary fields of the postdoctoral fellows' affiliated laboratories.
3) Persons affiliated as of November 2009.
Source: NISTEP, "Survey on Postdoctoral Fellows Regarding Employment and Moving-out Situations: Complete Survey for Universities and Public Research Institutes in Japan (FY2009 Data)"

Chart 2-1-15 shows the percentage of postdoctoral fellows in the U.S. who are foreign nationals (temporary visa holders). The fields here refer to the fields of the institutions with which the postdoctoral fellows are affiliated.

Overall, more than half of U.S. postdoctoral fellows, 53.1%, are foreign nationals. By sector, the highest percentage is in engineering at 63.0%, and the second highest is in physics at 62.0%.

Chart 2-1-15: Employment status (percentage of foreign nationals by field) of postdoctoral fellows at U.S. universities (2009)



Note: 1) "Foreign nationals" here refer to temporary visa holders. "U.S. residents" refers to U.S. citizens and permanent residents.
2) "Postdoctoral fellow" as used here refers to a person meeting both of the following qualifications.
(i) A person who has within the last five years received a PhD or equivalent (e.g., SCD [Doctor of Science] or Deng [Doctor of Engineering]), or a primary professional degree (MD [Doctor of Medicine], DDS [Doctor of Dental Science], DO [Doctor of Osteopathic Medicine/Osteopathy], or DVM [Doctor of Veterinary Medicine]), or a foreign degree equivalent to a U.S. doctoral degree.
(ii) A person who is generally employed for a period from five to seven years, mainly for training in a discipline and in research, and who works under a senior scholar in an assigned unit in an institution.
3) "Research field" refers to the fields of the postdoctoral fellows' affiliated organizations
Source: NSF-NIH Survey of Graduate Students and Postdoctorates in Science and Engineering, 2009.

(3) Mobility of Japanese researchers between sectors

The status of new graduate employment[4] and entering[5] and exiting[6] a place of employment among Japanese researchers was examined (Chart 2-1-16(A)). The number of researchers hired in Japan in 2011 was 64,175. Of these, 28,259 were new graduate hires and 35,916 were mid-career recruits. The number of researchers who left their place of employment was 48,779. The number of new graduates employed peaked in 2009 and has been declining since then.

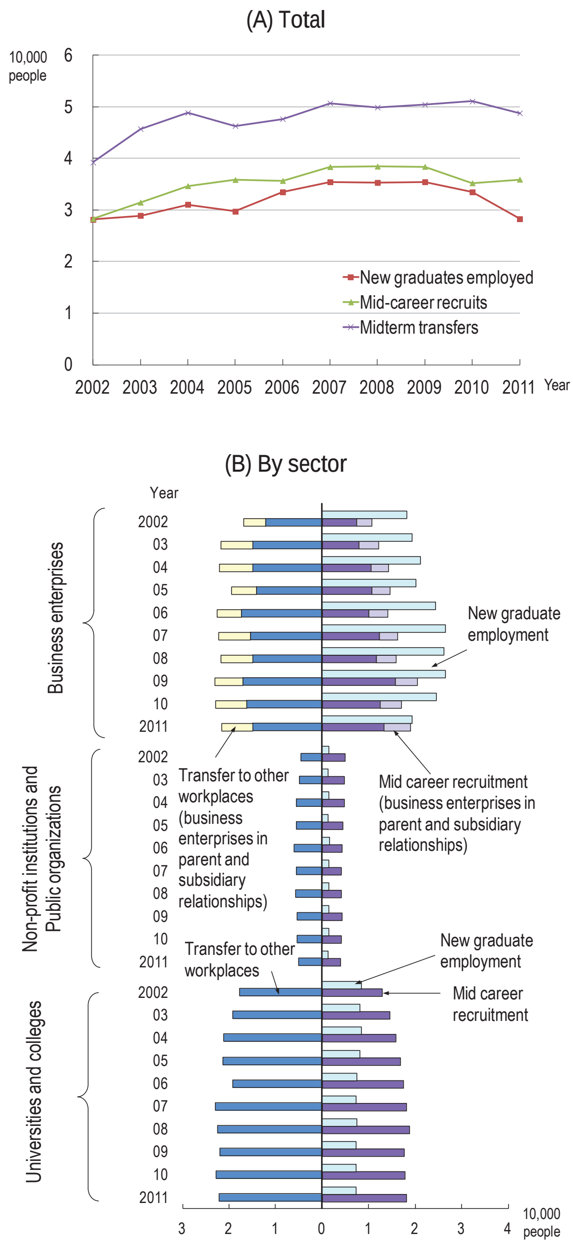
By sector, in the business enterprises sector new graduates employed have consistently outnumbered mid-career recruits. In recent years, however, the gap has been closing. New graduate employment peaked in 2009 and has been declining since then. In 2011, year-on-year growth declined sharply, by 20.8%. On the other hand, the number of researchers leaving their workplaces has been flat in recent years.

In the universities and colleges sector, the number of mid-career recruits has been higher than that of new graduates employed. The number of new graduates employed has been falling over the long term, while in recent years the number of mid-career recruits has been flat.

In the non-profit institutions and public organizations sector, the number of mid-career recruits has been higher than that of new graduates employed.

In both the business enterprises sector and the universities and colleges sector, the number of new graduates employed and mid-career recruits was higher than the number of people transferring to other sectors. In the non-profit institutions and public organizations sector, the number of new graduates employed and the number of mid-career recruits has been gradually declining.

Chart 2-1-16: Numbers of new graduates employed and midterm recruits/transfers among researchers



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

(4)New graduate employment refers to so-called new university graduates. Casual and part time workers are included only if they have completed school and have experience as temporary workers at universities or research institutes. Researchers hired for fixed terms are considered new graduate employees if the term is at least nine months.
(5) People coming from outside the organization (not including new graduate hires)
(6) People exiting employment in a workplace include retirees.

The sectors of origin of researchers who were mid-career recruits were examined by comparing data from 2002 with that from the most recent available year (Chart 2-1-17).

In 2011, a very large percentage, 95.1%, of researchers transferring in the business enterprises sector came from another business enterprises. Compared with 2002, this was a 4.3 percentage point increase. Of these transfers, however, 40% were from a parent or subsidiary company.

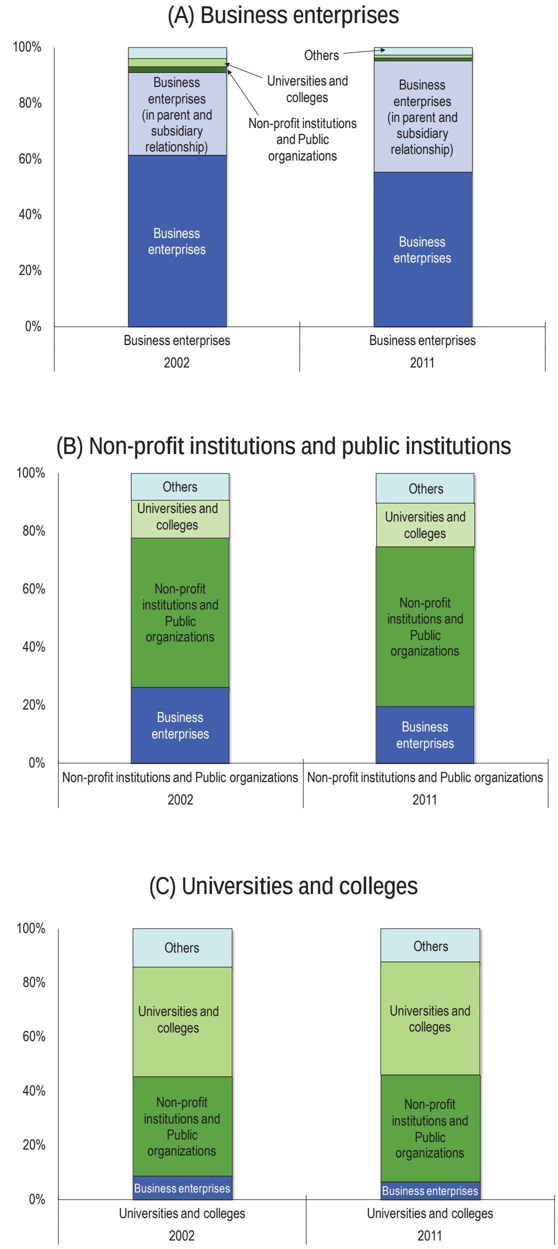
In the non-profit institutions and public organizations sector, researchers transferring within the sector accounted for the largest percentage at 54.9%. This was a 3.4 percentage point increase from 2002.

In the universities and colleges sector, 41.7% of researcher transfers came from within that sector, but there were also many transfers from other sectors. The percentage coming from the non-profit institutions and public organizations sector was almost the same at 39.4%.

Transfers from the non-profit institutions and public organizations sector accounted for the largest percentage of transfers into the universities and colleges sector, and the percentage is rising. Researchers from the business enterprises sector accounted for a relatively large percentage of transfers into the non-profit institutions and public organizations sector, but the percentage declined compared with 2002.

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 assert that mobility among sectors is increasing.

Chart 2-1-17: Breakdown of mid-career researchers by sectors of origin



Sources: 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. In order to pursue this question, last year's column analyzed the movement of international research personnel 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 data from May 2011 confirmed that the Great East Japan Earthquake affected the number of foreign nationals entering and leaving the country, but also indicated that things returned to normal within a relatively short time. Data for subsequent months has since been released, so that will be discussed here. 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 2-1-18 shows monthly fluctuations in the number of international research personnel leaving Japan from January 2009 through December 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 2011. 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. Beginning in April 2011, however, the numbers settled back to figures 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.

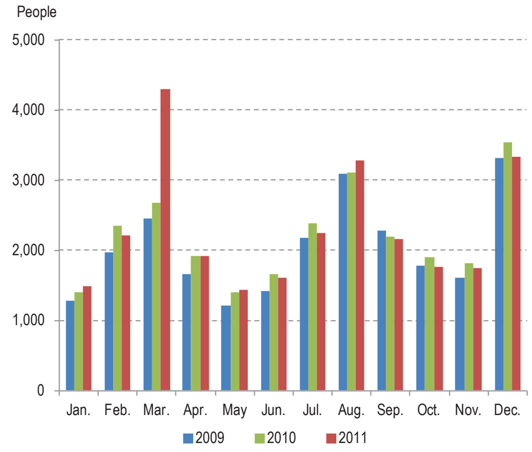
What, then, is the state of international research personnel entering Japan? Chart 2-1-19 shows monthly fluctuations in the number of international research personnel entering Japan from January 2009 through December 2011. As with research personnel leaving Japan, the figures fluctuate on a monthly basis, and those fluctuations were stable when comparing 2009, 2010 and 2011. 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. Beginning in June 2011, the number of research personnel entering the country each month has been similar to the previous year's figures.

Thus, while consideration of the latest data confirms that the Great East Japan Earthquake 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. Measures such as the U.K.'s Government Chief Scientific Adviser announcing his opinion that there was no need to leave Japan, as well as the careful responses of each research organization to their foreign researchers' concerns, seem to have had the desired effects. Meanwhile, the Ministry of Justice adopted a system of "points-based preferential immigration treatment for highly skilled foreign professionals" in May 2012 in order to accept foreign nationals with advanced skills and qualifications. This initiative should generate incentives for foreign research personnel to come to Japan.

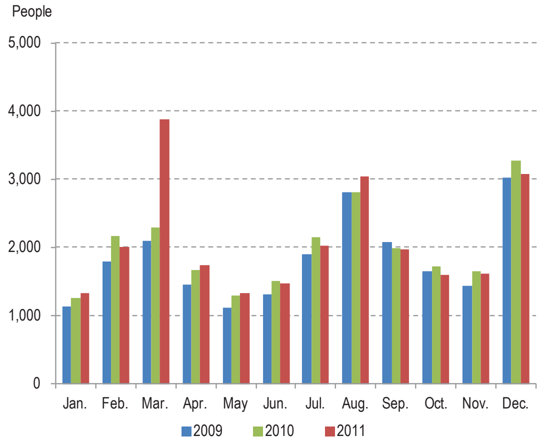
(Ayaka Saka)

Chart 2-1-18: Changes in the number of foreigners (with research-related statuses of residence) departing Japan

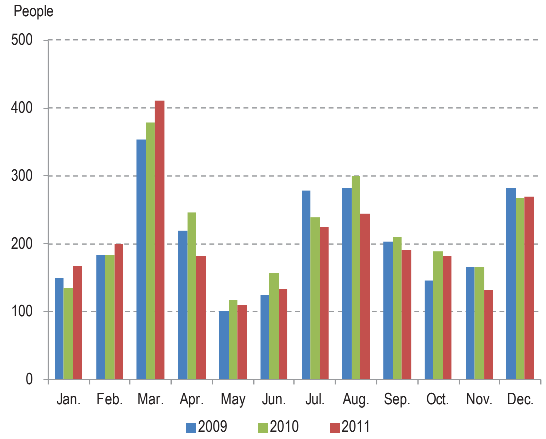
(A) Number departing Japan



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



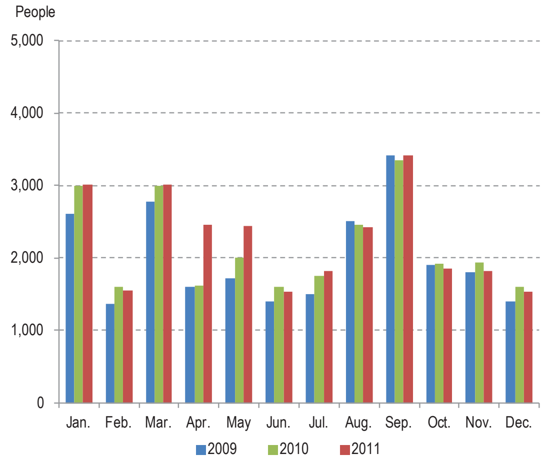
(C) Of those departing, number without re-entry permits



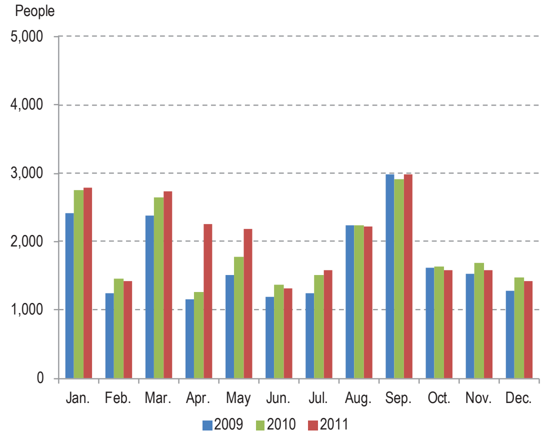
Note: 1) Data as of February 24, 2012.
2) Persons with resident statuses of "professor" or "researcher" were analyzed.
Source: Compiled by the National Institute of Science and Technology Policy (NISTEP) based on Ministry of Justice, "Statistics on the Foreigners Registered in Japan."

Chart 2-1-19: Changes in the number of foreigners (with research-related statuses of residence) entering Japan

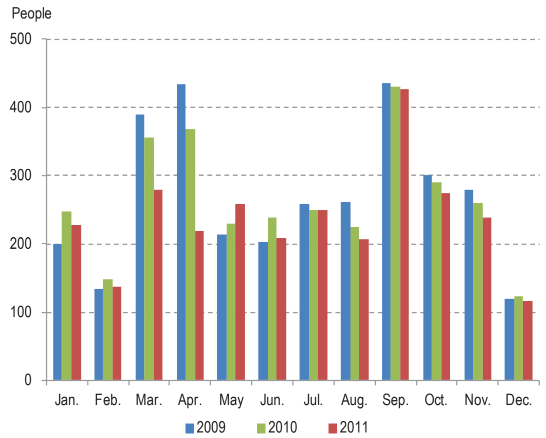
(A) Number entering Japan



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



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



Note: Same as Chart 2-1-18
Source: Same as Chart 2-1-18.

2.2 Researchers by sector

Key points

○The number of researchers in the public organizations sector per 10,000-person population in the latest available year was 6.2 in Germany, which was the highest value, followed by 4.5 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 enterprises sector, Japan and the U.S. showed a long-term rising trend, but in recent years have been flat. In 2011, 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 universities and colleges 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 organizations 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 organizations 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 organizations sector in the long term. The 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 enterprises 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 organizations sector in 1985 was transferred to the business enterprises sector, and DERA(7) ceased operations in 2000.

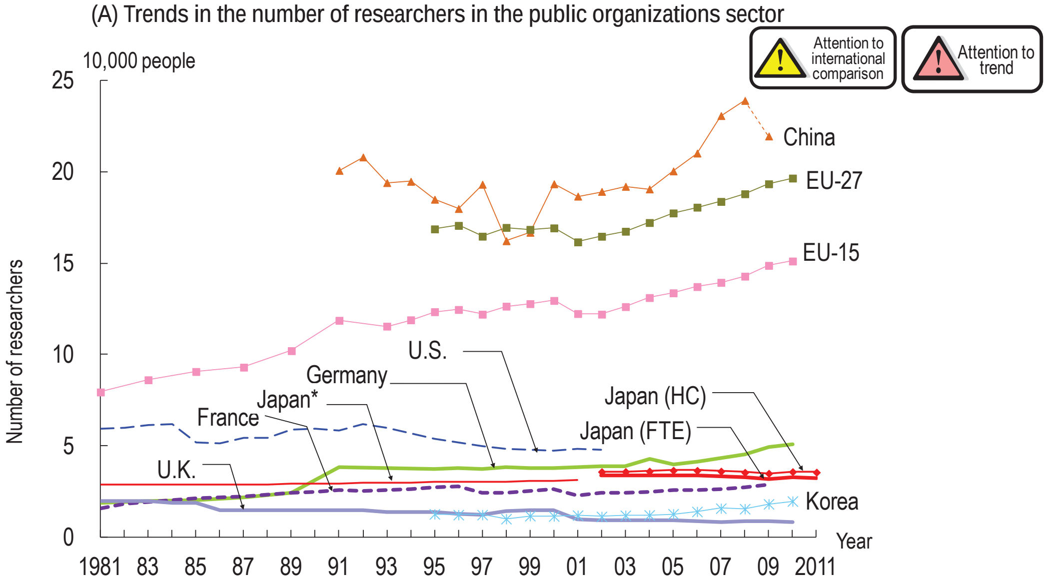
The U.S. stopped publishing the number or researchers in 2002.

The number of researchers in the public organizations sector per 10,000 population in the most recent available year was 6.2 in Germany, which was the highest value, followed by 4.5 in France and 2.5 in Japan. However, the number of researchers in local governments (state governments, etc.) is included for Japan and Germany. The figure for the U.S., where data did not include researchers in local governments, was 1.7. The number of researchers in the public organizations sector in China is extremely large compared to that in other countries. With a ratio of 1.6 such researchers per 10,000 population, however, the figure is less remarkable. In 2009, China began using the definitions in the OECD's Frascati Manual to collect statistics. This resulted in a big drop from the 2008 figure. In the U.K., both the number of researchers and their ratio per 10,000 population are small (Chart 2-2-1 (A, B)).

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

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

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



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

(Unit: people)

Country (year)	
Japan (2011)	2.54
U.S. (2002)	1.66
Germany (2010)	6.23
France (2009)	4.45
U.K. (2010)	1.31
China (2009)	1.64
Korea (2010)	4.04

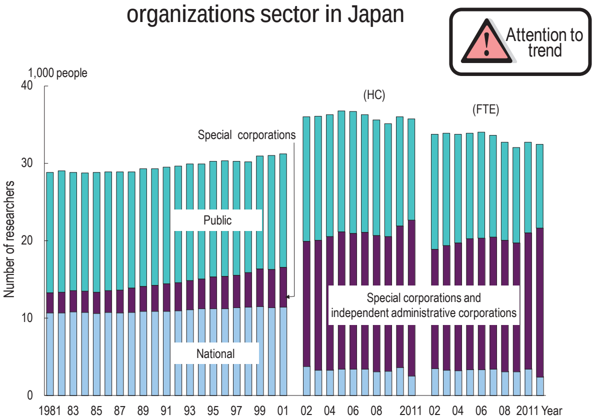
Note: 1) The definition and measurement method of researchers in the public organizations sector is different depending on country. Therefore it is necessary to be careful when international comparisons are being made. Refer to Chart 2-1-1 for the definition of researchers in each country.
2) Values 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 since 1998.
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.
3) Figures for 2010 are national projections or estimated values.
<France> 1) 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.
2) Data continuity with the previous year is impaired for 1992, 1997 and 2000. Defense-related research is not included from 1997 on.
<U.K.> 1) The central government (U.K), decentralized governments (Scotland etc.) and research councils.
2) Data continuity with the previous year is impaired for 1981, 1986, 1991–1993 and 2001. Figures for 2010 are provisional.
<China> 1) Research institutes run by the government.
2) Through 2008, the definition of researcher used was not in complete accordance with the OECD. The measurement method was changed in 2009. Caution is therefore necessary when observing changes over time.
<Korea> National and public research institutes, government supported research institutes and national and public hospitals.
<E.U.> 1) OECD Secretariat estimate/projection based on each country's materials. Figures for 2009 and 2010 are provisional.
2) Data continuity with the previous year is impaired for the E.U.-15 for 1991 and 1993 and for the EU-27 for 1997.

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"; from 2000, OECD, "Main Science and Technology Indicators 2011/2"
<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 2011/2)" since 2008.
<France, U.K., China, Korea, and EU> OECD, "Main Science and Technology Indicators 2011/2"

(2) Researchers in the public organizations sector in Japan

It should be noted that in Japan's public organizations 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 organizations sector was 32,422 people in total in 2011. When examined by type of organization, the number of researchers in "special and independent administrative corporations" accounts for more than half of the total or 19,234 people, while that in "public" research institutes accounts for approximately 30% of the total or 10,796 people, and that in "national" research institutes accounts for slightly less than 10% of the total or 2,392 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 organizations sector in Japan



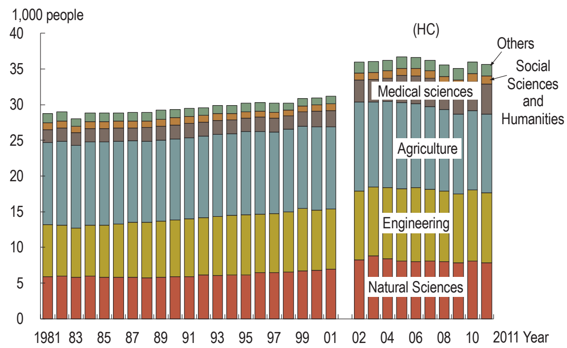
Note: 1) A part of national research institutes turned into independent administrative corporations in 2001. Therefore it is necessary to be careful when trends in time series are being examined.
2) Values for "special corporations and independent administrative corporations" until 2000 represent values for only "special corporations".
3) Because of changes to the content and timing of surveys, the number of regular researchers as of April 1 were used until 2000 and the number as of March 31 have been used since 2001.
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" are affiliated with research institutes at special and public administrative corporations as well as at public research institutes (Chart 2-2-3).

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

(A) Trend in the number of researchers



(B) Affiliations of researchers by specialty (2011)

Field of research	Public organizations			
	Total	National	Public	Special Corporations and Independent Administrative Corporations
Natural Sciences	7,834	511	1,778	5,545
Engineering	9,812	820	2,167	6,825
Agriculture	11,062	206	6,293	4,563
Medical Sciences	4,186	555	1,409	2,222
Social Sciences and Humanities	1,122	327	182	613
Others	1,677	128	1,193	356
Grand Total	35,693	2,547	13,022	20,124

Note: 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 enterprises sector

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

The number of researchers in the business enterprises 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.

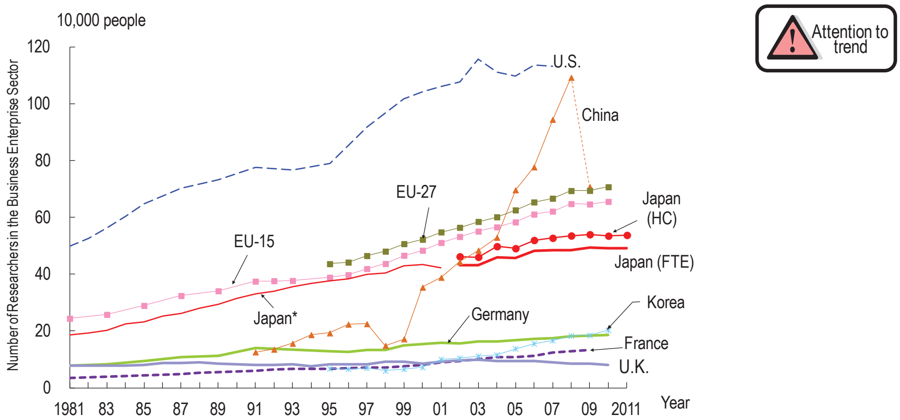
The number of researchers in the business enterprises sector (FTE value) in Japan had been on a continually rising trend, but in recent years it has been flat. In 2011, there were 490,000 such researchers.

China has shown rapid growth during the 2000s. However, in 2009, it began using the definitions in the OECD's Frascati Manual to collect statistics. This resulted in a big drop from the 2008 figure.

The U.S. experienced drastic growth from 1995 through 2003. A 1995 revision in the scope of statistical surveys of R&D, which started including a wider range of enterprises and counting researchers in service industries, is likely to have influenced these statistics.

In France and the U.K., some public organizations were privatized and transferred to the business enterprises 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



Note: 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.
3) Figures for 2008 are national projections or estimated values. Figures for 2010 are provisional.

<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 enterprises 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.
4) Data continuity with the previous year is impaired for 2000 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 enterprises 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 enterprises 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.
5) Figures for 2010 are provisional

<China> 1) Through 2008, the definition of researcher used was not in complete accordance with the OECD.
2) Until 1999, figures were underestimated, or based on underestimated data.

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 2011/2"
<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 2011/2)" since 2008.
<France, U.K., China, Korea, and EU> OECD, "Main Science and Technology Indicators 2011/2"

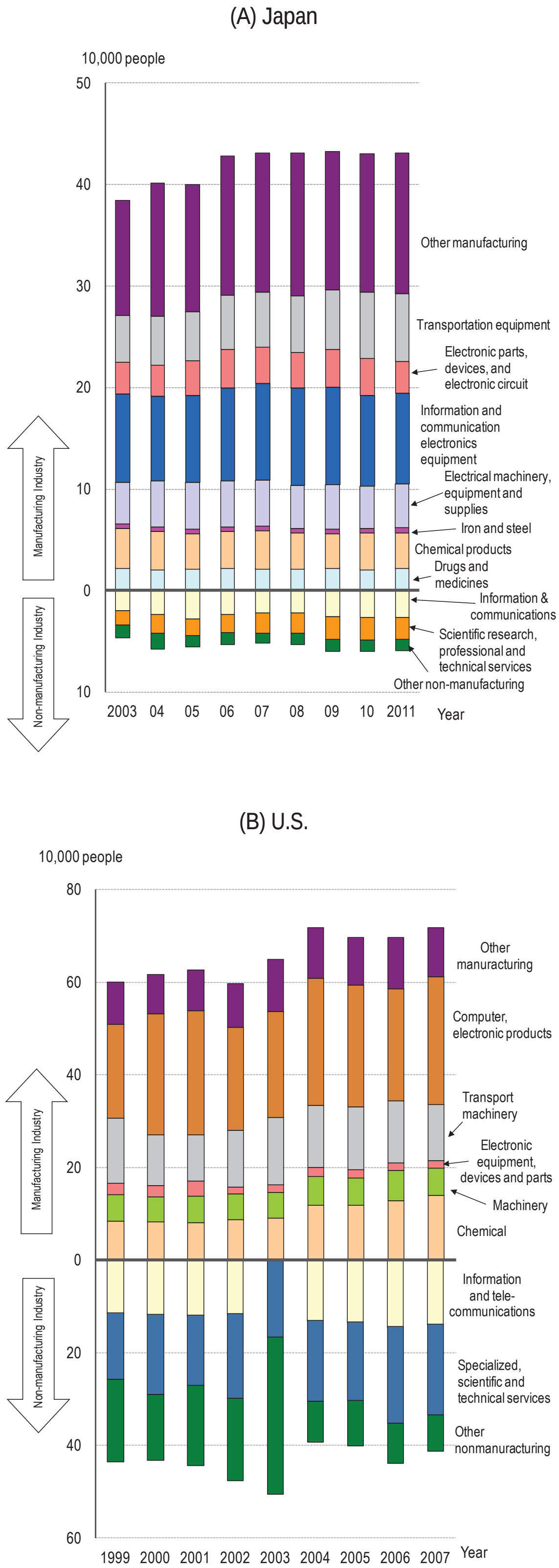
(2) Researchers by industry in each country

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 enterprises 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.

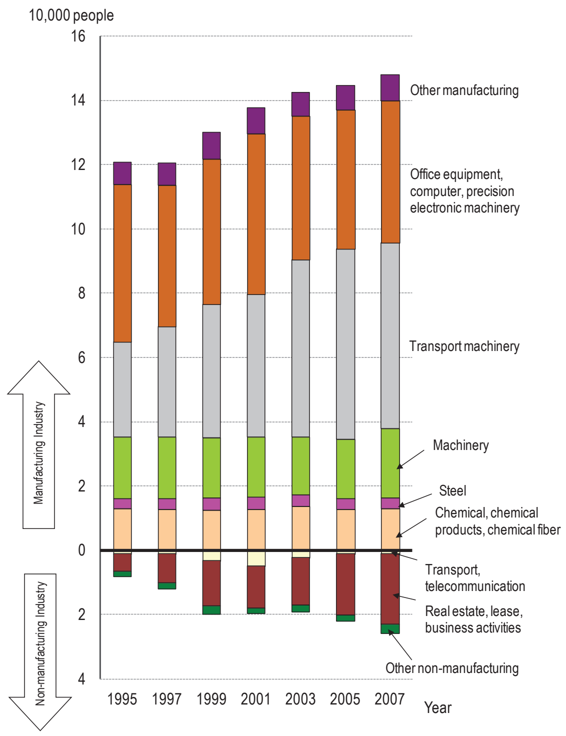
Given the background mentioned above, by examining the number of researchers by industry in Japan, the U.S., and Germany, it was found that the number of researchers in the manufacturing industry accounted for a considerably large ratio in Japan. This means that the increase in the number of total researchers was probably greatly influenced by the manufacturing industry. However, the trend has been flat since about 2006. In the non-manufacturing industry, growth has been flat since about 2008.

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. In manufacturing industries, the transportation equipment sector is large and growing. In non-manufacturing industries, the real estate, lease and business activities sector is large and growing.

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



(C) Germany



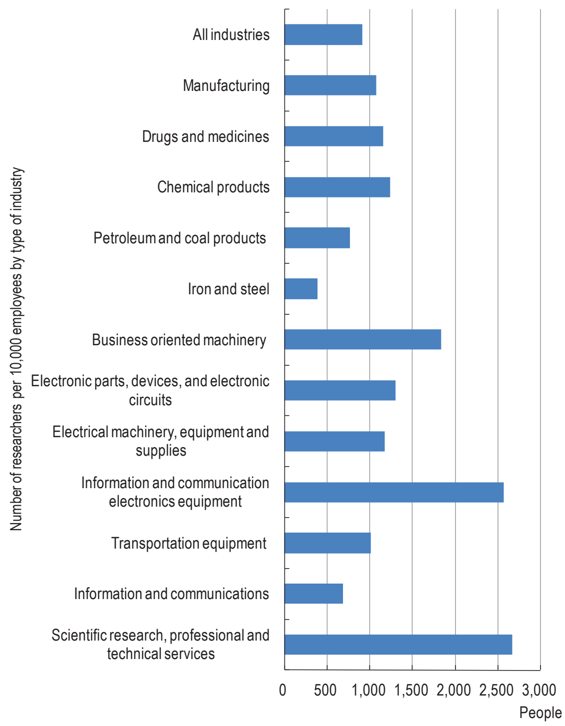
Note: Same as for Chart 2-2-4.
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "Industrial R&D for each year" Industrial R&D Information System
<Germany> BMBF, "Research and Innovation in Germany 2007", "Bundesbericht Forschung und Innovation 2008, 2010"

(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 highest number in 2011 was in the academic research, specialized and technical service sector with 2,665 researchers, followed by the information and telecommunication machinery and equipment sector with 2,569 (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 (2011)



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

2.2.3 Researchers in the universities and colleges sector

(1) Researchers in the universities and colleges sector in each country

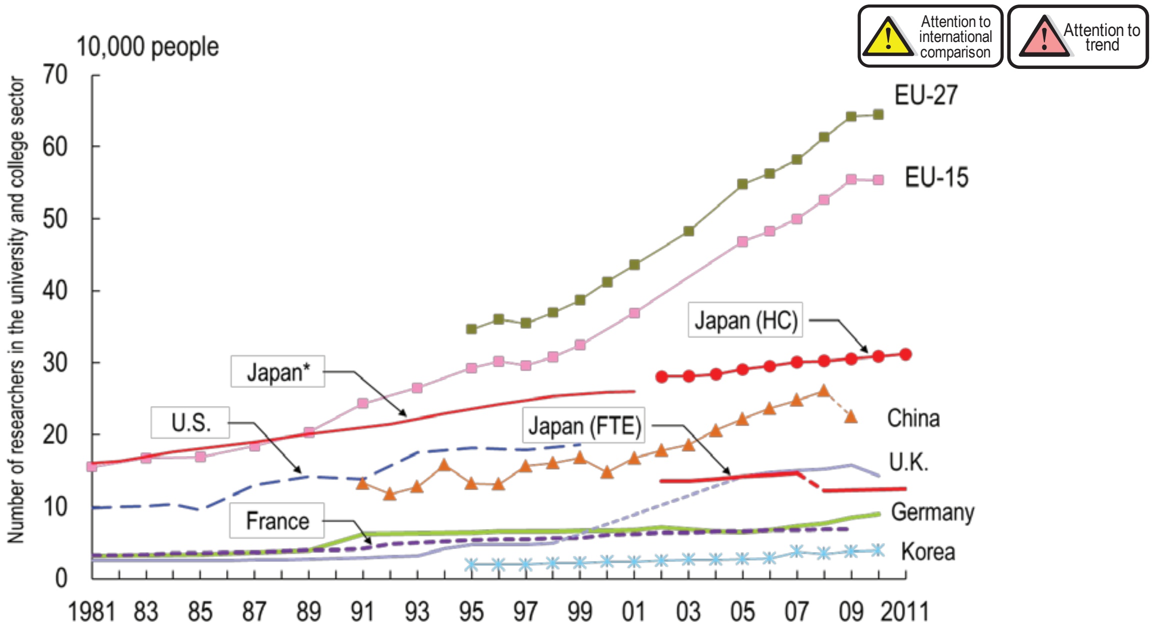
International comparison of the number of researchers is difficult in the universities and colleges sector. The details were described in 2.1.1., and the main points which should be noted are restated below.

(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 universities and colleges 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 in order to measure the FTE number of researchers in Japan's universities and colleges sector by finding an FTE coefficient. 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 universities and colleges sector was approximately 124,000 people in 2011, 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. In 2009, it began using the definitions in the OECD's Frascati Manual to collect statistics. This resulted in a big drop from the 2008 figure.

In Korea, the number of researchers is rising, although there is still a gap with the other countries (Chart 2-2-7).

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



Note: 1) The definition and measurement method of researchers in the universities and colleges 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.

3) For 2010, estimated values have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards.

<France> 1) 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.

2) Data continuity with the previous year is impaired for 1997 and 2000.

<U.K.> 1) Data continuity with the previous year is impaired for 1994 and 2005.

2) For 2005‐2008, estimated values have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards.

<China> Through 2008, the definition of researcher used was not in complete accordance with the OECD. The measurement method was changed in 2009. Caution is therefore necessary when observing changes over time.

<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 2011/2)” since 2008.

<France, U.K., China, Korea, and EU> OECD, “Main Science and Technology Indicators 2011/2”

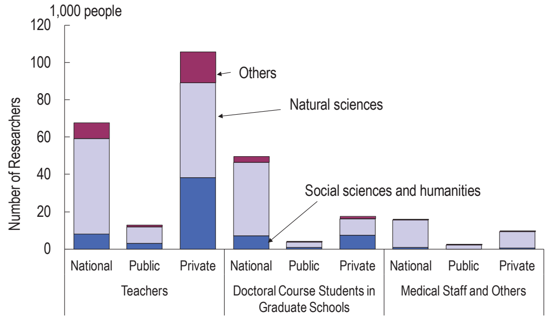
(2) Researchers in the universities and colleges sector in Japan

Chart 2-2-8 shows the number of researchers in the universities and colleges 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 universities and colleges 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 284,025 people on March 31, 2011, and 65.4% of those or 185,858 people are teachers. The number of researchers in the universities and colleges sector includes "doctoral course students in graduate schools (71,074 people)" and "medical staff and others (27,093 people)". In these statistics, almost all the teachers in universities are measured as researchers(8).

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 universities and colleges sector in Japan (2011)



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

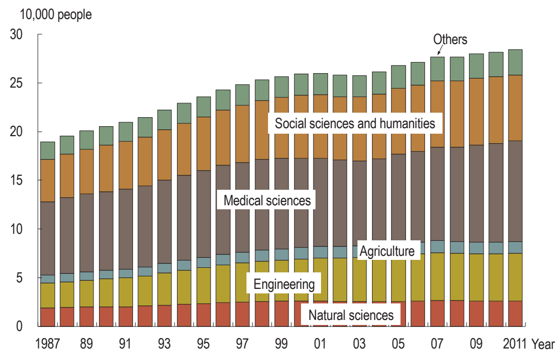
Next, the trend in the number of researchers by specialized field of study was shown (Chart 2-2-9(A)).

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 universities and colleges sector in Japan

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



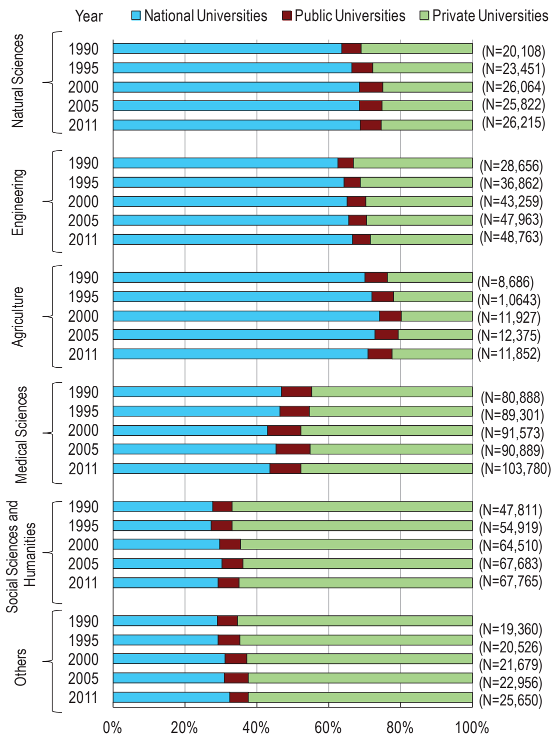
(8) According to the statistics on universities and colleges (MEXT, "Report on School Basic Survey" 2011 version), as of May 1, 2010, the number of regular teachers in faculties of universities combined with graduate schools was 176,684 and in junior colleges was 9,274, respectively, totaling 185,958.

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". Researchers in medical sciences have been about equally common at national universities and private universities, although in 2000 and 2011 there were more at private universities.

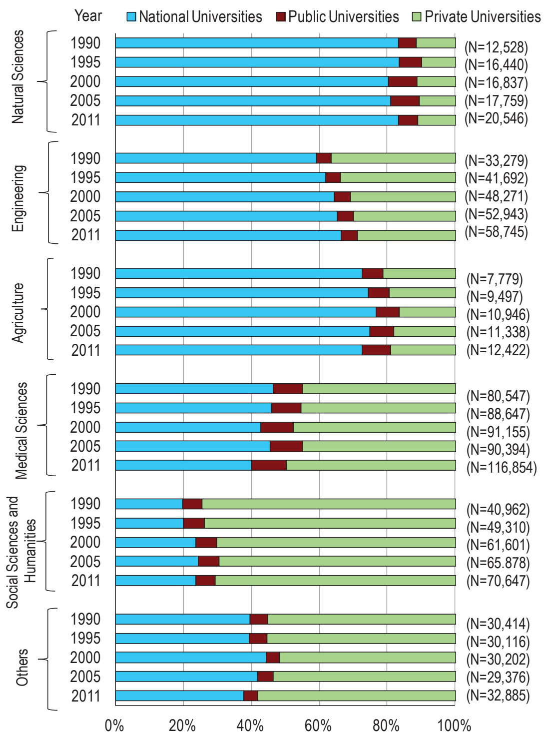
(B) Proportion of researchers by type of university (national, public and private) in each personal specialized field of study



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".

(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

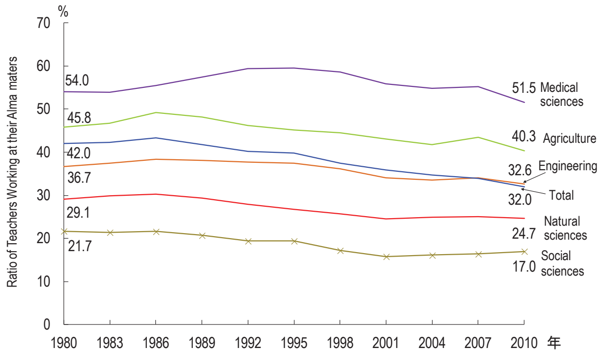
In Japan, traditionally many teachers currently working for a university graduated from the same university. Therefore the diversification of teachers' alma maters is a policy objective.

The average ratio of university teachers working at their alma mater in FY 2010 was 32.6% against the total, but is decreasing in the long term. By field of study, the medical sciences field has the largest proportion of teachers working at their alma maters, approximately 50%. The smallest proportion of teachers working at their alma maters is in the social sciences at around 20%.

Over the long term, there has been a declining trend in every field, indicating a decrease in teachers working at their alma maters (Chart 2-2-10(A)).

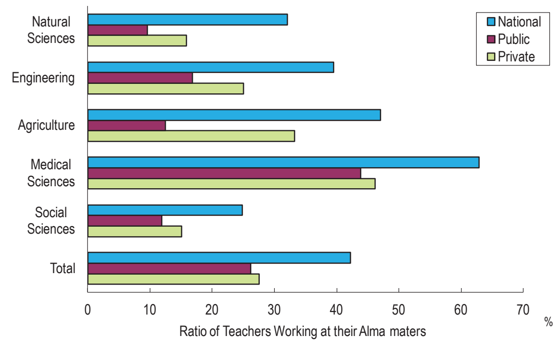
Chart 2-2-10: Ratio of university teachers working at their alma maters

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



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. In the natural sciences, on the other hand, the ratio for such teachers was much higher at national universities. It was only half as high at private universities and a quarter as high at public universities (Chart 2-2-10(B)).

(B) Ratios by type of university (FY 2010)



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

Column: The aging of university teachers: The changing age distribution of regular university teachers

(1) The age distribution of regular teachers at universities

In April 2012, the Ministry of Internal Affairs and Communications announced Japan's population[9] as 128 million as of October 1, 2011. Since declining year-on-year for the first time since World War II in 2005, the population has been alternately rising and falling. With the population age 65 and older increasing and the population age 14 and younger decreasing, the phenomenon of an aging population with a declining birthrate continues to advance. Japan's changing demographics are likely to affect every part of society. What, then, is the current state of the age distribution of university teachers?

This column will use data on regular university teachers to examine the state of the age distribution of university teachers. "Regular teachers" as used here refers to full-time faculty members affiliated with a university. Contract teachers and specially-appointed teachers are also considered regular teachers if they are full-time at their employing university.

Chart 2-2-11(A) shows the structural ratio of the age distribution of all university teachers in Japan. In 1986, teachers between the ages of 25 and 39 accounted for 39% of the total, but in 2010 they had fallen to 26%. Meanwhile, the percentage of teachers who were 60 and older rose from 11.9% to 19.6% in 2010. The percentage of teachers aged 40–49 surpassed that of teachers aged 25–39 in 2004. The percentage aged 50–59 has become even with that aged 25–39.

Next, the age distribution of regular teachers at national universities and private universities were compared (Chart 2-2-11(B) and (C)).

At national universities, the largest percentage during the 1980s was the 25–39 group. The percentages decreased in order from the youngest group to the oldest. However, the percentage accounted for by the 40–49 group increased, until it passed the 25–39 group in 2004. The group aged 60 and above originally had a small percentage, but it has increased.

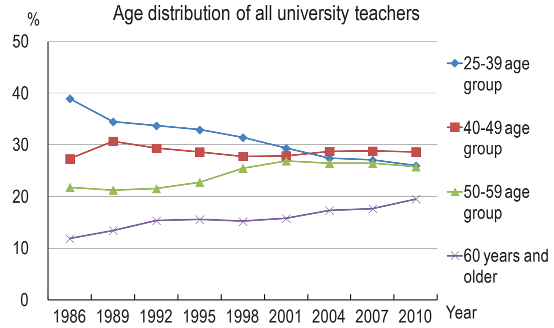
At private universities as well, the younger the age group, the higher its percentage during the 1980s. They differed from national universities in that their 60 and above group accounted for a higher percentage, but recently the distribution of each age group has become approximately equal.

Looking at age distribution, the age of regular teachers has thus risen faster at private universities than at national universities.

Chart 2-2-11: Age distribution of regular university teachers

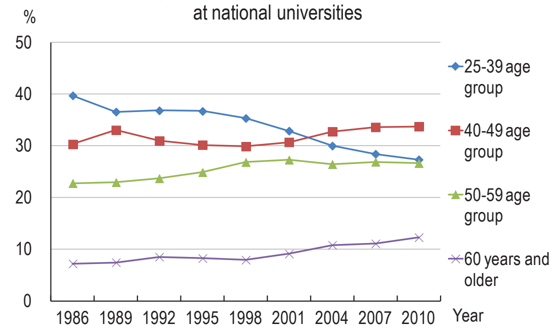
(A) All universities

Age distribution of all university teachers



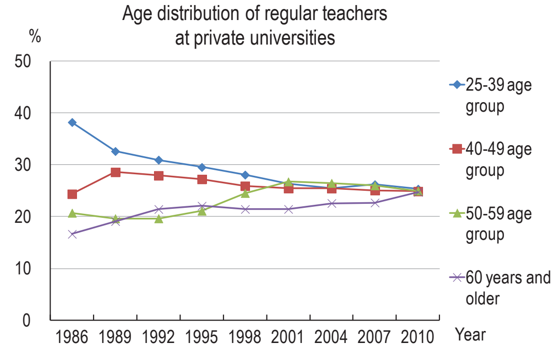
(B) National universities

Age distribution of regular teachers at national universities



(C) Private universities

Age distribution of regular teachers at private universities



Note: "Regular teachers" are full-time faculty at their universities.
Source: Ministry of Education, Culture, Sports, Science and Technology, "Statistical Survey on School Teachers"

(2) Changes in the age distribution of newly hired teachers

Changes in the age composition of university teachers are significantly affected by the ages of new hires each year. The age distribution of newly hired university teachers was therefore examined.

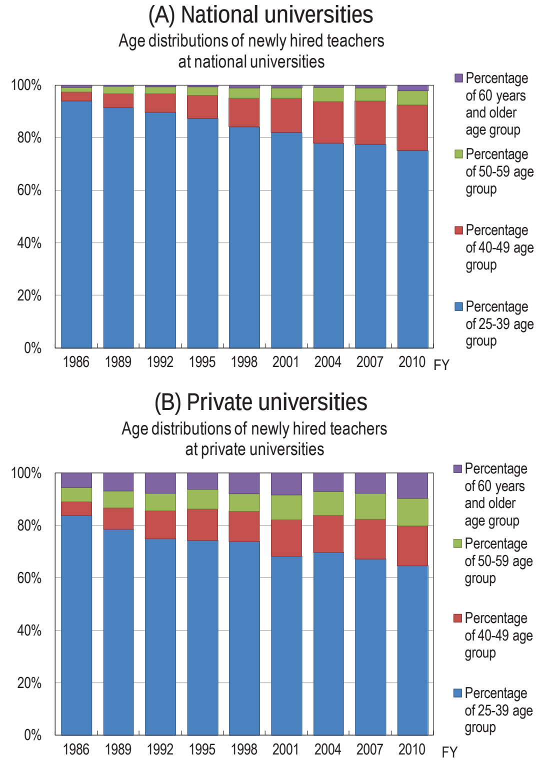
(9)Ministry of Internal Affairs and Communications, "Current Population Estimates (As of October 1st, 2011)"

Because movement from one university to another does not affect the overall age distribution in the sector, such movement was not included in the data used.

Looking at the age distributions of newly hired teachers at national universities and private universities (Chart 2-2-12), 93.9% of new hires at national universities in 1986 were in the youngest group. By 2010, that percentage had decreased to 75%. The percentages of other age groups increased accordingly. The 40–49 age group in particular increased from 3.4% to 17.5%. At private universities, the percentage of new hires in the youngest age group is smaller than it is at national universities, but it has shown a similar decrease. It is also notable that the percentages for the 50–59 and 60 and above age groups are larger than they are at national universities and they are increasing. Thus, the ages of new university teachers are increasing every year.

Factors underlying this change are increasing tendencies to demand an outstanding research record when hiring new university teachers and to seek people with real-world experience and expertise when hiring.

Chart 2-2-12: Age distribution of newly hired university teachers



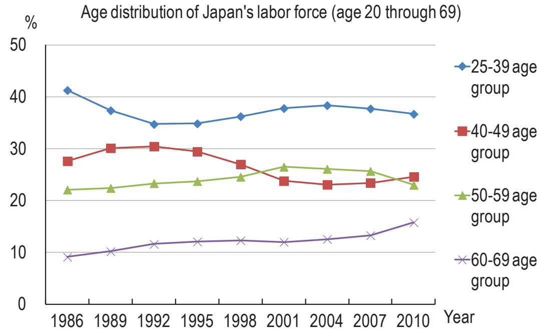
Note: "New hires" refer to people hired as regular teachers at universities, junior colleges and technical colleges, who are moving from positions other than regular teacher.

Source: Ministry of Education, Culture, Sports, Science and Technology, "Statistical Survey on School Teachers"

(3) The aging of regular university teachers

What is the relationship between the age distribution of university teachers and the age distribution of Japan's labor force? Looking at the age distribution of Japan's labor force, age 25 through 69 (Chart 2-2-13), the percentage accounted for by the 40–49 age group is decreasing more than that of the 25–39 group. The 50–59 group has been flat over the long term, and the 60–69 group has been increasing. Thus, university teachers are aging faster than workers in general are.

Chart 2-2-13: Age distribution of Japan's labor force (25 through 69)



Sources: Ministry of Internal Affairs and Communications, "Labor Force Survey"

The changes in the age distribution of university teachers discussed above may affect their activities. For example, there is concern about effects on research performance. The abilities of university teachers are certainly not affected by age, but the rate of growth of academic papers produced by Japanese universities has slowed in the 2000s versus the years before 2000.[10] the decrease in the number of young teachers may be one cause of this phenomenon.

A time to consider what to do for the sake of sustained development not only of research but of all university functions has arrived.

(Yumiko Kanda)

(10)NISTEP, "Shrinking Research Time for University Faculty Members" (December 2011)

2.3 Research assistants

Key Points

- ○With regard to the number of research assistants per researcher by sector, the number of research assistants in the universities and colleges sector is smaller than in other sectors in Japan, Germany, France, the U.K. and China. The number of research assistants in the universities and colleges sector is large in Korea. Over time, growth has been flat or has declined in almost all the countries, but it has been increasing in Korea since 2000.
- ○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 highest at national universities. Looking at trends by field of study, the number has particularly increased since 2000 in the fields 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(11)” and “Other supporting staff(12)” 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 (hereinafter referred to as "number of research assistants") by sector.

Looking at Japan's most recent available year, the number of research assistants in public organizations is high at 1, while in the universities and colleges sector the number is low at 0.2. Over time, the number of research assistants in non-profit institutions has been increasing. It has been flat in the other sectors.

In the most recent available year for Germany, the number of research assistants was 0.8 in the business enterprises, public organizations and non-profit institutions sectors. This was higher than the 0.4 for the universities and colleges sector. Over time, the number has been decreasing in each sector.

In the most recent available year for France, the number of research assistants in the public organizations and non-profit institutions sectors was 0.9. It was 0.7 in the business enterprises sector and 0.5 in the universities and colleges sector. Over time, the number has been flat in the universities and colleges sector and has declined sharply in the other sectors.

For the U.K., there are no data for non-profit instituions and universities from 1994 through 2004. The U.K. began announcing estimated figures for universities in 2005. The continuity of data from before 1994 and from 2005 on is therefore impaired. During the most recent available year, the number of research assistants was high in the public organiza-

(11) 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.
(12) Other supporting staffs include skilled and unskilled craftsmen, secretaries and clerical staff who participate in R&D projects or are related to those projects.

tions sector and low in the universities and colleges sector.

China began counting researchers in accordance with OECD standards in 2009, so their number has decreased. Consequently, the number of research assistants increased dramatically in 2009.

In the most recent available year for Korea, the number of research assistants was large in the universities and colleges sector at 0.9 and small in the business enterprises sector at 0.1. This is the opposite of the situation in the other countries. Moreover, the number of research assistants in the universities and colleges sector has been increasing over time, which also differs from what is happening in the other countries.

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

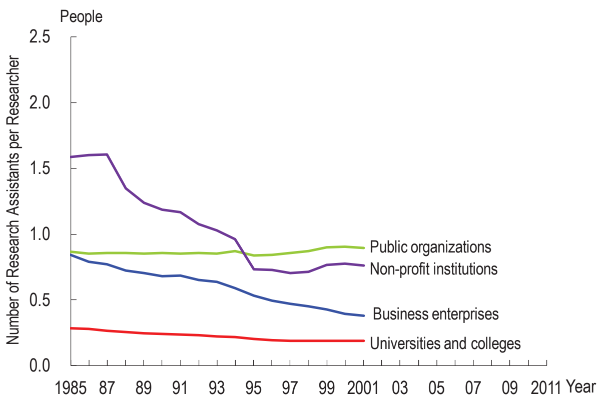
Country	Business Enterprises	Universities and Colleges	Public Organizations	Non-profit Institutions
Japan	(1) Assistant research workers (2) Technicians (3) Clerical and other supporting personnel	(1) Assistant research workers (HC) (2) Technicians (HC) (3) Clerical and other supporting personnel (HC)	(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

Note: 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)

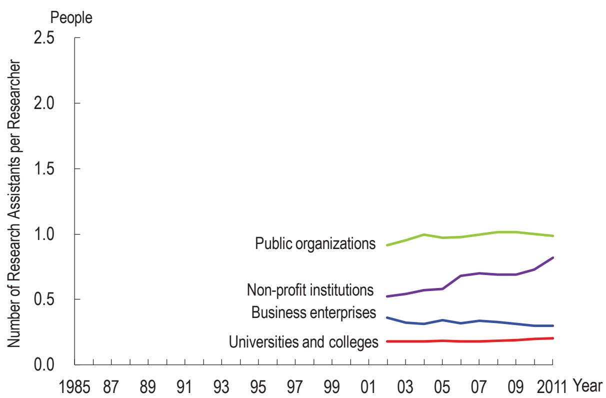
Chart 2-3-2: Trends in the number of research assistants per researcher by sector for selected countries

Attention to international comparison

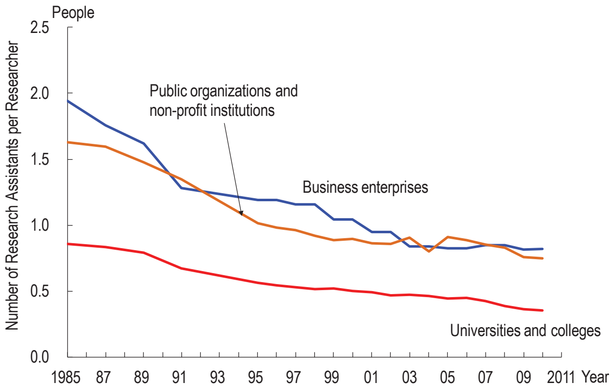
(A) Japan *



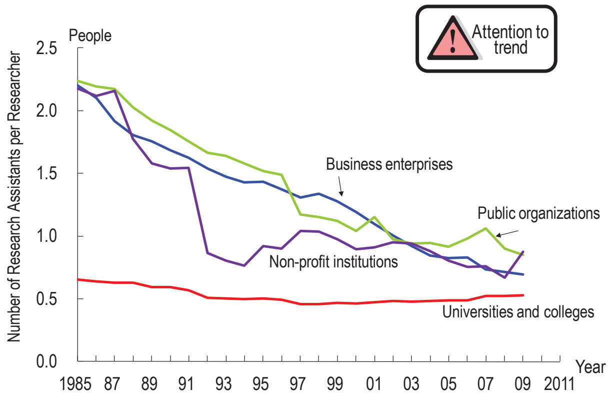
(B) Japan (HC)



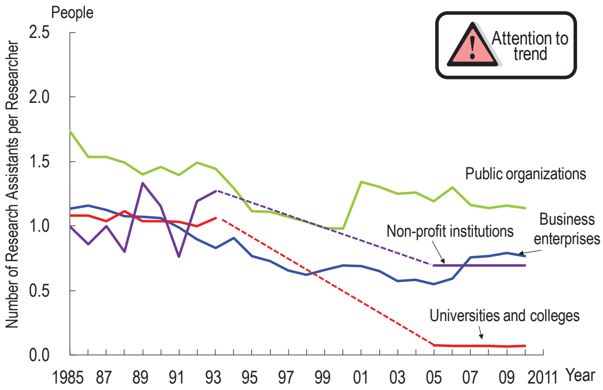
(C) Germany



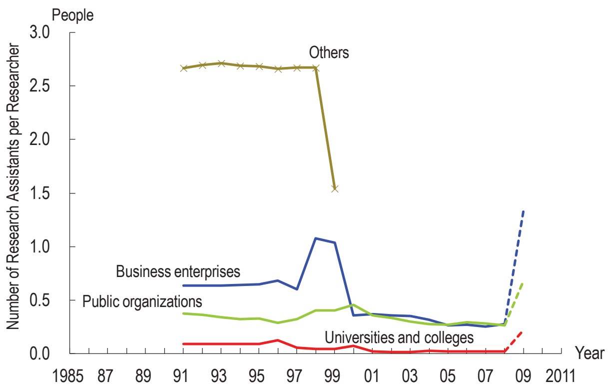
(D) France



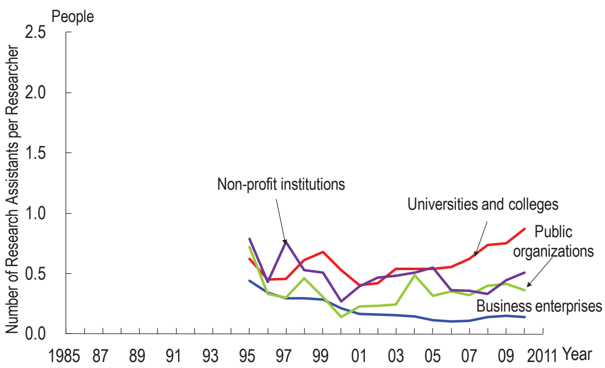
(E) U.K.



(F) China



(G) Korea



Note: 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 universities and colleges 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.

7) With no data for assistants at U.K. universities and non-profit institutions for 1994–2004, estimated values for 2005 on have been corrected by the Secretariat to accord with national estimates and, where necessary, with OECD standards. Because the values may have been underestimated, or may be based on underestimated data, caution is necessary when making comparisons over time.

8) Through 2008, China's definition of researcher used was not in complete accordance with the OECD. The measurement method was changed in 2009. Caution is therefore necessary when observing changes over time.

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 2011/2)" since 2008.
<Other countries> OECD "Main Science and Technology Indicators 2011/2"

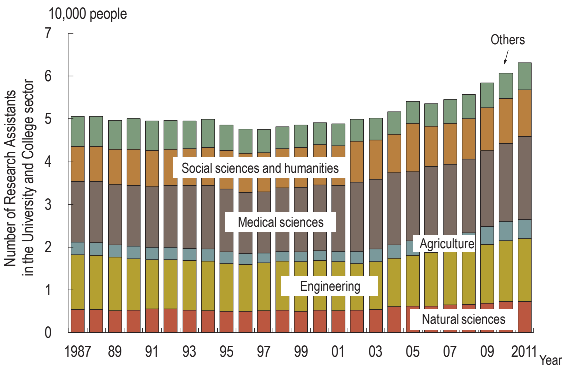
2.3.2 Status of research assistants in the universities and colleges sector in Japan

(1) Breakdown of the number 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 universities and colleges 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 63,000 people in 2011.

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



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

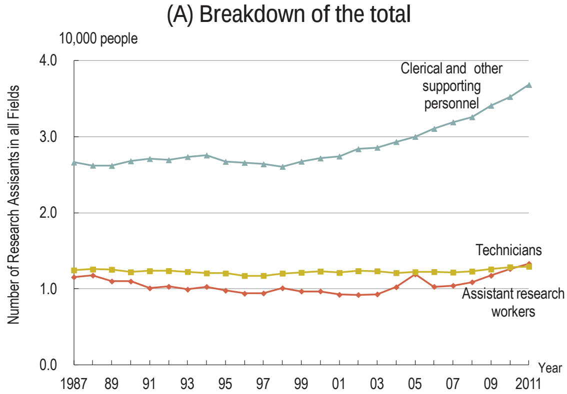
Next, looking at the breakdown of the number of research assistants, the number of "clerical and other supporting personnel", which account for the largest proportion of the total, has been increasing since 2000. It was and 37,000 people in 2011 (Chart 2-3-4(A)).

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.

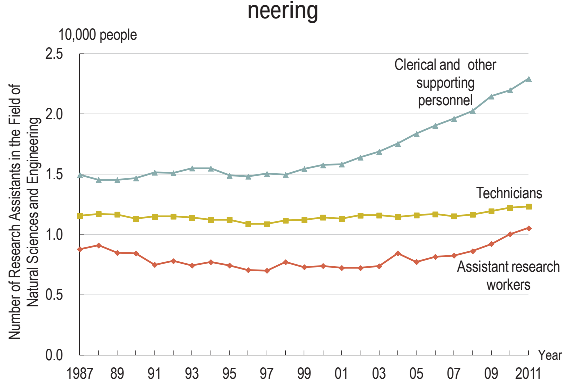
The breakdown of the number of research assistants by the academic field of their affiliation shows that the number of "clerical and other supporting personnel" is highest both in the field of "natural sciences" and the field of "social sciences and humanities" as it was in the breakdown of the total. 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 universities and colleges sector

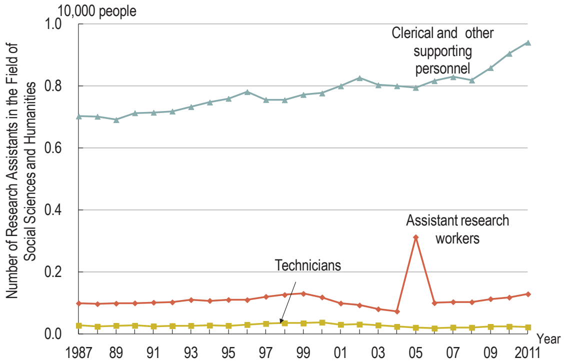
(A) Breakdown of the total



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



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



Note: 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”

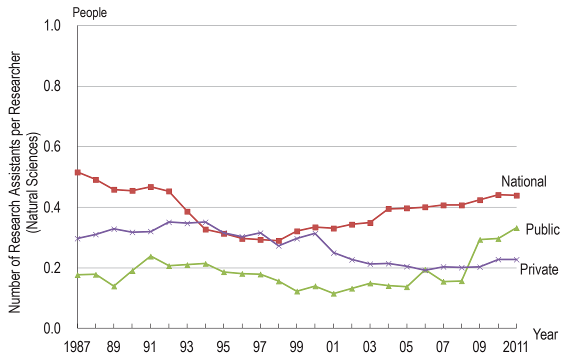
(2) Number of research assistants per researcher

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.)

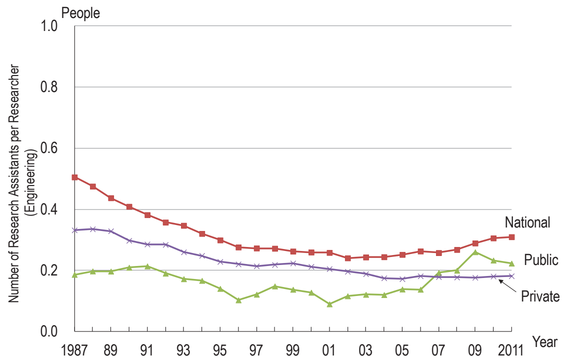
The number of research assistants per researcher is large in national universities in every field. In the field of engineering, although the number had been decreasing over the long term for both national and private universities, the trend has been flat in recent years. In the field of "medical sciences", the number of 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

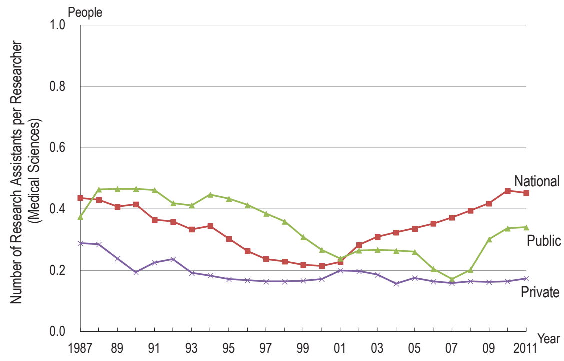
(A) Natural sciences



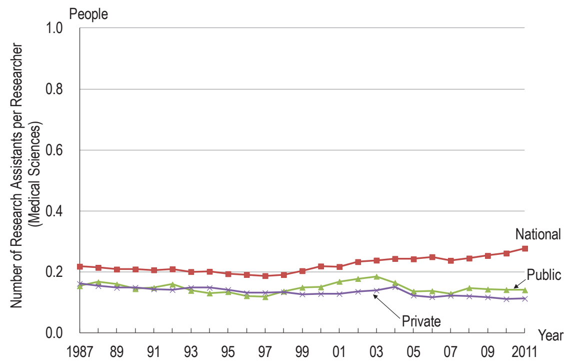
(B) Engineering



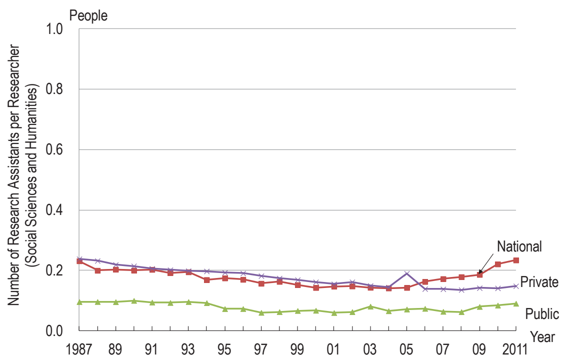
(C) Agriculture



(D) Medical sciences



(E) Social sciences and humanities



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

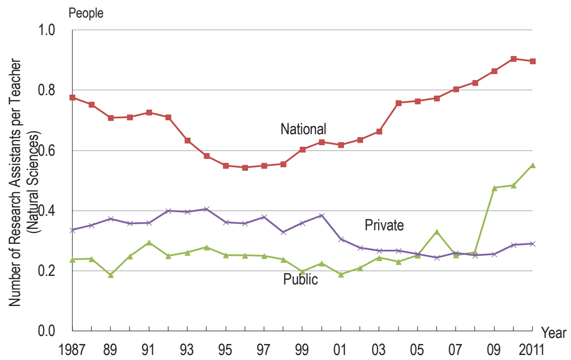
(3) Number of research assistants per teacher

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).

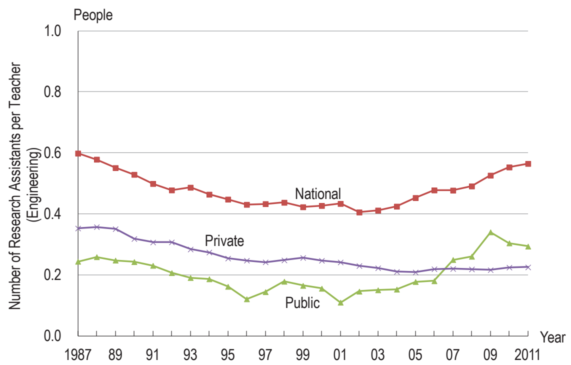
In every field, the number of research assistants at national universities is large and rising. In addition, the number of research assistants per teacher in the field of "natural sciences" and "agriculture" of "national universities" has a similar tendency of a decreasing trend until the 1990s which begins to rise in 2000. In the other fields as well, a rising trend at national universities becomes apparent during the mid-2000s (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

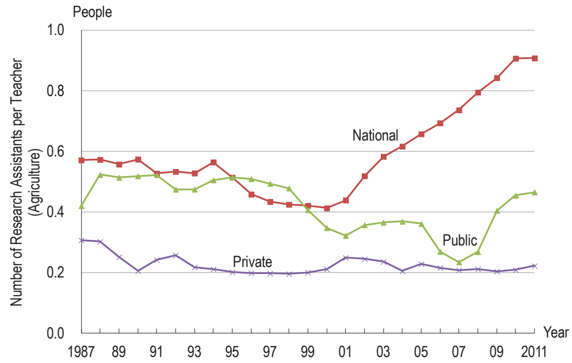
(A) Natural sciences



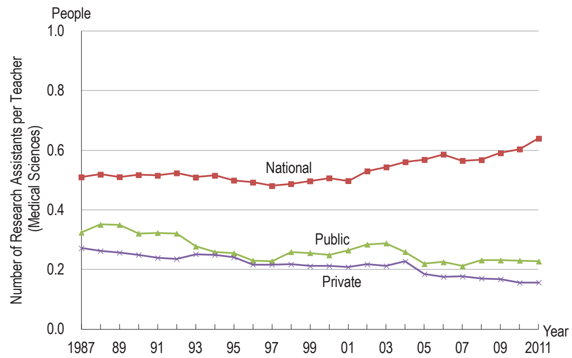
(B) Engineering



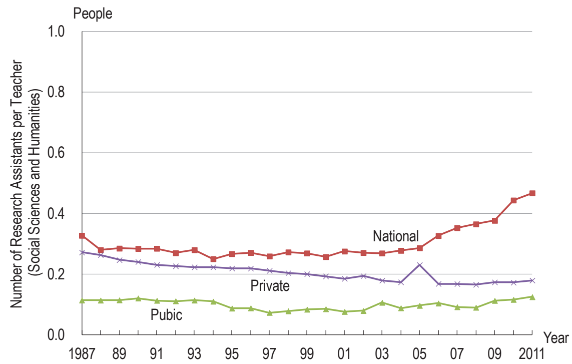
(C) Agriculture



(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

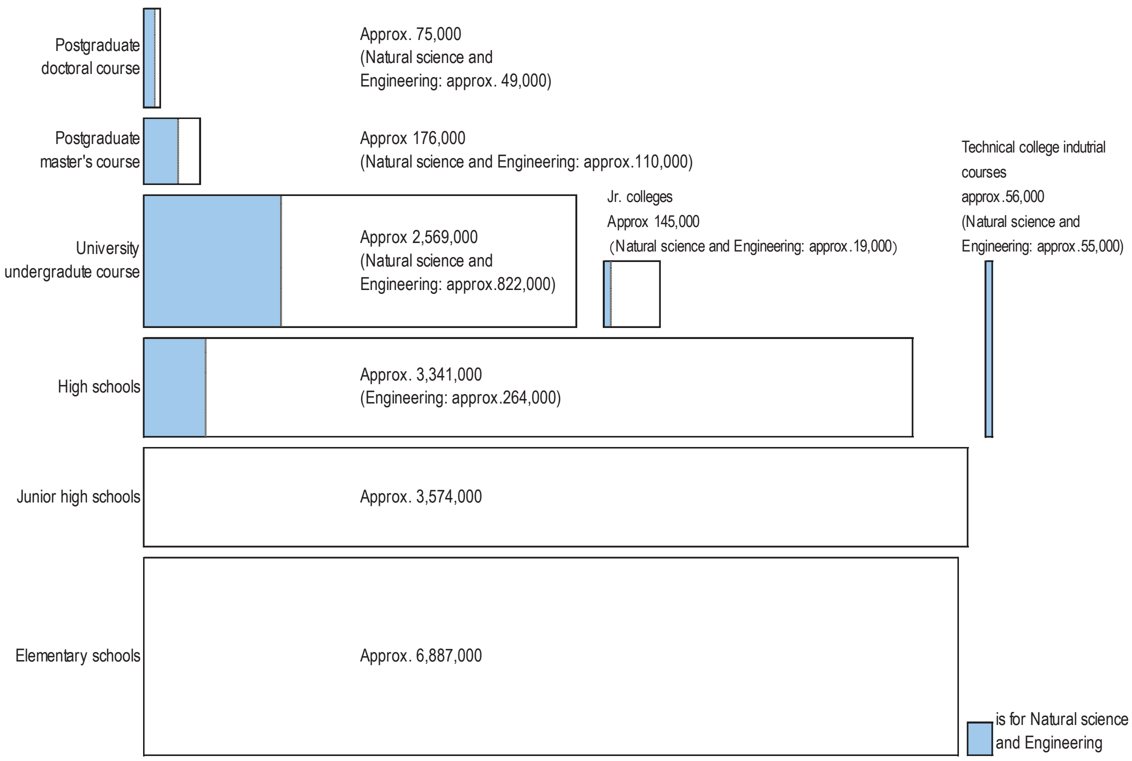
The cultivation of human resources relevant to science and technology is one of the most important basic infrastructures for promoting science and technology. This chapter describes the cultivation of human resources for science and technology in school education, mainly looking at conditions in universities 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 2011, 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 6,887,000, that of pupils in junior high schools are about 3,574,000, and that of high school students are about 3,341,000 (including only the regular courses). The number of undergraduate students is about 2,569,000 (including approx 822,000 in the field of "Natural science and engineering"), and that of college students is about 145,000 (including approx 19,000 in the field of "Natural science and engineering"). The number of master's program students in graduate schools is about 176,000 (including approx 110,000 in the field of "Natural science and engineering") and that of doctoral program students is about 75,000 (including approx 49,000 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 2011)



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 FY2011 it decreased by 1% versus the previous year, to about 613,000. The number newly enrolled in private universities and colleges was high, constituting 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 FY 2010 it increased by 5.4% over the previous year. In FY 2011, however, it decreased by 3.6%, to 79,000. 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.

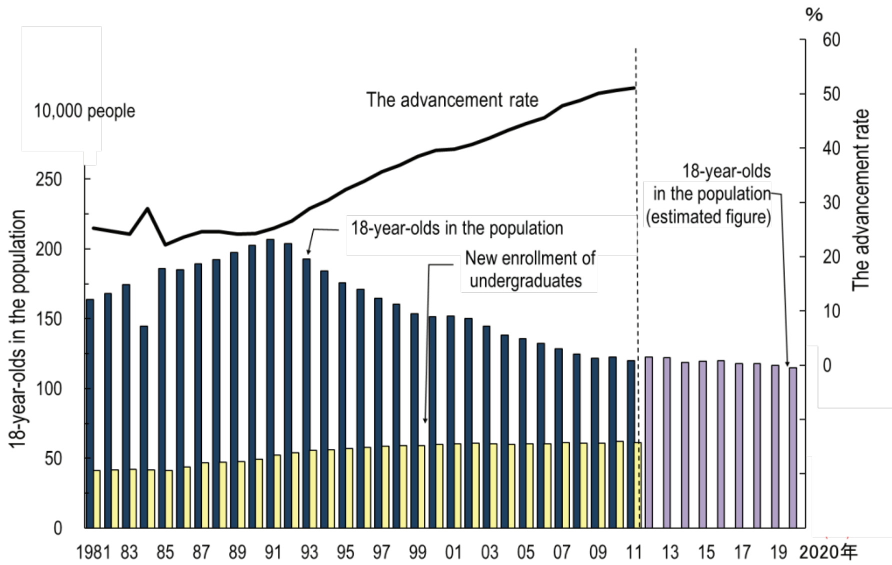
○The number of people newly enrolled in doctoral programs had been decreasing since peaking in 2003, but it increased by 3.6% over the previous year in FY 2010. In 2011, however, it decreased by 4.8%, to 16,000. The number newly enrolled in national universities and colleges was high and constituted 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 1,149,000 in 2020, which 55.5% 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 613,000 for the FY 2011, which represents a growth of 1.5 times. As a result, the advancement rate for the FY 2011 (the ratio of the number newly enrolled to the total of 18-year-olds) is 51%, 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 number newly enrolled for undergraduate studies is the number of students who enrolled in a university or college in the year noted and were still registered as of May 1 (the date of the survey) 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 2007>Ministry of International Affairs and Communications, Statistics Bureau, "Population Estimates" (as of October in every year).
<After 2011>National Institute of Population and Social Security research, "Population Projections for Japan: January 2012"
2) The numbers newly enrolled for undergraduate studies: MEXT, "Report on School Basic Survey"

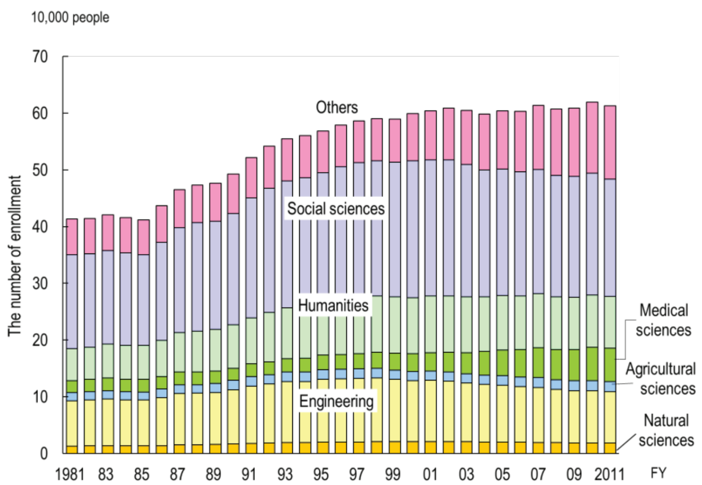
Chart 3-2-2 (A) shows changes in new enrollment of undergraduates by major fields. New enrollment of undergraduates in Japan has been largely unchanged since FY 2000. In FY 2011, it decreased by 1% from the previous year, to 613,000.

Breaking down the new enrollment, the field of "Social sciences" had about 207,000 newly enrolled students, "Humanities" about 91,000, "Engineering" about 90,000, "Medical sciences" about 60,000, "Natural sciences" about 19,000 and Others (Home economics, Education, Art, others) about 129,000. The number of students newly enrolled in the field of "Medical sciences" was 2.7 times as high compared with FY1981, while "Others" was 2.1 times 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
2011	Total	612,858	90,865	207,179	18,825	90,141	17,516	59,552	-	18,091	44,580	17,762	48,347
	National	101,917	6,586	15,026	7,023	29,537	6,554	10,587	-	291	15,948	848	9,517
	Public	29,657	4,740	8,355	653	3,338	1,041	5,961	-	670	594	1,169	3,136
	Private	481,284	79,539	183,798	11,149	57,266	9,921	43,004	-	17,130	28,038	15,745	35,694

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

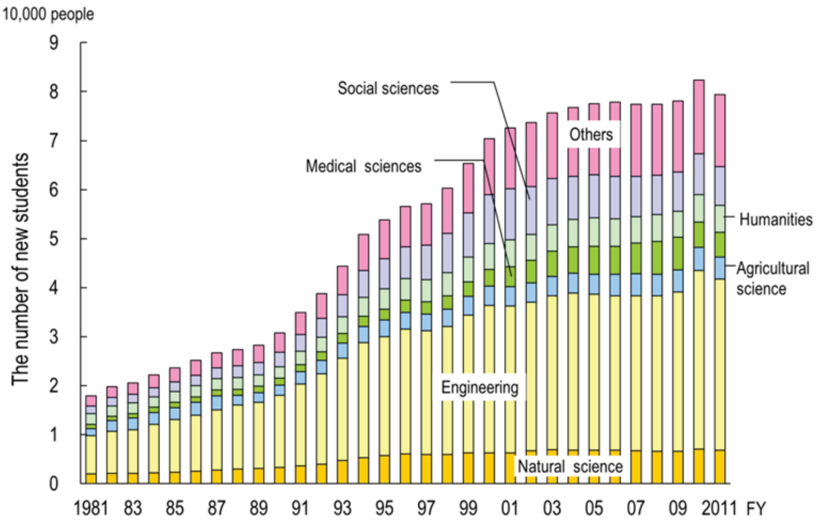
The number of new enrollments in graduate school master's programs in FY 2011 totaled 79,000. It decreased by 3.6% from the previous year. Broken down by major subject, "Engineering" accounted for the largest share, with 35,000 students (43.9% of the total). It was followed by "Social sciences" with 8,000 students (9.9%), "Natural science" with 7,000 (8.6%) and "Medical sciences" with 5,000 (6.4%).

Because there has been a greater of focus on graduate school since FY 1990, the number of new enrollments in master's programs in graduate schools increased greatly between FY 1990 and FY 2000. It grew 2.3 times as large. Growth slowed during the 2000s, but increased to 82,000 in 2010, before decreasing in 2011. Enrollment increases and decreases in "Engineering," the most popular major, contributed significantly to these changes (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
2011	Total	79,385	5,498	7,866	6,848	34,855	4,477	5,094	21	476	4,722	2,090	7,438
	National	44,842	1,618	2,152	4,584	21,545	3,625	2,582	21	88	3,865	504	4,258
	Public	5,085	226	512	634	1,811	166	756	-	120	21	337	502
	Private	29,458	3,654	5,202	1,630	11,499	686	1,756	-	268	836	1,249	2,678

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 FY 2003, but in FY 2010 it increased by 3.6% from the previous year. In FY 2011, however, it decreased by 4.8%, to 15,000. By major, "Medical sciences" had a new enrollment of 6,000, accounting for 36.8%, of the total and "Engineering" had 3,000 (17.9%), 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 a sharp decrease, 10.8%. New enrollments in "Humanities and social sciences" also decreased.

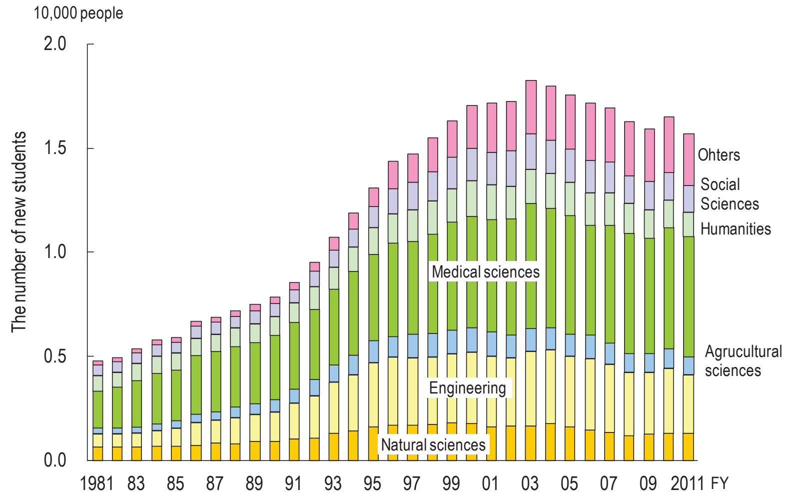
The number of new enrollments in graduate school doctoral programs has increased largely since the beginning of the 1990s. This resembles the increase in the number of new enrollments in graduate school master's programs. The number of new enrollments in master's programs had been flat since the mid-2000s, while that of enrollments in doctoral programs had been decreasing since peaking in 2003. However, new enrollments in both master's and doctoral programs are similar in that they increased in 2010 and decreased in 2011.

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
2011	Total	15,685	1,190	1,269	1,284	2,800	874	5,770	-	65	480	175	1,778
	National	10,557	568	547	1,053	2,273	745	3,637	-	10	340	82	1,302
	Public	1,041	42	74	99	132	29	534	-	15	4	26	86
	Private	4,087	580	648	132	395	100	1,599	-	40	136	67	390

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 FY 2011 was 269,000, accounting for 43.8% of the total. It was an increase of 13.5 percentage points from the FY 1990 figure of 30.2% (Chart 3-2-5).

By department, "Humanities" accounted for the largest share. Next largest was "Medical sciences," which has seen the largest increase, quadrupling since FY 1990 (Chart 3-2-5 (A)).

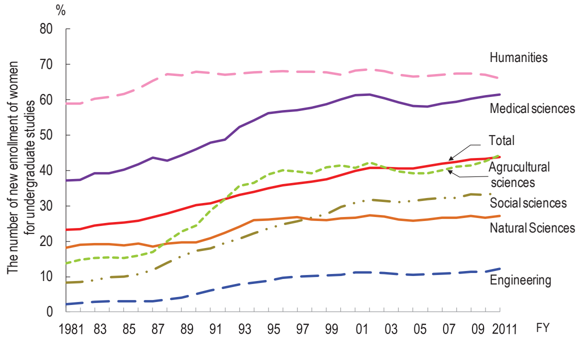
Next, when looking at the percentage of new enrollment by women in master’s programs, many take “Humanities” which is the same as in the case of new enrollments for undergraduates. However, the percentage of female students in “Medical sciences” is also high. Although the percentage for the FY 1990 was 22.9%, it became 53.1% in FY 2011, which was more than the percentage of men (Chart 3-2-5 (B)).

The percentage of new enrollment of female students in doctoral programs for the FY 2011 was 31.4%, which was 2.5 points higher than the percentage of new enrollment of female students in master’s programs in the same year.

The percentage of new enrollment in "Natural sciences and engineering" departments accounted for by women showed a rising trend until the early 1990s. While the trend has slowed recently, the percentage of women entering higher education at the doctoral program level has been increasing significantly in "Natural sciences."

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

(Unit:%)

	FY	Total	Humanities	Social sciences	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Others
Undergraduate 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
	2011	43.8	66.1	33.9	27.1	12.2	44.4	61.5	60.4
Master's programs	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
	2011	28.9	61.4	40.2	22.1	10.2	35.7	53.1	47.8
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
	2011	31.4	52.4	35.6	16.1	14.4	33.5	32.8	42.3

Source: MEXT, “Report on School Basic Survey”

3.2.5 Mature students in higher education institutions

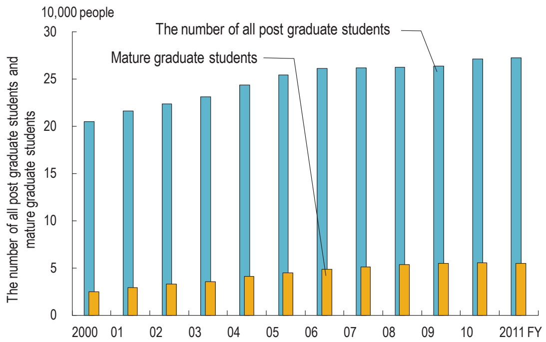
Utilization of higher education institutions to give opportunities for the reeducation of people in the working world who are highly motivated to study is helpful to advance the cultivation of excellent human resources and use them. Moreover, it contributes to energizing society as a whole.

Of all postgraduate students in Japan for the FY 2011, the number of working people was 55,000, which accounts for 20.2%. This is about double the 25,000 mature students in FY 2000, when statistical data on them was first gathered. The number of mature graduate students has consistently increased, although in FY 2011 it decreased slightly for the first time, by 0.6%, compared with the previous fiscal year (Chart 3-2-6).

Looking at the number of mature graduate students in "Natural sciences" and "Engineering" by degree, 4,128 were enrolled in doctoral programs in "Engineering" in FY2011, a decrease after peaking in FY2008. The number of mature graduate students in master's programs in "Engineering" has been on a downward trend since FY2004. At 1,133 in FY2011, there was about one-fourth as many mature students in master's programs as there were in doctoral programs.

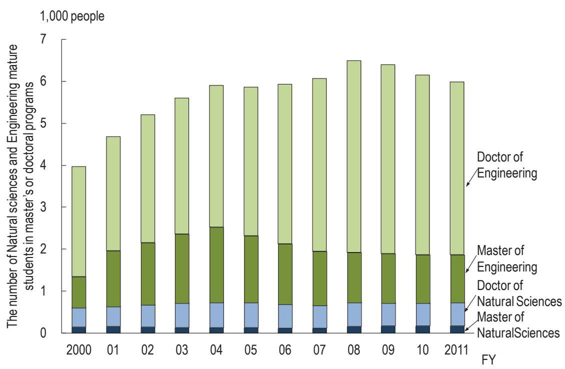
Mature students enrolled in doctoral courses in "Natural sciences" during FY2011 numbered 574. Those in master's courses in "Natural sciences" numbered 162. This was only about 1.2 times the number enrolled during FY2000, a slower growth rate than for "Engineering" (Chart 3-2-7).

Chart 3-2-6: 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"

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, during the 1980s generally about 80% of those receiving bachelor's degrees obtained employment. However, that percentage dropped sharply during the 1990s. In FY 2011, only 46.6% of them obtained employment, while 39.4% proceeded to further higher education.

○As for the career paths of those obtaining master's degrees in natural sciences and engineering, about 80% have been obtaining employment. This percentage had further increased since entering the 2000s. In 2010, however, the percentage decreased slightly. In 2011, 83.8% obtained employment.

○Turning to the career paths of those obtaining doctoral degrees in natural sciences and engineering, the percentage obtaining employment began dropping significantly around 2000, but in recent years it has been climbing again. The percentage obtaining employment in 2011 was 66.6%.

○Looking at the industrial classifications in which graduates receiving bachelor's degrees in natural sciences and engineering obtained employment, over 50% of those obtaining employment during the 1980s went to work in a manufacturing industry. In recent years, however, that percentage fell into the 30s, and in 2011 it was only 29.2%.

○In the case of those receiving master's degrees in natural sciences and engineering, during the 1980s, over 70% of them obtained employment in a manufacturing industry. In recent years, however, the percentage has been in the 60s, and in 2011 it was 56.4%. The percentage obtaining employment in education (employed at schools, etc.) shrank from the 4% level to the 1% level.

○About 30% of those obtaining doctoral degrees in natural sciences and engineering have been obtaining employment in manufacturing industries. In 2011, the figure was 30.9%. During the 1980s, 40 to 50% obtained employment in education (employed by schools, etc.), but in 2011 the percentage was 32.7%. In 2001, 12.9% obtained employment in research (employed by academic or research institutions, etc.).

○Looking by industrial classification at graduates of undergraduate, master's, and doctoral courses in natural sciences and engineering who obtain employment, the majority have become professional and technical workers. In the case of those with master's or doctoral degrees, they have accounted for almost 90% of those obtaining employment. For those with bachelor's degrees, the long-term trend has been downwards. In recent years, their percentage has been in the 70s.

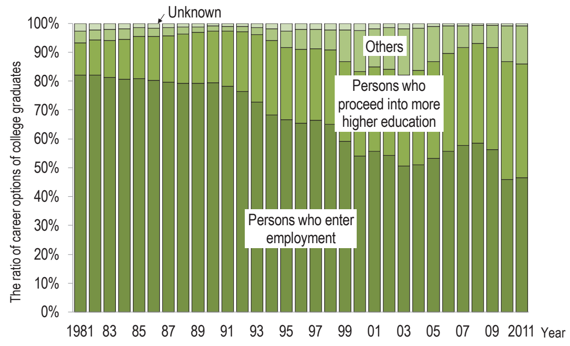
3.3.1 The status of employment and continuing education among students of Natural sciences and Engineering

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 2011, the percentage of “persons who entered employment” was 46.6%, which is the biggest share, and that of “persons who proceeded with more higher education” was 39.4% 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 people proceeding to further education has been trending upward (Chart 3-3-1).

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

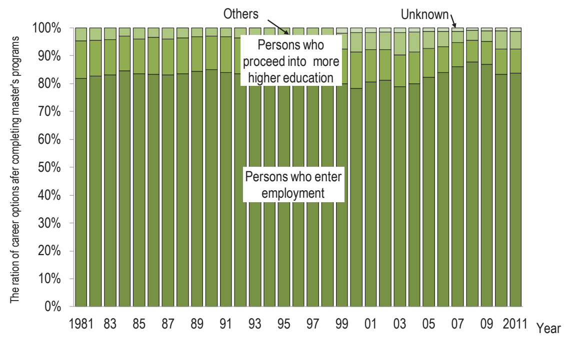


Note: 1) Chart indicates the number of people graduating in March of each year.
2) This chart includes both “persons who entered employment” and “persons who proceeded with more higher education” in the “number of persons who entered employment”.
3) Persons who entered employment are persons who work for current income
4) 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.
5) Unclear: Deceased/Unknown
6) 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. The percentage had been increasing since the beginning of the 2000s, but it decreased slightly in 2010. The rate was virtually unchanged in 2011 at 83.8%. The percentage of "persons who proceeded to higher education" had been declining through the 2000s, but it increased slightly in 2010. It held steady in 2011 at 8.5% (Chart 3-3-2).

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

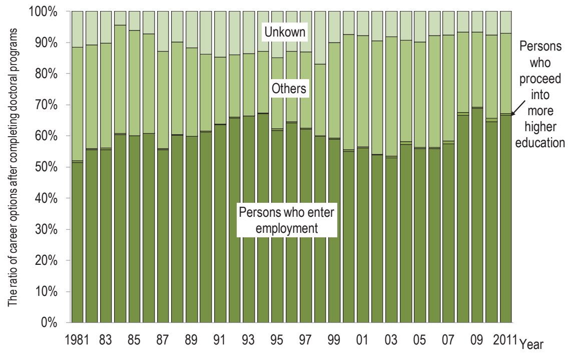


Note: Same as Chart 3-3-1
Source: MEXT, “Report on School Basic Survey”

(3) Career options of people who complete doctoral programs

Looking at the career paths of people who completed doctoral programs in natural science and engineering in 2011 (Chart 3-3-3), "persons who obtained employment" was most common, accounting for 66.6%. The percentage shrunk markedly around 2000, but in recent years it has been on an upward trend. "Other" accounted for 25.8%, a larger percentage than for graduates with bachelor's or master's degrees.

Chart 3-3-3: Postdoctoral career options in natural sciences and engineering



Note: Same as for Chart 3-3-1.
Sources: MEXT, "School Basic Survey."

Chart 3-3-3 shows "Postdoctoral career options in natural sciences and engineering." The percentage of "Other" is higher than it is for those completing bachelor's or master's degrees. "Other" as used here refers to the sum of "medical residents," "persons enrolled in special course schools and schools abroad," "persons with temporary jobs" and "Not applicable" in the School Basic Survey. The following are two probable reasons that the percentage of "Other" is high.

One factor is the effect of career path classifications for postdoctoral fellows. It is unclear whether the School Basic Survey classifies postdoctoral fellows as "persons obtaining employment," "persons obtaining temporary work" or "Not applicable." The employment patterns of postdoctoral fellows are diverse; in some cases, they are employed for terms of a few months at a time. They might therefore be classified as "persons obtaining temporary work" or "Not applicable."

The second reason is probably the effect of graduates with undetermined career paths at the time of the survey. Unlike graduates with bachelor's and master's degrees, most doctoral graduates aim for academic careers. Hiring by businesses in Japan generally takes place during a set period each year. Hiring for academic posts, however, occurs throughout the year. Many doctoral graduates seeking academic careers may therefore have not yet established their career paths as of May 1 of the year following graduation when the School Basic Survey is performed. Having neither obtained employment nor proceeded to further education, those people would likely be classified as "Not applicable." In fact, "Not applicable" accounted for the lion's share, about 70%, of the 1,193 people classified as "Other" in FY 2011.

Moreover, with their career options undetermined at the time of the survey, some people may not have responded to it. (Such cases would end up classified as "Unknown.")

It is thus apparent that, with the percentage of doctoral graduates in natural sciences and engineering entering employment at about 60% annually over the past 20 years, the reason for the high percentage of "Other" is that the career path pattern of doctoral graduates differs from that of bachelor's and master's degree graduates.

In order to obtain more detailed information, it would be necessary to conduct ongoing follow-up surveys to analyze which occupations and industries human resources with doctoral degrees work in, as is done in the U.S.

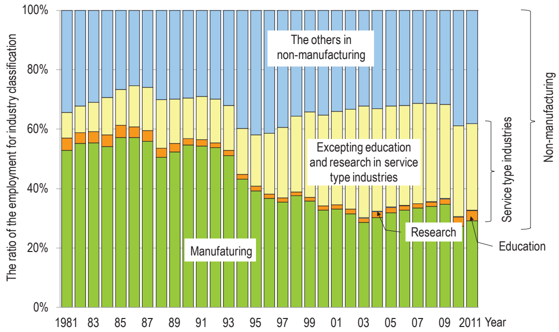
3.3.2 The employment status of students of Natural sciences and Engineering by industry classification

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 (Chart 3-3-4), 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 2011 it dropped to 29.2%. As will be discussed below, this is even lower than the percentage of doctoral recipients who enter employment in "Manufacturing" (30.9%). Meanwhile, the percentage of employment in "Service-type industry" within "Non-manufacturing" increased from the 10s to the 30s. In 2011, it was 29%. Within this, "Education" had decreased from the 4% level to the 1% level, but it rebounded to the 3% level in 2010 and 2011. Additionally, the percentage in "Other non-manufacturing" grew large beginning in 2010.

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

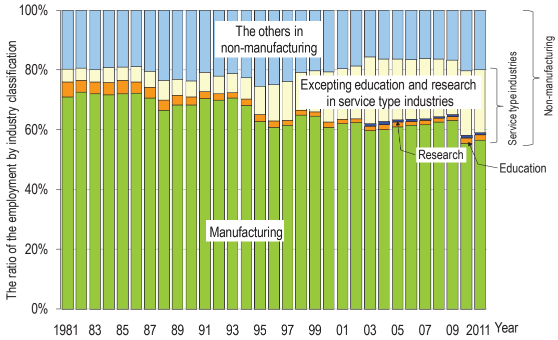


Note: 1) Includes both "persons who entered employment" and "persons who proceeded with more higher education" in the "number of persons who entered employment".
2) 1981 - 2001
Service-type industry: "Service industry" in Japan Standard Industry Classification (1993 revision)
Education: "Education" within "service industry" in the same Classification
Research: No applicable classification
2002 – 2006
Service-type industry: 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/research: "School education" within "Education, Study-support services" and "Academic field/R&D" within "Unclassified other services"
2007 -
Service-type industry: 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/research: In Japan Standard Industry Classification (2007 revision), "Academic field/R&D institutions" within "Academic research, Specialty services" and ""School education" within "Education, Study-support services"
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 in 2011 it dropped to 56.4%. 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% (Chart 3-3-5).

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

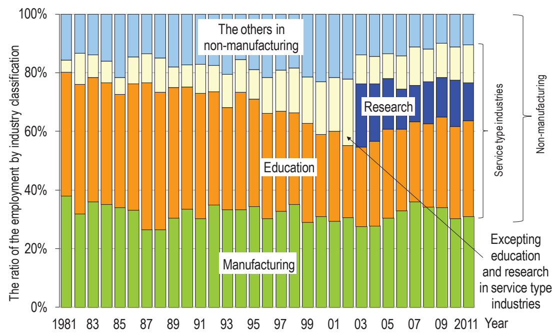


Note: Same as Chart 3-3-4
Source: MEXT, "Report on School Basic Survey"

(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 2011, it was 30.9%. The percentage obtaining employment in "Non-manufacturing" was higher than this. Within "Non-manufacturing," the percentage in "Service-type industry" began increasing during the 2000s. In 2011, it was 58.6%. "Education" within "Service-type industry" declined from between 40% and 50% in the 1980s to less than 30% in the 2000s. In 2011, it accounted for 32.7%. 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. In 2011, it was 12.9% (Chart 3-3-6).

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



Note: 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

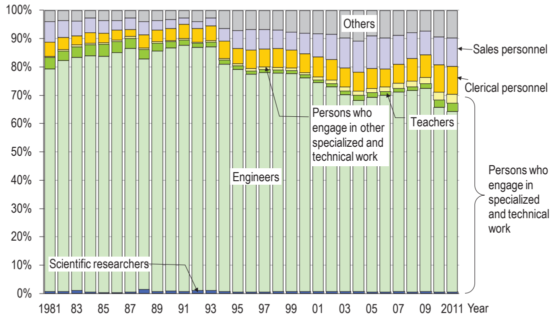
This section shows the place of employment by occupation classification of the students described in section 3.3.1, "The status of employment and education continuance on Natural sciences and Engineering students". Occupation classification referred to herein means the "Japan Standard Occupational Classification" 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." This includes "researchers" in this report. "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, "Engineers" have accounted for a large percentage, but this has been declining over the long term. In 2011, they accounted for 63.8%, the lowest figure ever recorded. The percentage of "persons who engage in clerical work," on the other hand, has been increasing. In 2011, it was 9.9% (Chart 3-3-7).

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

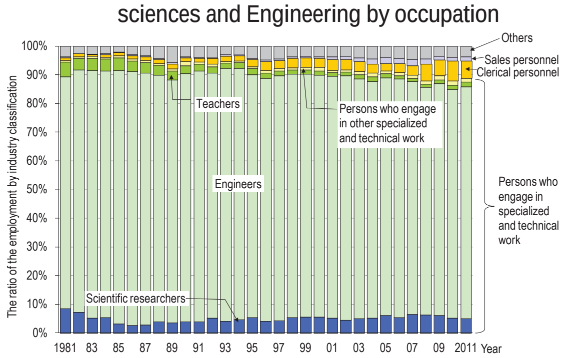


Note: Following a 2011 revision of classifications, researchers are now called "Researchers" rather than "Scientific researchers."
Source: MEXT, "Report on School Basic Survey"

(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

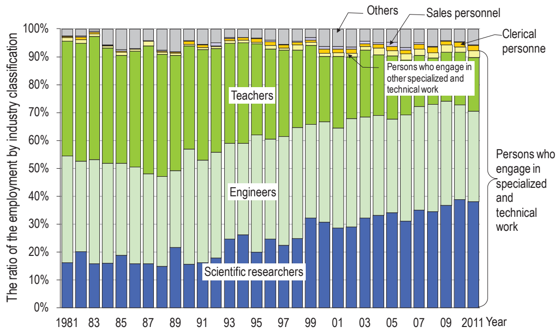


Note: Following a 2011 revision of classifications, researchers are now called "Researchers" rather than "Scientific researchers."
Source: MEXT, "Report on School Basic Survey"

(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 38.1% in 2011. 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



Note: Following a 2011 revision of classifications, researchers are now called "Researchers" rather than "Scientific researchers."
Source: MEXT, "Report on School Basic Survey"

3.4 International comparison of degree awarded

Key Points

○The number of degrees awarded in natural sciences in Japan in 2008 was 1,525. The number had been increasing since FY 1991, but it has been flat since entering the 2000s.

○The number of engineering degrees awarded in Japan in 2008 was 3,954. 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. In recent years, there has been a declining trend.

○Per one million population in Japan, the number of people receiving degrees was 4,322 bachelor's degrees, 584 master's degrees and 131 doctoral degrees.

○Looking at degree recipients per million population in various countries in the most recent available year, Korea (5,843) and the U.K. (5,435) had the highest number of bachelor's degree recipients. The U.K. (3,044) and the U.S. (2,155) had the highest number of master's degree recipients. Germany (306) and the U.K. (288) had the highest number of doctoral degree recipients.

3.4.1 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

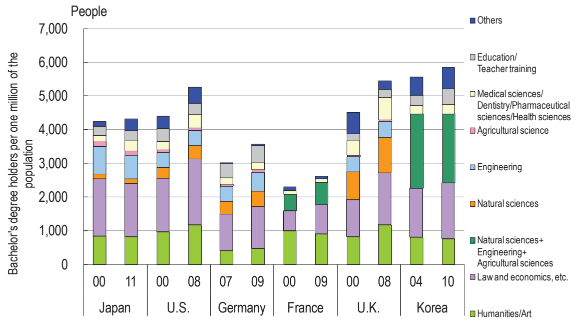
When looking at bachelor's degrees awarded per one million of the population, Japan had about 4,322 in 2011. Countries awarding more than 5,000 in the most recent available year were Korea with 5,843 (in FY2010), the U.K. with 5,435 (FY2008) and the U.S. with 5,254 (FY2008). Germany and France awarded relatively fewer, at 3,576 and 2,615, respectively (both in FY2009).

Regarding the rate of increase when comparing the figures for FY 2000 (FY 2007 for Germany and FY 2004 for Korea) with those for the latest available year in each country, the U.K. had the highest growth rate, becoming 1.21 times as large. It was followed by the U.S. (1.19 times as large), France (1.14), Korea (1.05) and Japan (1.02).

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 Korea, about the same as "Natural science and engineering". In the U.K., "Natural science and engineering" accounts for about 50%.

Chart 3-4-1: 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.

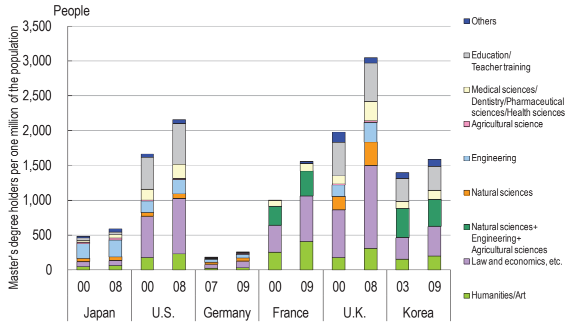
(2) Master's degrees awarded per one million of the population

Looking at the number of master's degrees awarded in each country per one million population, Japan's figure was low at 584 (FY 2008). With about 3,044 in FY 2008, the U.K. marked the largest figure by far, and the U.S. was also large, with around 2,155 in FY 2008.

Regarding the rate of increase when comparing the figures for FY 2000 (FY 2007 for Germany and FY 2003 for Korea) with those for the latest available year in each country, France had the highest rate of increase, becoming 1.56 times as large. It was followed by the U.K., which grew to 1.54 times as large. Japan became 1.22 times as large. Germany has just recently adopted a new master's degree system, so there is little data, but it grew to be 1.47 times as large.

As for composition ratio by field of study in Japan, natural science and engineering accounted for about 60%, double the share in bachelor's degrees. Humanities and social sciences accounted for less than half. In the other countries, the ratio was roughly the same as that for 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 3-4-1

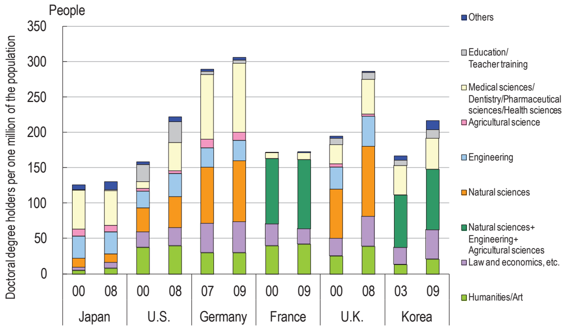
(3) Doctoral degrees awarded per one million of the population

When looking at the number of doctoral degrees awarded in each country per one million heads of the population, Japan had about 131 (in FY 2008), which is less than in other countries. The number for Germany was 306 (in FY 2009), which was the largest of the countries. And that of the U.K. was also high, at 288 (in FY 2008).

Regarding the rate of increase when comparing the figures for FY 2000 (FY 2007 for Germany and FY 2003 for Korea) with those for the latest available year in each country, the U.K. had the highest rate of increase, becoming 1.48 times as large. It was followed by the U.S. (growing 1.4 times as large) and Korea (1.3). Japan grew to only 1.03 times as large, and France also showed almost no growth.

As for composition ratio by field of study, in case of doctoral degrees awarded, the percentage for natural sciences and engineering was high in every country. The ratio was especially high in Japan at about 80%. "Medical sciences / Dentistry / Pharmaceutical sciences/Health sciences" accounted for the largest share of that figure. The percentage for natural science and engineering was high in Germany as well, accounting for about 70% of the total. As in Japan, "Medical sciences/Dentistry/Pharmaceutical sciences/Health sciences" accounted for a large share, although "Natural sciences" did so as well. In France, the ratio of bachelor's and master's degrees awarded in "Social sciences and humanities" was high. For doctoral degrees, however, 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 3-4-1

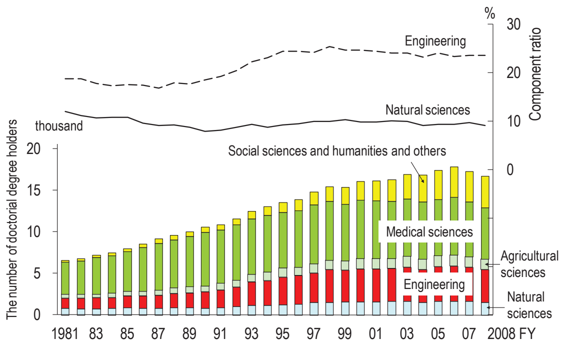
3.4.2 Doctoral degree awarded in Japan

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 3-4-2 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). In FY 2008, 16,735 doctoral degrees were awarded. Over the long term, the number had continually increased, until growth slowed during the 2000s and peaked during FY 2006. Since then it has been declining.

A breakdown of the doctoral degrees awarded during FY 2008 by main subjects of study finds that "Medical sciences" (medicine, dentistry, pharmaceutical science and health science) was the most common subject, accounting for 6,241 degrees, 37.3% of the total. This was followed by engineering with 3,954 degrees (23.6%) and natural sciences with 1,525 degrees (9.1%).

Chart 3-4-2: 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

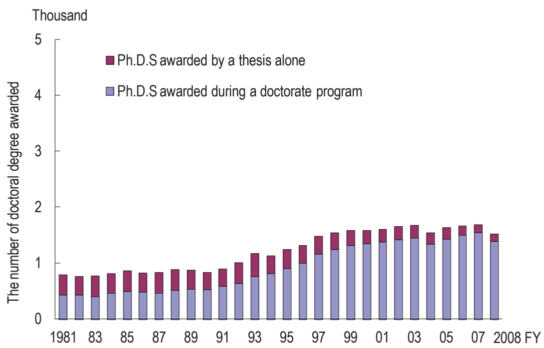
Chart 3-4-3 shows the change in the number of degrees awarded by the breakdown of the number of Ph.D.s awarded during a doctoral program and Ph.D.s awarded by a thesis alone.

In 2008, 1,525 degrees were awarded in natural sciences. The number of degrees awarded began increasing in 1991, but it 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 90% in FY2008.

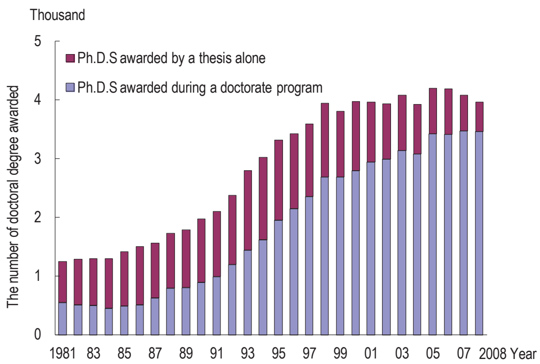
In FY 2008, 3,954 engineering degrees were conferred. There had been a sharp increase in the number of engineering degrees conferred since the late 1980s, but, as with natural sciences, growth flattened during the 2000s and a downward trend has since appeared. Looking at the breakdown of Ph.D.s awarded through a doctoral program and Ph.D.s awarded through a thesis alone, until the mid-1990s, the number conferred through a thesis exceeded the number awarded through a program. Since then, however, the number awarded through a program has increased markedly, to the point of accounting for the vast majority of degrees awarded. In FY 2008, degrees awarded through a program accounted for 90 percent of doctoral degrees.

Chart 3-4-3: 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



Note: Same as Chart 3-4-2.
Source: Same as Chart 3-4-2

3.5 Foreign students in institutions of higher education

Key Points

○Looking at the state of foreign graduate students in Japan and the U.S., Japan had 16,000 foreign graduate students in 2011. Chinese graduate students accounted for the largest number, 8,000, which was half the total. In the U.S., there were 176,000 foreign graduate students in 2010. Indian students accounted for the largest number, with 62,000.

○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 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., and the largest number of students from the U.S. is enrolled in the U.K.

3.5.1 Foreign graduate students in Japan and the U.S.

This section discusses the state of foreign students in graduate schools, which train researchers and advanced specialist. These foreign graduate students can be considered an indicator of globalization in higher education. Chart 3-5-1 shows the number of foreign students from the top 10 countries registered in graduate schools in Japan and the U.S. each year. The fields are "Natural science and engineering" in Japan and "Science and engineering" in the U.S.

As seen in the chart, Japan had 16,000 foreign graduate students in 2011. Chinese graduate students accounted for the largest number, 8,000, which was half the total. There was a considerable gap between first and second place, with the next highest total less than 2,000 (from North and Korea).

In the U.S., there were 176,000 foreign graduate students in 2010. Indian students accounted for the largest number, with 62,000, followed by 47,000 Chinese students. The gap between first and second place was not as large proportionally as it was in Japan.

Comparing the most recent available years for Japan and the U.S., the U.S. has about 10 times as many foreign graduate students as Japan. Indian students, who rank number one in the U.S., are only in eighth place in Japan. Graduate students from European countries such as Germany, the U.K. and France did not make the top 10 in either Japan or the U.S.

Chart 3-5-1: Foreign graduate students in Japan and the U.S.

(A) Japan: Natural sciences and engineering

(Unit people)

No.	Country/Region	2006	2007	2008	2009	2010	2011
1	China	5,414	5,464	5,592	6,014	7,211	8,089
2	Korea	1,432	1,412	1,393	1,431	1,582	1,614
3	Indonasia	616	599	612	703	864	916
4	Vietnam	435	474	538	664	689	765
5	Thailand	494	529	508	571	629	694
6	Bangladesh	604	624	590	597	598	555
7	Malaysia	275	300	333	370	462	484
8	India	161	182	162	199	215	255
9	Egypt	173	205	240	249	231	183
10	Nepal	129	155	159	174	177	171
	France	63	66	81	86	92	115
	U.S.	64	67	71	83	97	101
	Germany	26	32	30	32	41	39
	U.K.	23	26	27	27	20	23
	Total	12,062	12,343	12,518	13,458	15,274	16,368

(B) U.S.: Science and engineering

(Unit people)

No.	Country/Region	2006	2007	2008	2009	2010
1	India	38,862	46,743	50,290	61,420	62,450
2	China	30,862	32,167	33,140	42,440	47,370
3	Korea	10,120	10,068	9,830	10,120	9,210
4	Taiwan	5,869	6,084	5,980	6,530	6,100
5	Turkey	3,407	3,420	3,330	3,480	3,260
6	Canada	2,105	2,094	2,090	3,120	2,690
7	Nepal	1,119	1,416	1,630	2,220	2,310
8	Japan	2,674	2,508	2,240	2,060	1,710
9	Mexico	1,190	1,325	1,380	1,500	1,470
10	Colombia	1,195	1,276	1,310	1,480	1,370
	U.K.	825	830	×	840	810
	France	1,021	1,035	1,020	×	×
	Germany	1,310	1,348	1,350	×	×
	Total	131,455	141,767	146,020	172,250	176,120

Note: 1) For Japan, foreign students are those without Japanese citizenship. For the U.S., foreign students are those without U.S. citizenship.
2) In the U.S. chart, "X" indicates no data were available.
Sources: <Japan> Ministry of Education, Culture, Sports, Science and Technology, "Report on School Basic Survey"
<U.S.> NSF, "Science and Engineering Indicators 2006, 2008, 2010, 2012"

3.5.2 Foreign students in institutions of higher education in selected countries

Chart 3-5-2 shows changes in the number of foreign students at institutions of higher education in each country. 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.

Turning first to Japan's situation, in 2009, the largest number of foreign students was from China, at 79,000. It was followed by Korea, with about 25,000 students in Japan. In contrast, there were 2,000 students from the U.S., and less than 500 each from Germany and the U.K. As for changes, the number of Chinese students peaked in 2006 and has been declining since. The number of Korean and U.K. students has been flat, while those from the U.S., Germany and France have been increasing.

Looking at the situation in the U.S., Chinese students accounted for the largest number in 2009 at 124,000. It was followed by Korea with 74,000 students, and Japan with 28,000. The numbers of students from both China and Korea have been increasing, but the number from Japan has been decreasing. Although there were about 28,000 students from Japan in the U.S. during 2009, 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 2009. The trend, however, has been downward since about 2006. French students account for the next largest number, with 6,000. At 5,000, the number of Korean students is also large. 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 24,000 in 2009, 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.

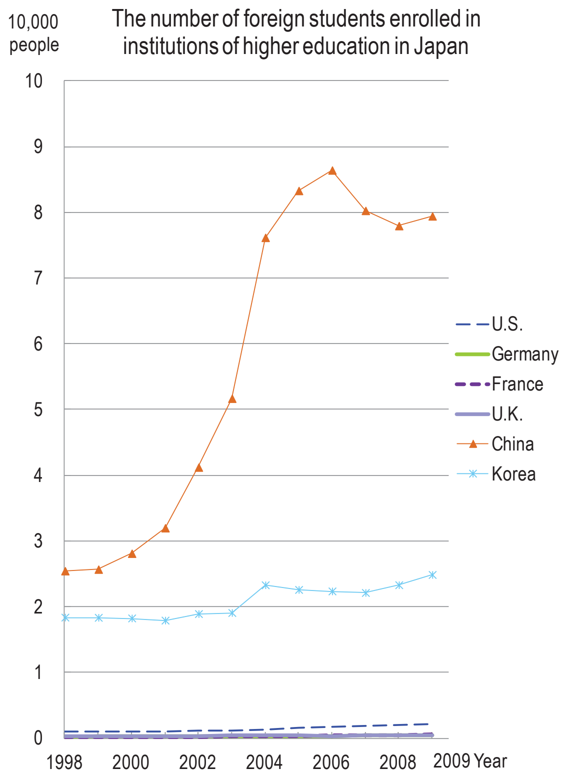
In the U.K. as well, Chinese students accounted for the largest number, with 54,000 in 2009. However, the numbers have been fluctuating since about 2005. The next largest number of foreign students, 19,000, was from Germany. The number of students from Japan has been on a downward trend during recent years. There were 4,000 Japanese students in the U.K. during the most recent available year.

China accounted for the largest number of foreign students in Korea too, with 40,000, and the number has been increasing. The next largest number of students was from Japan, but they only numbered about 1,000.

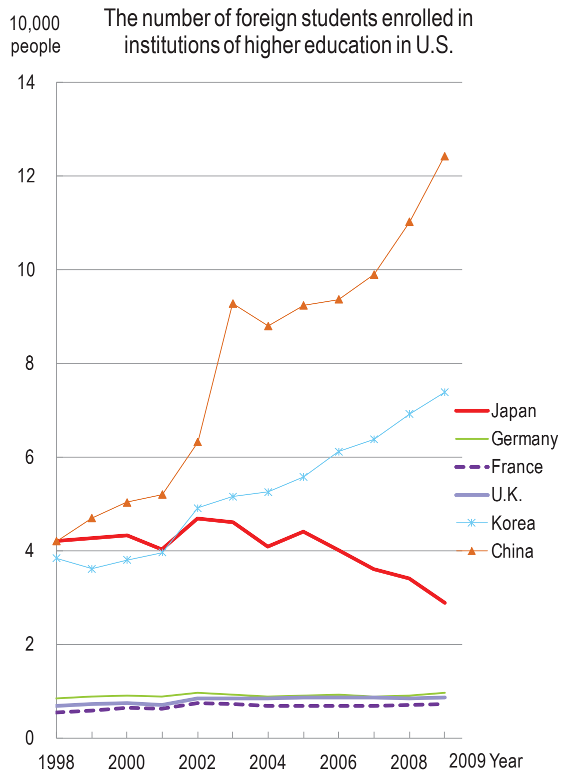
As for where the most foreign students from the different countries enroll in institutions of higher education, the U.S. accounts for the largest numbers of students from Japan, China and Korea. The largest numbers of students from Germany and France are enrolled in the U.K. The largest number of students 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 3-5-2 The number of foreign students enrolled in institutions of higher education in selected countries

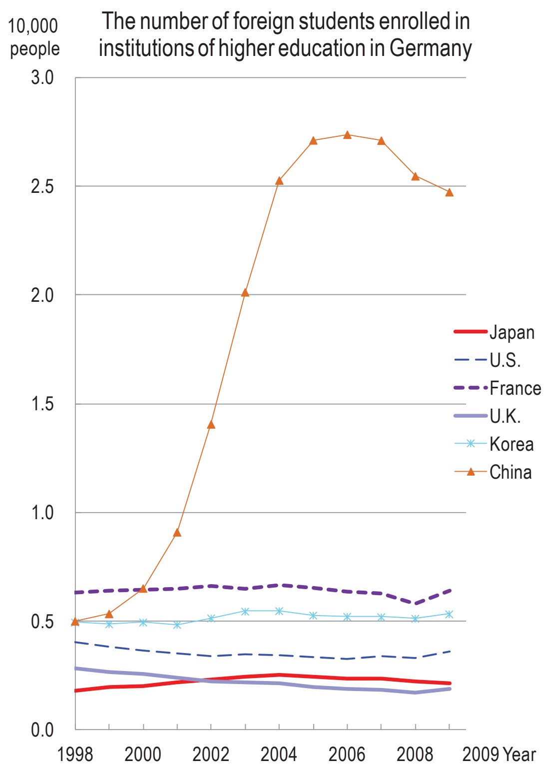
(A) Japan



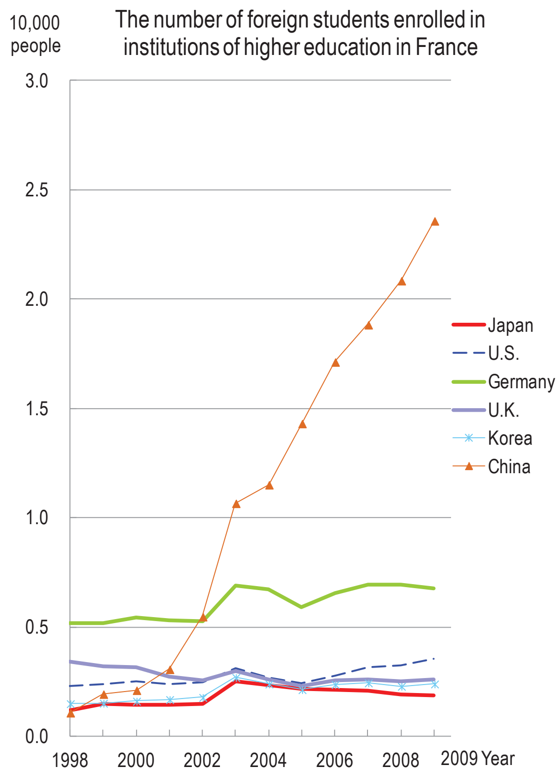
(B) U.S.



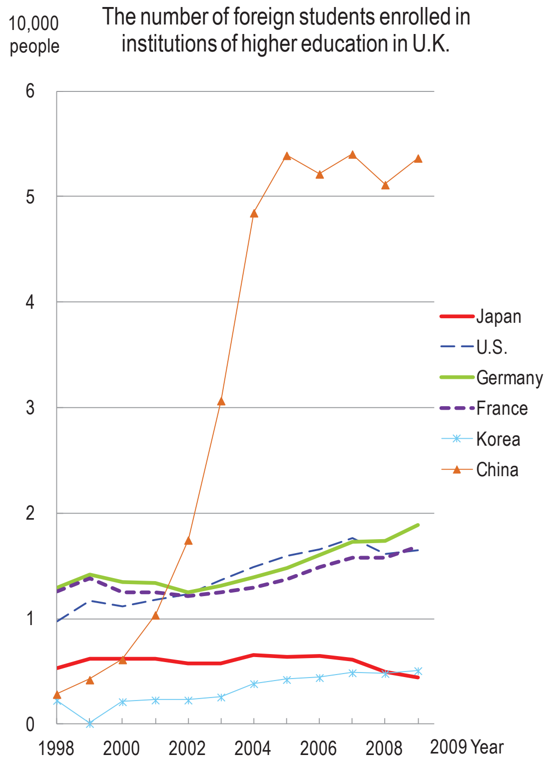
(C) Germany



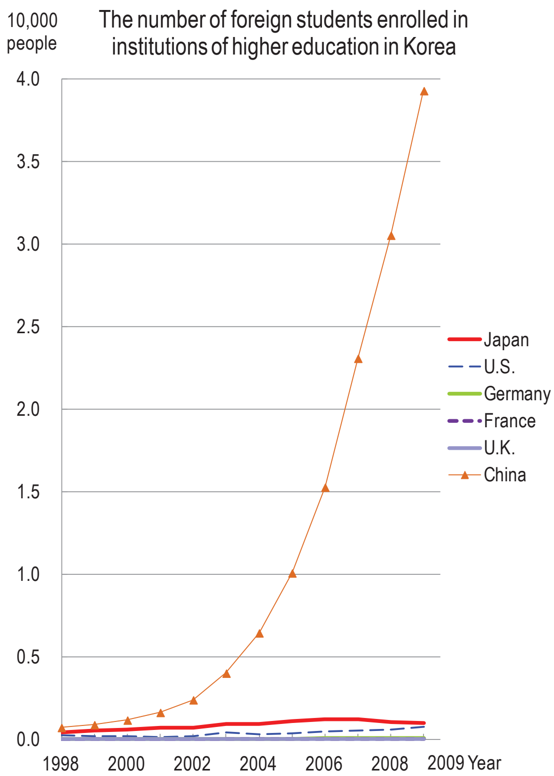
(D) France



(E) U.K.



(F) Korea



Note: Foreign students are students who are not citizens of their host countries.
For the U.S., numbers are for foreign students through 2003 and for international students (non-citizen students without permanent or long-term residency) from 2004 on.
Sources: OECD Stat (via internet)

Column: Ranking of the medal count in the International Science Olympiad

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. The results of each Olympiad are generally announced by the host country's secretariat. They are not collected in one source. The results of the Olympiads in mathematics, physics, chemistry, biology and informatics have therefore been collected here for comparison at three time points.

In the International Science Olympiads, more than one set of medals is awarded. The number of Gold, Silver and Bronze Medals awarded and the number of participants vary by Olympiad. The order of the rankings used here is determined by the number of Gold Medals won by each country. In the event of a tie in Gold Medals, rank is determined by the number of Silver Medals, and then Bronze Medals if necessary. In the event a tie is still not broken, the countries are assigned the same rank and listed in alphabetical order. The performances of major countries appearing in the Science and Technology Indicators, such as Japan, the U.S., Germany, France, the U.K., China and Korea, is noted even when they fall outside the top 10.

Looking at Chart 3-6-1, in each Olympiad the performances of East Asian nations such as China and Korea stand out. Countries such as Iran and Vietnam began appearing in the top 10 in 2000.

As for Europe, Russia and other Eastern European nations appear in the top 10 more often than Western European nations such as Germany, France and the U.K. do. Countries such as Romania and Belarus also began appearing often in the top 10 in 2000. The U.S. appears in the top 10 in almost every Olympiad.

Japan only began participating in all the Olympiads in recent years. It began participating in the Mathematical Olympiad in 1990, but it first joined in the International Physics Olympiad in 2006 and in the International Chemistry Olympiad in 2003. Japan participated in the International Olympiad in Informatics from 1994 through 1997, but then stopped before joining in again starting in 2006. It began participating in the International Biology Olympiad in 2005.

Japan thus began participating later than other countries did. However, it has posted excellent results, usually finishing in the top 10 in each Olympiad.

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 3-6-1: Medal counts in the International Science Olympiads

	Mathematics														
	2000				2006					2011					
Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze
1	China	6	-	-	1	China	6	-	-	1	China	6	-	-
2	Russia	5	1	-	2	Korea	4	2	-	1	U.S.	6	-	-
3	Korea	3	3	-	3	Germany	4	-	2	3	Singapore	4	1	1
3	U.S.	3	3	-	4	Iran	3	3	-	4	North Korea	3	3	-
5	Taiwan	3	2	1	4	Russia	3	3	-	5	Thailand	3	2	1
5	Vietnam	3	2	1	6	Romania	3	1	2	5	Turkey	3	2	1
7	Bulgaria	2	3	1	7	U.S.	2	4	-	7	Iran	2	4	-
7	Iran	2	3	1	8	Japan	2	3	1	7	Russia	2	4	-
9	Belarus	2	2	2	9	Vietnam	2	2	2	7	Taiwan	2	4	-
10	Ukraine	2	2	-	10	Italy	2	2	-	10	Korea	2	3	-
15	Japan	1	2	3	20	France	1	-	3	11	Japan	2	2	2
17	Germany	1	1	2	23	U.K.	-	4	1	14	U.K.	2	1	2
20	U.K.	-	2	4						16	Germany	1	3	2
43	France	-	-	3						41	France	-	1	4

Physics														
2000					2006					2011				
Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze
1	China	5	-	-	1	China	5	-	-	1	China	5	-	-
2	Russia	2	2	1	2	Indonesia	4	1	-	1	Korea	5	-	-
3	Hungary	2	-	3	2	Korea	4	1	-	1	Singapore	5	-	-
4	India	2	-	2	4	U.S.	4	1	-	1	Taiwan	5	-	-
4	Taiwan	2	-	2	5	Taiwan	3	1	1	5	Hong Kong	3	2	-
6	Bulgaria	1	-	-	6	Russia	2	3	-	5	India	3	2	-
6	Switzerland	1	-	-	7	Germany	2	1	2	5	Japan	3	2	-
8	Iran	-	3	2	7	India	2	-	3	8	Kazakhstan	3	1	1
9	Korea	-	3	-	9	Canada	2	-	1	8	Slovakia	3	1	1
10	U.S.	-	1	4	10	Hungary	1	4	-	8	Thailand	3	1	1
					10	Iran	1	4	-					
					10	Thailand	1	4	-					
16	Germany	-	-	2	21	France	-	2	3	11	U.S.	2	3	-
16	U.K.	-	-	2	23	Japan	-	1	3	14	Germany	1	4	-
Japan was nonparticipation (joined in 2006)					33	U.K.	-	-	5	17	France	1	2	2
France was nonparticipation (joined in 2001)										26	U.K.	-	3	2

Chemistry														
2000					2006					2011				
Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze
1	Russia	4	-	-	1	China	4	-	-	1	China	4	-	-
2	China	3	1	-	2	Korea	3	1	-	1	Korea	4	-	-
3	Hungary	2	2	-	2	Russia	3	1	-	3	Russia	3	1	-
3	Taiwan	2	2	-	2	Taiwan	3	1	-	4	Indonesia	2	2	-
5	Austria	2	1	1	5	Vietnam	2	2	-	4	Thailand	2	2	-
5	Slovakia	2	1	1	6	Poland	2	1	1	4	U.S.	2	2	-
7	U.S.	2	-	2	7	Japan	1	3	-	7	Czech Republic	2	1	1
8	Belarus	1	2	1	8	Canada	1	2	1	7	France	2	1	1
8	Iran	1	2	1	8	Denmark	1	2	1	7	India	2	1	1
8	Turkey	1	2	1	8	Germany	1	2	1	7	Iran	2	1	1
8	Vietnam	1	2	1	8	India	1	2	1					
					8	Singapore	1	2	1					
					8	Thailand	1	2	1					
					8	Ukraine	1	2	1					
12	Korea	1	1	2	18	U.S.	-	3	1	11	Japan	1	3	-
15	Germany	-	4	-	25	France	-	2	1	13	Germany	1	2	1
32	France	-	-	4	26	U.K.	-	1	3	17	U.K.	1	1	1
32	U.K.	-	-	4										
Japan was nonparticipation (joined in 2003)														

Informatics														
2000					2006					2011				
Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze
1	Russia	4	-	-	1	China	4	-	-	1	China	3	1	-
2	Romania	2	2	-	2	Poland	3	1	-	1	Taiwan	3	1	-
3	Canada	2	1	1	3	Russia	3	-	1	1	U.S.	3	1	-
3	China	2	1	1	4	Romania	2	1	1	4	Croatia	3	-	1
3	Iran	2	1	1	5	Belarus	2	1	-	5	Russia	2	2	-
6	Poland	2	1	-	6	Japan	2	-	1	6	Poland	2	1	1
7	U.S.	1	2	1	7	Korea	1	3	-	6	Thailand	2	1	1
7	Vietnam	1	2	1	7	U.S.	1	3	-	8	Belarus	1	3	-
9	Israel	1	2	-	9	Iran	1	2	1	8	Japan	1	3	-
10	Korea	1	1	2	9	Ukraine	1	2	1	10	Bulgaria	1	1	2
										10	Singapore	1	1	2
										10	Turkey	1	1	2
										10	Vietnam	1	1	2
19	Germany	-	2	2	27	France	-	1	2	15	France	1	-	1
28	U.K.	-	1	2	42	Germany	-	-	2	28	Germany	-	1	2
39	France	-	-	2	42	U.K.	-	-	2	46	U.K.	-	-	1
Japan was nonparticipation (joined in 2006)														

Biology														
2000					2006					2011				
Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze	Rank	County/Region	Gold	Silver	Bronze
1	Korea	4	-	-	1	China	4	-	-	1	Taiwan	4	-	-
2	Taiwan	3	1	-	2	Korea	3	1	-	1	U.S.	4	-	-
3	China	2	2	-	2	Taiwan	3	1	-	3	China	3	1	-
4	Russia	2	1	1	2	Thailand	3	1	-	3	Japan	3	1	-
5	Turkey	1	3	-	5	Singapore	2	2	-	3	Singapore	3	1	-
6	Australia	1	2	1	5	U.S.	2	2	-	6	Korea	2	2	-
6	Belarus	1	2	1	7	Australia	1	3	-	6	Thailand	2	2	-
6	Ukraine	1	2	1	8	Turkey	1	1	2	8	Hungary	1	2	1
9	Vietnam	1	-	1	9	Ukraine	1	-	3	9	New Zealand	1	1	1
10	Germany	-	3	1	10	India	-	3	1	10	Switzerland	1	-	2
10	Thailand	-	3	1	10	Iran	-	3	1					
					10	U.K.	-	3	1					
14	U.K.	-	1	3	13	Germany		2	2	15	Germany	-	2	2
Japan was nonparticipation (joined in 2005)					27	Japan			3	15	U.K.	-	2	2
U.S. was nonparticipation (joined in 2004)														
France was nonparticipation (joined in 2007)					France was nonparticipation (joined in 2007)					France was nonparticipation				

Note: 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.
Sources: Each Olympiad's website created by NISTEP.

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 2009–2011), using whole counting, Japan is ranked fifth in the world, after the U.S., China, Germany and the U.K.. Meanwhile, using fractional counting, Japan ranks third, behind the U.S. and China and slightly ahead of Germany in fourth place and the U.K. 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, 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.

○ Looking at the field portfolios of each country by world share, Japan's portfolio is heavily weighted towards Physics, Chemistry and Material science, while the weights of Computer science/Mathematics and Environment/Geoscience are light.

○The percentage of international co-authorship for 2011 was 52% for Germany, 54% for the U.K. and 54% for France, while the U.S. was 35% and Japan was 27%.

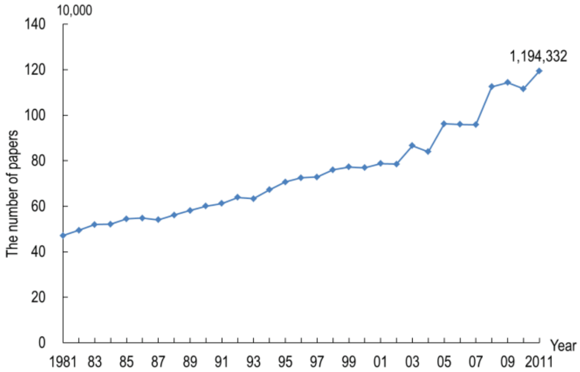
4.1.1 Quantitative and qualitative changes in research activities in the world

(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 "Science and Technology Indicators 2011" (August 2011) do not match.

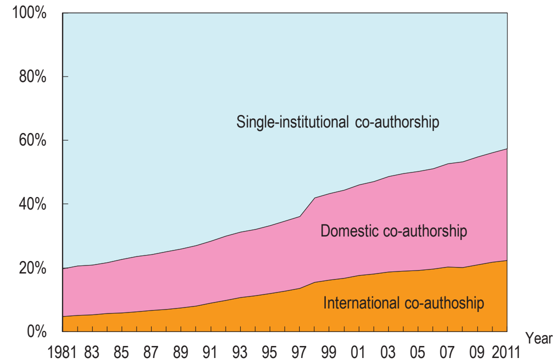
Compared with the early 1980s, the quantity of papers presented in the world has more than doubled, and the world's research activities have a consistent tendency to expand from a quantitative standpoint today. For this period, journals recorded in Databases, which have been used for analysis, were revised 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" (SCIE, CPCI: Science)

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)

(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).

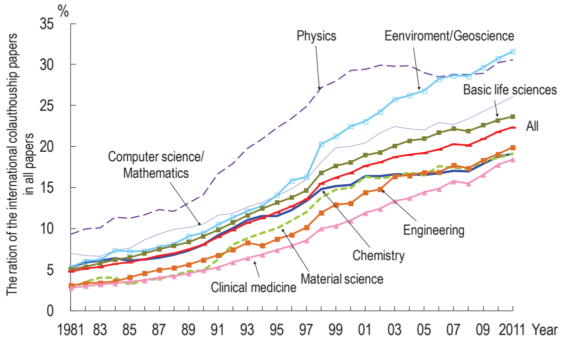
This figure shows that the ratio of single-institutional co-authorship papers has declined, and that of domestic co-authorship papers and internationally co-authored papers has increased. In the 1980s, single-institutional co-authorship papers accounted for approximately 80%, however, after that, domestic 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 2011, single-institutional co-authorship papers accounted for 42.5%, domestic co-authorship papers for 35.1%, and internationally co-authored papers for 22.3%.

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 31.6% and Physics at 30.6% than in other fields. At the same time, its share of Clinical medicine is 18.5%, 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 (2011 December) 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 adjusted top 10% papers is applied to indicate quality. Adjusted top 10% papers are obtained by finding papers for which the number of citations (value at the end of 2011) is in the top 10 in each field and then adjusting the figures so they total one-tenth of all papers. 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 adjusted 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.

Looking at the top five countries in terms of number of papers, whether the whole counting method or the fractional counting method was used made no difference in the countries' ranks during 1989–1991. During 2009–2011, however, the top five countries when using the whole counting method were the U.S., China, Germany, the U.K. and Japan. When using the fractional counting method, the order was the U.S., China, Japan, Germany and the U.K. Japan's position changed depending on the method used. This is because internationally co-authored papers have increased, and there are differences in intensity when counting international co-authorship. As shown in Chart 4-1-11, there are large differences between countries with high ratios of international co-authorship and countries with low ratios. 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, Article & Proceedings (Handled as Article), Review, Letter, Note	Article, Article & Proceedings (Handled as 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 adjusted 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: The number of adjusted top 10% papers is obtained by finding papers for which the number of citations (value at the end of 2011) is in the top 10 in each field and then adjusting the figures so they total one-tenth of all papers. See "2-2 (7) Method of calculating adjusted top 10% papers" in NISTEP, "Benchmarking Scientific Research 2011" (Research Material 204). The fields are made according to the note of Chart 4-1-3(B). The value of the end of 2011 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

1989 - 1991 (Average) The number of papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	207,157	34.6	1	195,346	32.7	1
U.K.	50,661	8.5	2	45,887	7.7	2
Japan	45,809	7.7	3	43,638	7.3	3
Germany	44,598	7.5	4	39,541	6.6	4
Russia	37,789	6.3	5	36,659	6.1	5
France	33,240	5.6	6	29,279	4.9	6
Canada	27,147	4.5	7	24,003	4.0	7
Italy	18,066	3.0	8	15,841	2.6	8
India	14,788	2.5	9	14,172	2.4	9
Australia	12,947	2.2	10	11,686	2.0	10
Netherlands	12,552	2.1	11	10,919	1.8	11
Sweden	10,327	1.7	12	8,843	1.5	13
Spain	10,016	1.7	13	8,957	1.5	12
China	8,504	1.4	14	7,551	1.3	14
Switzerland	8,501	1.4	15	6,739	1.1	15
Israel	6,265	1.0	16	5,244	0.9	16
Belgium	5,989	1.0	17	4,951	0.8	18
Poland	5,944	1.0	18	5,011	0.8	17
Denmark	4,929	0.8	19	4,141	0.7	19
Czech Republic	4,231	0.7	20	3,750	0.6	20
Finland	4,027	0.7	21	3,516	0.6	21
Austria	3,885	0.6	22	3,299	0.6	22
Brazil	3,576	0.6	23	3,055	0.5	24
South Africa	3,452	0.6	24	3,194	0.5	23
Norway	2,932	0.5	25	2,471	0.4	27

1989 - 1991 (Average) The number of adjusted top 10% papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	33,341	56.2	1	31,059	52.3	1
U.K.	5,807	9.8	2	4,935	8.3	2
Germany	3,927	6.6	3	3,134	5.3	4
Japan	3,809	6.4	4	3,463	5.8	3
Canada	3,308	5.6	5	2,718	4.6	5
France	3,205	5.4	6	2,542	4.3	6
Netherlands	1,711	2.9	7	1,407	2.4	7
Italy	1,559	2.6	8	1,184	2.0	8
Sweden	1,402	2.4	9	1,145	1.9	10
Australia	1,390	2.3	10	1,175	2.0	9
Switzerland	1,320	2.2	11	939	1.6	11
Israel	677	1.1	12	488	0.8	12
Denmark	645	1.1	13	487	0.8	13
Belgium	614	1.0	14	440	0.7	15
Spain	606	1.0	15	459	0.8	14
Russia	485	0.8	16	384	0.6	16
Finland	435	0.7	17	348	0.6	17
China	369	0.6	18	257	0.4	20
India	351	0.6	19	292	0.5	18
Norway	340	0.6	20	266	0.4	19
Austria	307	0.5	21	221	0.4	21
Poland	265	0.4	22	167	0.3	23
New zealand	263	0.4	23	216	0.4	22
Brazil	192	0.3	24	124	0.2	26
Taiwan	183	0.3	25	156	0.3	24

1999 - 2001 (Average) The number of papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	240,912	31.0	1	211,447	27.2	1
Japan	73,844	9.5	2	66,714	8.6	2
U.K.	70,411	9.1	3	56,527	7.3	3
Germany	67,484	8.7	4	53,086	6.8	4
France	49,395	6.4	5	38,676	5.0	5
Italy	32,738	4.2	6	26,543	3.4	6
Canada	32,101	4.1	7	25,209	3.2	8
China	30,125	3.9	8	26,192	3.4	7
Russia	27,210	3.5	9	22,280	2.9	9
Spain	23,149	3.0	10	18,823	2.4	10
Australia	20,756	2.7	11	16,581	2.1	11
Netherlands	18,653	2.4	12	13,983	1.8	13
India	17,863	2.3	13	16,166	2.1	12
Sweden	15,168	2.0	14	11,159	1.4	15
Switzerland	14,201	1.8	15	9,600	1.2	16
Korea	13,828	1.8	16	12,041	1.6	14
Brazil	10,630	1.4	17	8,638	1.1	18
Belgium	10,175	1.3	18	7,171	0.9	20
Poland	10,070	1.3	19	7,748	1.0	19
Taiwan	10,035	1.3	20	9,033	1.2	17
Israel	9,249	1.2	21	7,067	0.9	21
Denmark	7,864	1.0	22	5,542	0.7	23
Austria	7,388	1.0	23	5,373	0.7	24
Finland	7,341	0.9	24	5,586	0.7	22
Turkey	5,977	0.8	25	5,317	0.7	25

1999 - 2001 (Average) The number of adjusted top 10% papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	37,168	48.9	1	32,088	42.2	1
U.K.	8,644	11.4	2	6,237	8.2	2
Germany	7,685	10.1	3	5,347	7.0	3
Japan	5,764	7.6	4	4,737	6.2	4
France	5,380	7.1	5	3,700	4.9	5
Canada	4,099	5.4	6	2,867	3.8	6
Italy	3,336	4.4	7	2,267	3.0	7
Netherlands	2,772	3.6	8	1,893	2.5	8
Australia	2,413	3.2	9	1,700	2.2	9
Switzerland	2,314	3.0	10	1,394	1.8	12
Spain	2,098	2.8	11	1,446	1.9	10
Sweden	1,940	2.6	12	1,253	1.6	13
China	1,911	2.5	13	1,432	1.9	11
Belgium	1,244	1.6	14	735	1.0	15
Denmark	1,175	1.5	15	734	1.0	16
Israel	1,046	1.4	16	667	0.9	17
Korea	1,029	1.4	17	789	1.0	14
Finland	912	1.2	18	595	0.8	19
Russia	891	1.2	19	393	0.5	22
Austria	770	1.0	20	471	0.6	21
India	760	1.0	21	570	0.7	20
Taiwan	745	1.0	22	604	0.8	18
Brazil	593	0.8	23	369	0.5	23
Norway	573	0.8	24	349	0.5	24
Poland	503	0.7	25	245	0.3	28

2009 - 2011 (Average) The number of papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	308,745	26.8	1	253,563	22.0	1
China	138,457	12.0	2	121,209	10.5	2
Germany	86,321	7.5	3	60,551	5.3	4
U.K.	84,978	7.4	4	57,725	5.0	5
Japan	76,149	6.6	5	65,167	5.7	3
France	63,160	5.5	6	43,939	3.8	6
Italy	52,100	4.5	7	39,222	3.4	7
Canada	50,798	4.4	8	36,128	3.1	9
Spain	43,773	3.8	9	32,497	2.8	11
India	43,144	3.7	10	38,162	3.3	8
Korea	40,436	3.5	11	34,649	3.0	10
Australia	36,575	3.2	12	26,088	2.3	13
Brazil	31,592	2.7	13	27,068	2.4	12
Netherlands	28,759	2.5	14	18,975	1.6	17
Russia	27,840	2.4	15	22,594	2.0	14
Taiwan	23,883	2.1	16	21,051	1.8	15
Turkey	21,886	1.9	17	19,770	1.7	16
Switzerland	21,774	1.9	18	12,340	1.1	20
Poland	19,518	1.7	19	15,564	1.4	18
Sweden	18,812	1.6	20	11,620	1.0	21
Iran	17,268	1.5	21	15,518	1.3	19
Belgium	16,234	1.4	22	9,928	0.9	22
Denmark	11,466	1.0	23	7,115	0.6	25
Austria	11,301	1.0	24	6,782	0.6	27
Israel	10,849	0.9	25	7,683	0.7	24

2009 - 2011 (Average) The number of adjusted top 10% papers						
	Whole counting			Fractional counting		
Country/Region	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	46,972	41.0	1	37,134	32.4	1
U.K.	13,540	11.8	2	7,875	6.9	3
Germany	12,942	11.3	3	7,682	6.7	4
China	11,873	10.4	4	9,282	8.1	2
France	8,673	7.6	5	4,951	4.3	5
Canada	7,060	6.2	6	4,186	3.7	7
Japan	6,691	5.8	7	4,862	4.2	6
Italy	6,524	5.7	8	3,820	3.3	8
Spain	5,444	4.7	9	3,230	2.8	9
Australia	5,178	4.5	10	3,190	2.8	10
Netherlands	5,143	4.5	11	2,844	2.5	11
Switzerland	4,186	3.7	12	1,965	1.7	13
Korea	3,094	2.7	13	2,198	1.9	12
Sweden	2,859	2.5	14	1,353	1.2	16
Belgium	2,645	2.3	15	1,252	1.1	17
India	2,470	2.2	16	1,813	1.6	14
Denmark	2,045	1.8	17	1,033	0.9	18
Taiwan	1,944	1.7	18	1,482	1.3	15
Austria	1,752	1.5	19	796	0.7	23
Brazil	1,692	1.5	20	994	0.9	19
Israel	1,405	1.2	21	765	0.7	24
Finland	1,381	1.2	22	706	0.6	25
Singapore	1,306	1.1	23	851	0.7	22
Poland	1,272	1.1	24	608	0.5	26
Russia	1,243	1.1	25	484	0.4	30

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

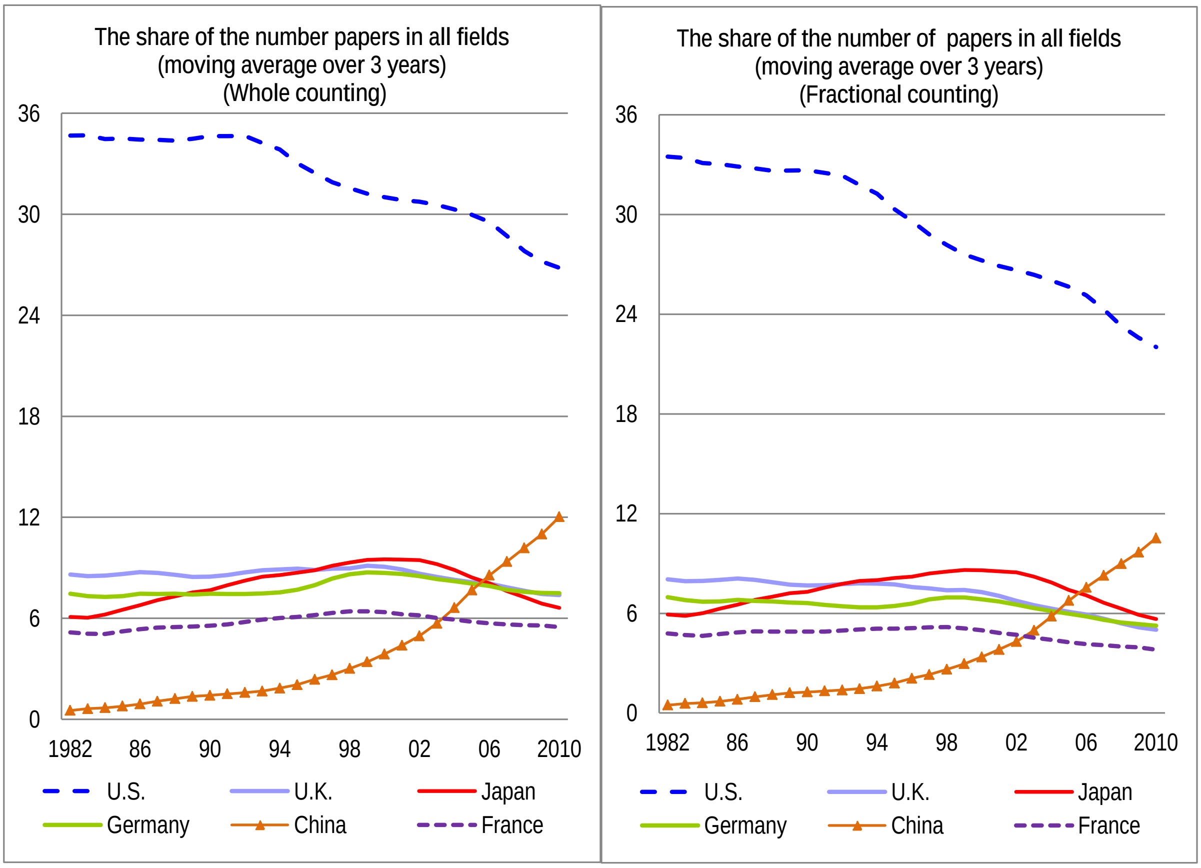
First, Chart 4-1-6 shows each county's share in the number of papers in the world, in order to grasp the quantitative aspect of each country's research activities. The results of the whole counting, degree of participation in the production of papers, and of the fractional counting, degree of contribution 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 2010 (2009–2011 average), behind the U.S., China, Germany and the U.K..

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 2010 (2009–2011 average). In addition, the gap between Japan and Germany and the U.K. 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 2010, the average value from 2009 to 2011). (A) is whole counting; (B) is fractional counting.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI: Science)

(3) Comparison of numbers of adjusted top 10% papers

Next, in order to understand the qualitative aspect of each country's research activities, Chart 4-1-7 shows each county's share of the number of adjusted top 10% papers in the world. The whole counting method is used for the degree of participation in high impact papers, and the fractional counting method is used for the degree of contribution to the production of high impact papers.

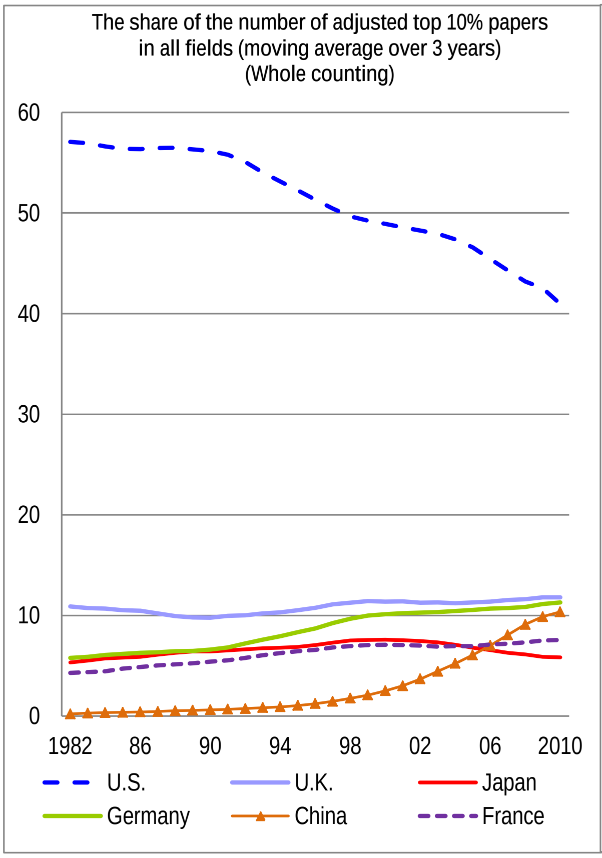
Regarding the “degree of participation in high impact papers in the world”, the U.K. and Germany have increased their share since the 1990s, and gotten a big lead on Japan. Japan has fallen to seventh place, behind the U.S., the U.K., Germany, China, France and Canada.

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 since the1990s, but during the 2000s the trend has been flat.

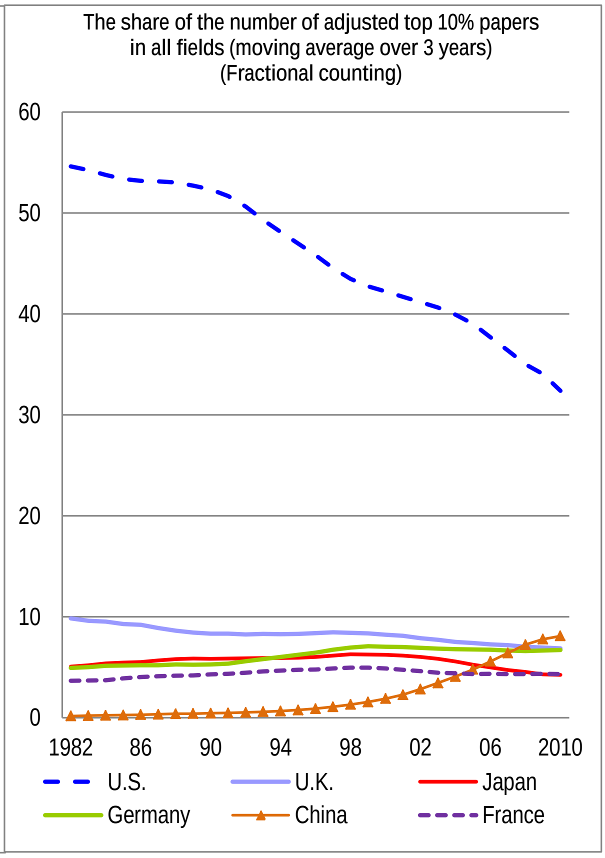
Japan's share dropped rapidly during the 2000s. It now ranks sixth, behind the U.S., China, the U.K., Germany and France.

Chart 4-1-7: The change in the share of the numbers of adjusted 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 2010, the average value from 2009 to 2011). (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

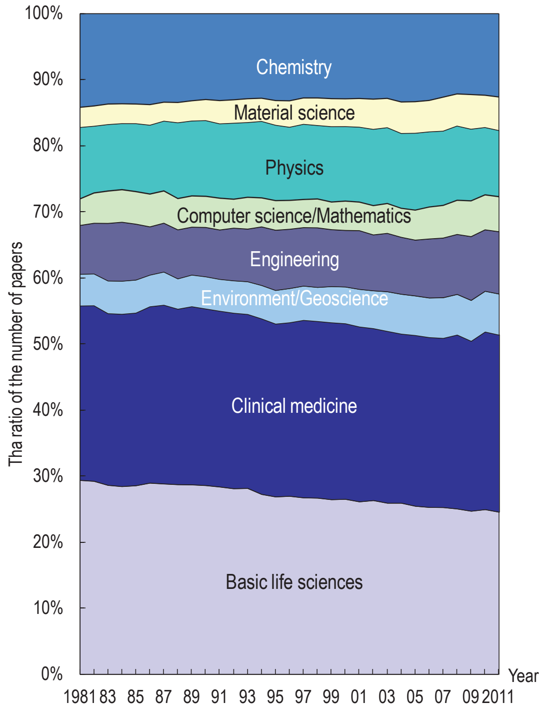
(1) The ratio of the numbers of papers in the world and main countries by field

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 2011 with 1981, Basic life sciences have fallen by 4.5 percentage points, Chemistry by 1.4 percentage points and Physics by 0.7 percentage points. On the other hand, Material science has increased its share by 2.0 percentage points, Engineering by 2.0 percentage points, Environment/Geoscience by 1.4 percentage points, Computer science/Mathematics by 1.3 percentage points and Clinical medicine by 0.6 percentage points.

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

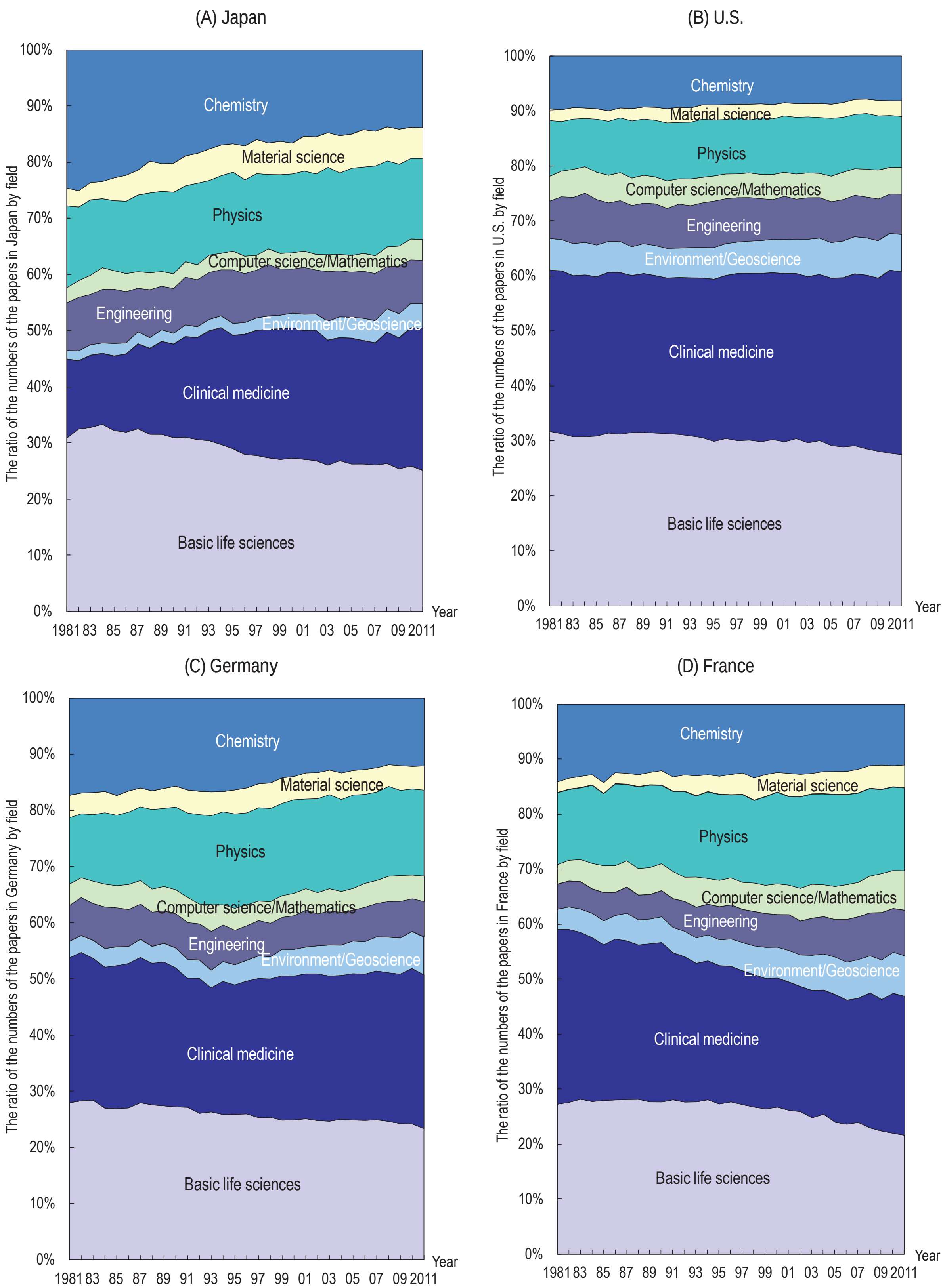


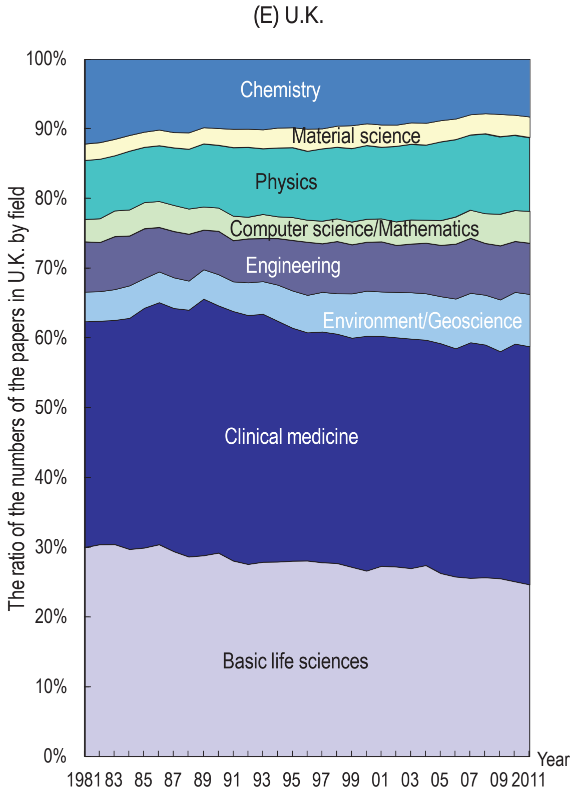
Note: The fields are in accordance with the note of Chart 4-1-3 (B).
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI: Science)

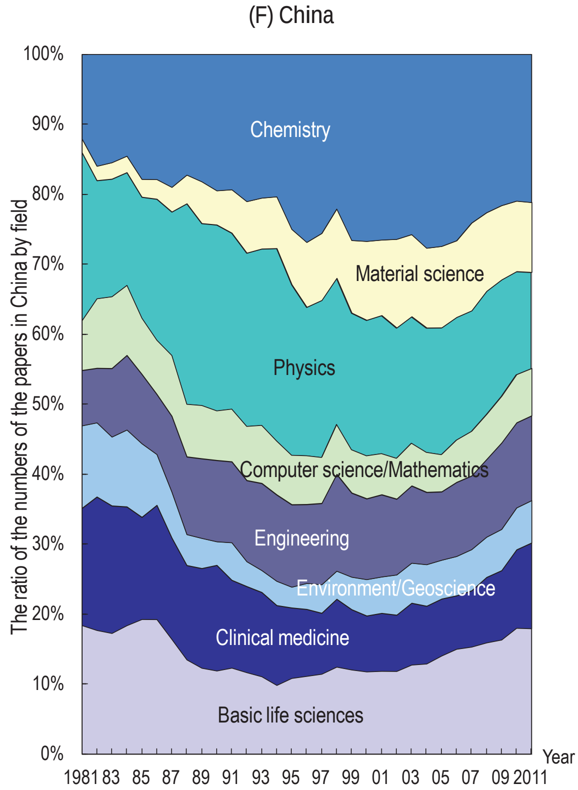
Chart 4-1-9 indicates the internal structure of major countries by showing changes in shares of papers in major countries for each field. In Japan, Basic life sciences, Chemistry and Physics accounted for large shares in the early 1980s. Comparing 2010 with 1981, however, Chemistry has fallen by 10.2 percentage points and Basic life sciences by 5.1 percentage points. On the other hand, Clinical medicine has risen by 11.4 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 4.2 percentage points, while Clinical medicine has risen by 3.6 percentage points. In Germany, the shares of Chemistry and Basic life sciences declined, while those of Environment/Geoscience, Physics and Clinical medicine increased somewhat. In France, shares of Environment/Geoscience, Engineering and Computer science increased, while those of Clinical medicine, Basic life sciences and Chemistry decreased. In the U.K., the percentages for Basic life sciences and Chemistry decreased, while those for Environment/Geoscience, Physics and Clinical medicine increased. As for China, its shares for the life sciences (Basic life sciences and

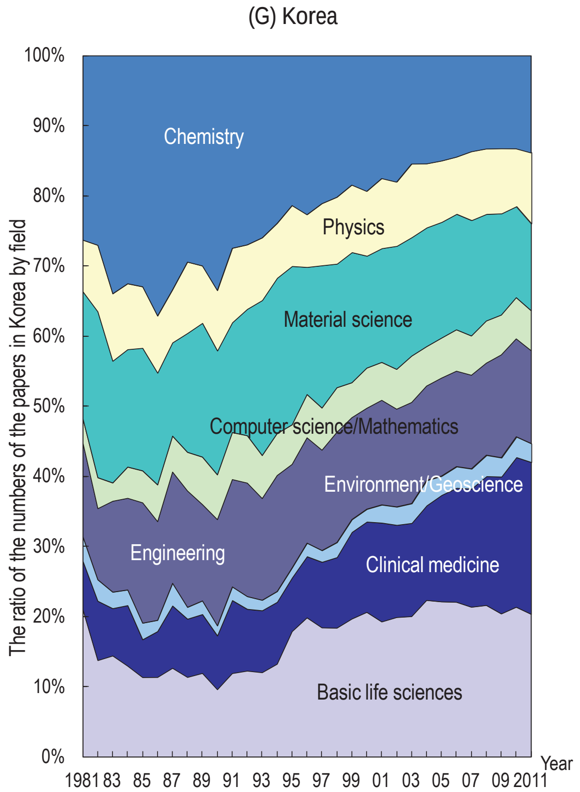
Clinical medicine) are lower than those of the other selected nations.

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

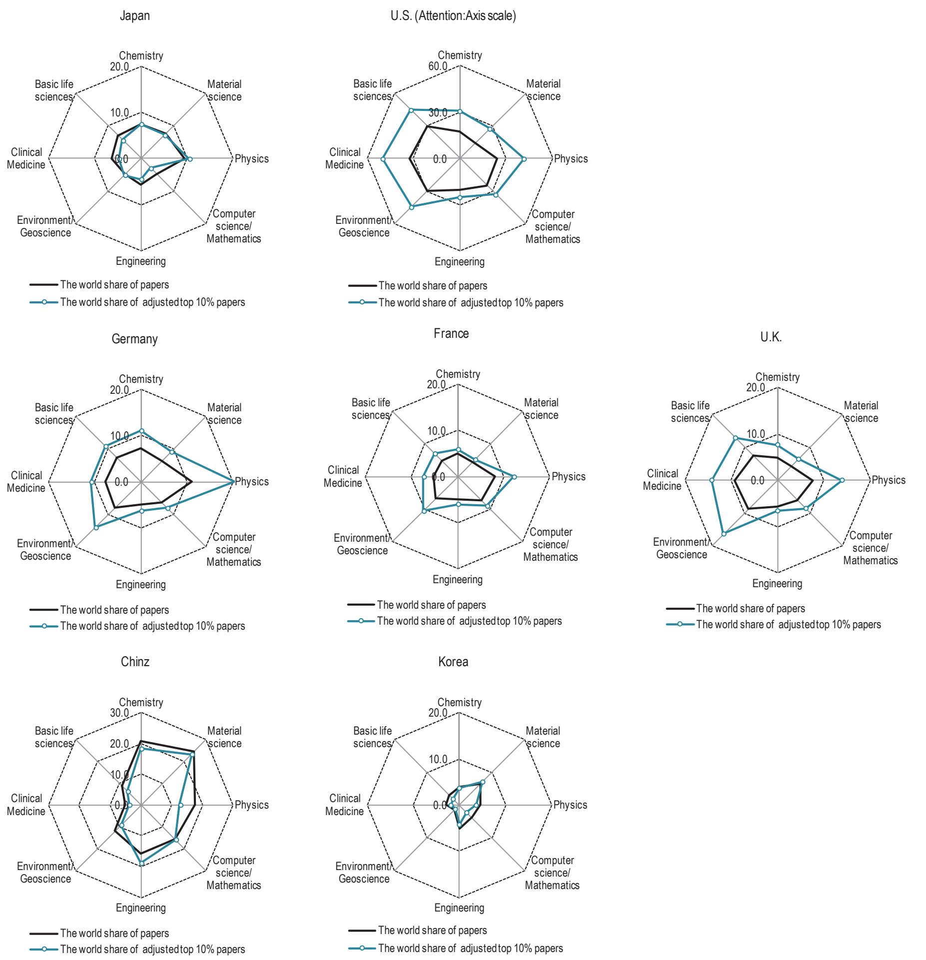
In Chart 4-1-10, a comparison is shown, which is the results of field portfolio (2009–2011) of the share of papers and the share of adjusted top 10% papers. Here the whole counting method is used, in order to find the ratio that is occupied by each field in the world and in each country from the viewpoint of participation.

Comparing the papers share and adjusted top 10% papers share, the countries can be divided into those where the adjusted 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 adjusted top 10% papers 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 adjusted top 10% papers in Material science, Chemistry and Physics.

Chart 4-1-10: A comparison of the share of the papers and adjusted top 10% papers in main countries by field (%, 2009–2011)



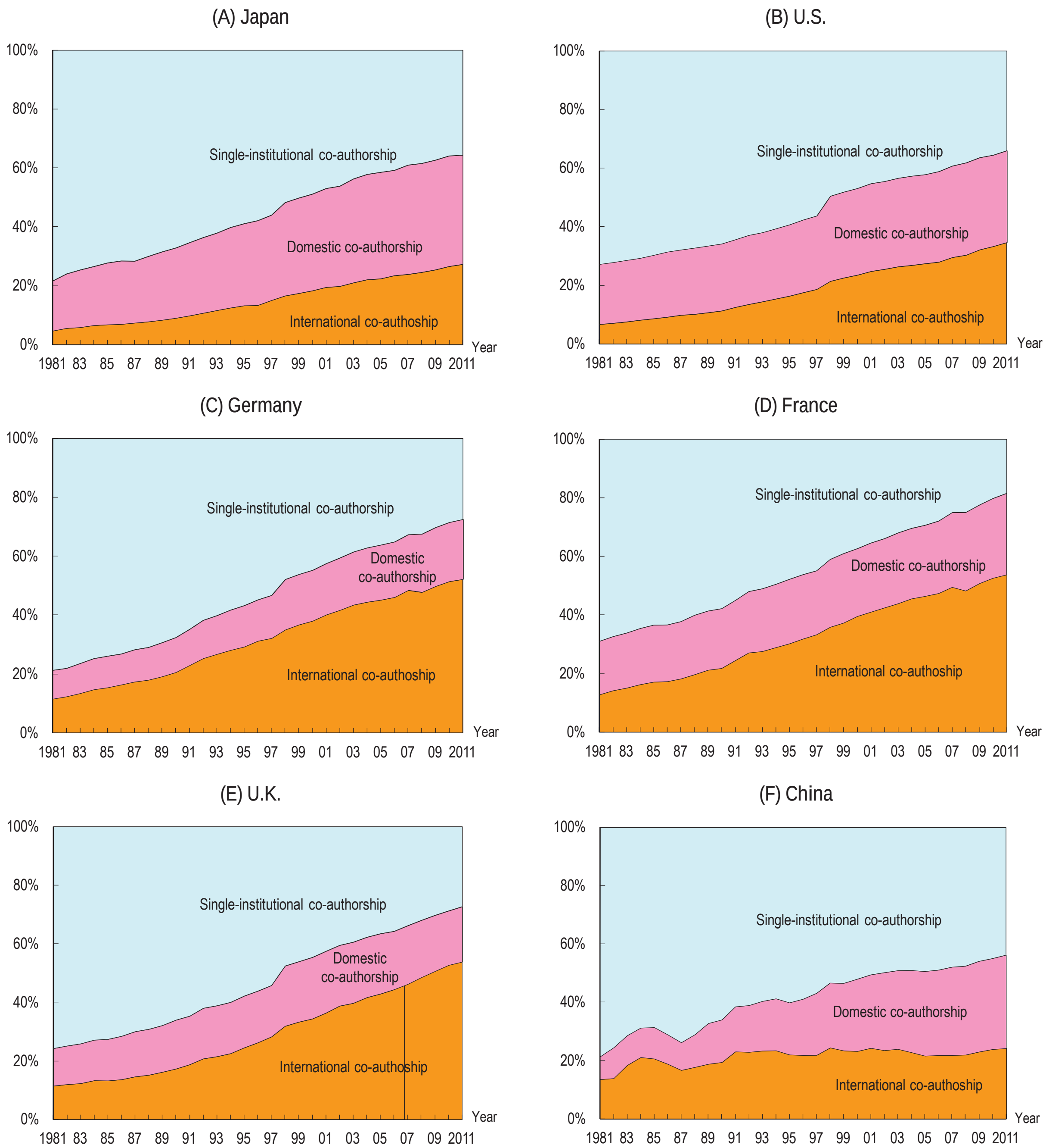
Note: Analyzed article, letter, note and review by the whole counting method. The fields are in accordance with the note of Chart 4-1-3 (B). The number of citations is the value as of the end of 2011.
Source: Compiled by NISTEP based on Thomson Reuters Web of Science (SCIE, CPCI: Science)

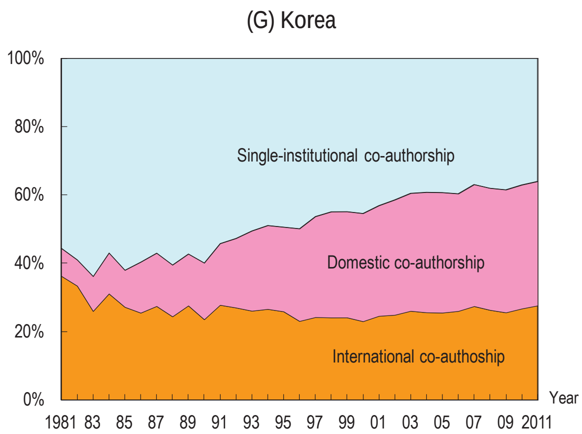
(3) The change in the production styles of papers in main countries

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 2011, however, compared with Japan at 27.3% and the U.S. at 34.6%, the ratio is very high in Europe, with Germany at 52.2%, France at 53.8% and the U.K. at 53.8%.

In Japan, in addition to internationally co-authored papers, the ratio of domestic co-authorship papers has increased by 20 percentage points since the 1980s. This indicates that relationships between research institutions play a larger role in Japan than they do 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





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)

4.2 Patents

Key Points

- ○The number of world patent applications declined sharply in 2009 amidst the recession following the "Lehman Brothers shock," but it began rising again in 2010. The number of applications is approaching 2 million annually.
- ○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 since the mid-2000s. The number of applications to the U.S. (about 490,000 annually) has been flat for the past few years, but there was an approximately 7% increase from 2009 to 2010. In 2010, there were about 390,000 patent applications to China, more than there were to the Japan Patent Office.
- ○As for patent applications from Japan, the U.S., China and Korea, more are directed within each country than are directed to other countries. Out of all patent applications from Japan, about 60% are to Japan (the JPO). China is increasing the volume of its domestic patent applications, but at only 14,000, its number of patent applications to other countries remains low.
- ○Looking at the numbers of patent applications to the JPO, the USPTO and the EPO, Japan has maintained a large presence for the past 10 years. As for applications by technical field, Japan's a share in Renewable energy has been on a downward trend.

4.2.1 The patent applications in the world

(1) The number of patent applications in the world

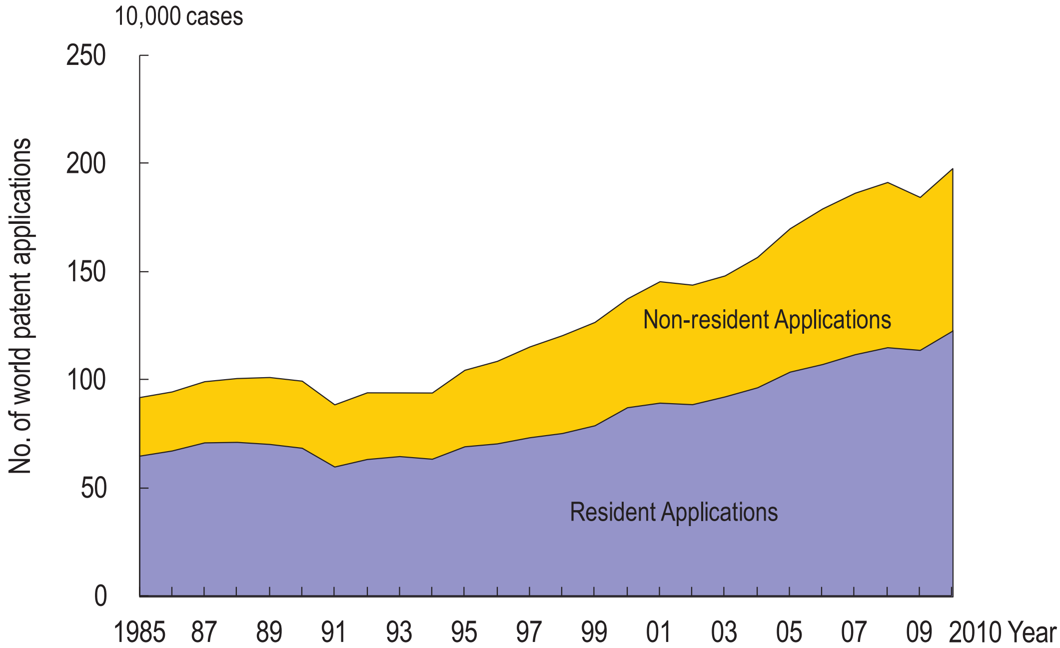
Chart 4-2-1 shows the change in the numbers of patent applications for about 230 countries and regions as of December 2011. The data is obtained from the “Statistics on Patents” by the WIPO (World Intellectual Property Organization). Here, the applications are divided to show Resident applications, which 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 number of world patent applications has increased at an average annual rate of about 5% since the mid-1990s. Worldwide, there were almost 2 million patent applications in 2010. 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 declined sharply in 2009 amidst the recession following the "Lehman Brothers shock," but it began rising again in 2010.

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: December 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. Here, 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, the number of applications fell by about 10% compared with 2008, and this situation continued in 2010. Looking at the breakdown, the applications to the JPO from applicants, who have their residency in Japan, accounts for over 84%.

The number of applications to the U.S. has been flat for the past few years, but there was an approximately 7% increase from 2009 to 2010. 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 system, which was introduced in 1995, is considered to be a reason that the numbers of applications has increased.

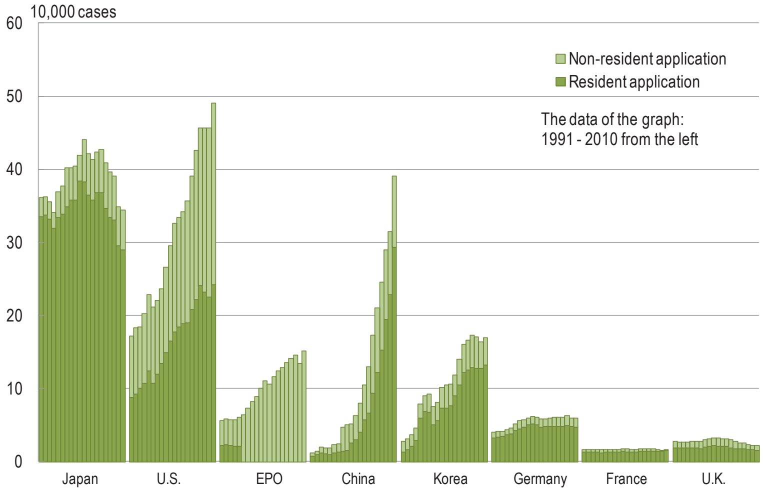
With the exception of 2009, the number of applications to the EPO has grown steadily. In 2010, they surpassed 150,000. The numbers of applications to Germany, France and the U.K. has generally been flat. The fact that patent applications can be made to each country that has ratified the European Patent Convention through applications to the European Patent Office is likely responsible for the flat or downward trend in individual countries.

The number of applications to SIPO has drastically increased. They increased by an annual average of about 22% over 10 years (2001–2010). In 2010, there were about 390,000 patent applications, more than the number to the JPO. The number of applications from residents was about 50% from 2000 to 2002, but in 2008–2010 it was about 70%. This indicates that applications from applicants in China have especially increased.

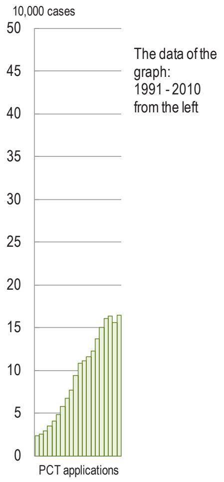
Chart 4-2-2 (B) shows numbers of PCT applications. PCT applications can be seen as a bundle of patent applications to the various patent authorities. One PCT application is the same as an application to multiple patent authorities. The number of PCT applications has been flat in recent years.

Chart 4-2-2: The situation of patent applications to and from main countries

(A) The numbers of patent applications to main countries (1991–2010)



(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: December 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.

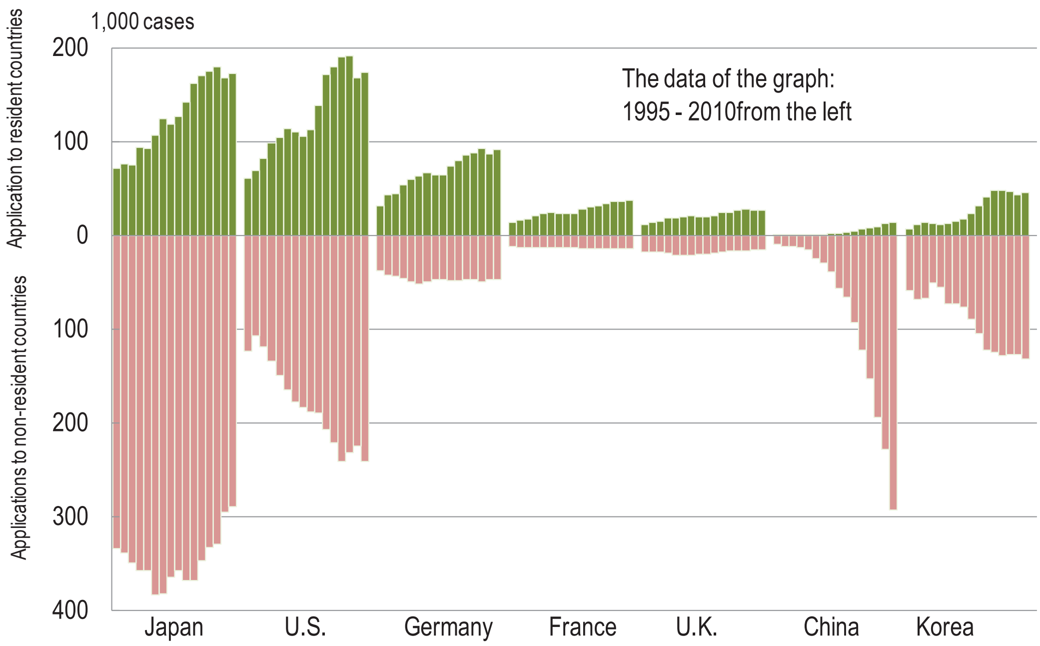
The results shown here are from the WIPO "Statistics on Patents" as of December 2011. This analysis calculates the share for each country by using the country that the first applicant or assignee belongs to. For instance, if there is a joint application with an applicant (the first) in Japan and an applicant (the second) in the U.S., only Japan is counted.

In Japan, the U.S., China and Korea, there are more applications to the country of residence than there are to countries of non-residence. Approximately 60% of the total numbers of applications from Japan are to the JPO. China is increasing the volume of its domestic patent applications, but at only 14,000, its number of patent applications to other countries remains low.

Turning to changes in the number of applications to country of residence, Japan has been decreasing recently. It is now at about 75% of its peak of about 380,000 in 2000. 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.

Looking at the number of applications to a country of non-residence, Japan and the U.S. have the highest numbers. Those countries showed a rising trend until 2008, but growth has been flat since then.

(C)The numbers of patent applications from main countries (1995–2010)



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: December 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 2010 was approximately 2.00 Million, as shown in Chart 4-2-1. Applications to the trilateral patent offices (the JPO, the EPO and the USPTO) accounted for about half of this total. 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.

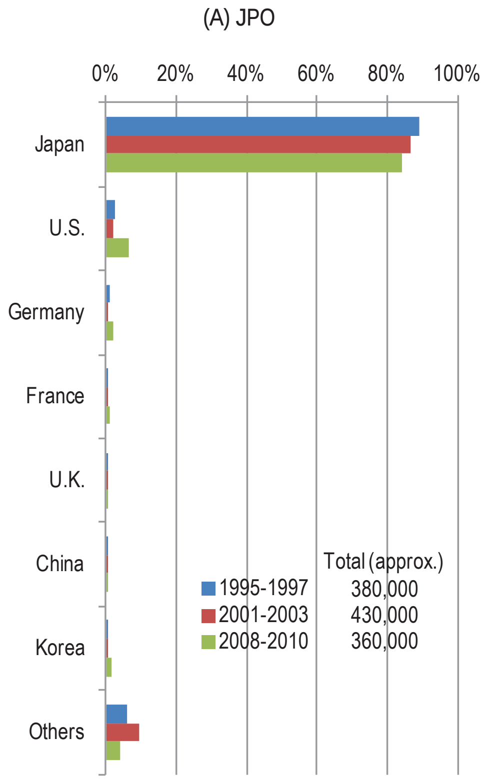
Chart 4-2-3 shows the share of the main countries of patent applications to the JPO, the EPO and the USPTO. The results shown here are from the WIPO, "Statistics on patents," as of December 2011. In this analysis, when there are multiple applicants, the country of the first applicant or assignee is used 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.

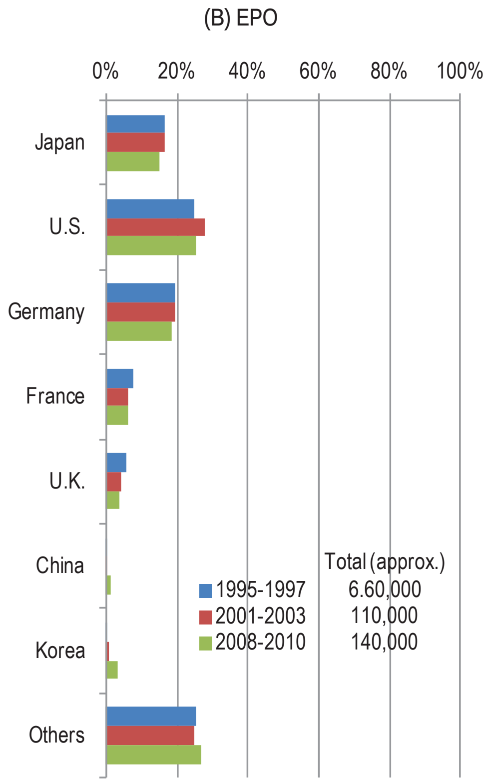
Looking at the each country's share of applications to the Japan Patent Office (Chart 4-2-3 (A)), Japan had an overwhelming share at about 84% from 2008 to 2010. The U.S. has kept second place over the past 10 years, however, its share did not reach 10%. The share of Germany was in third place (approximately 2.0% during 2008–2010). The number of applications from Korea has grown recently (approximately 1.4% during 2008–2010). It was in fourth place, behind Germany.

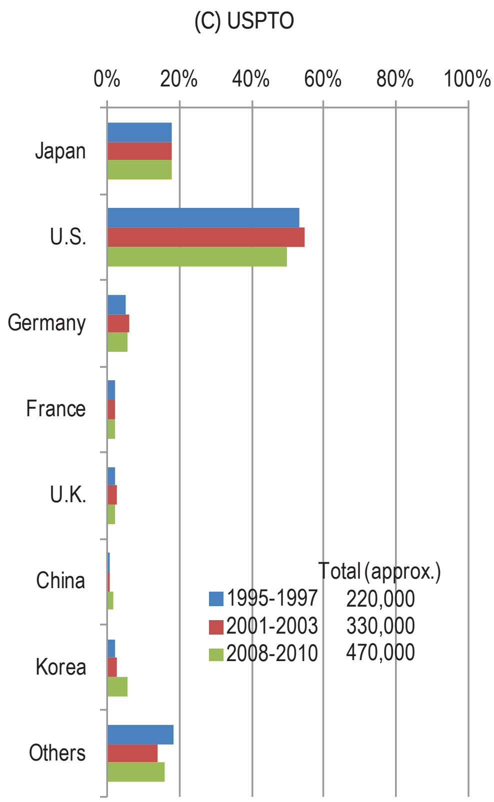
Looking at national shares of applications to the EPO (Chart 4-2-3 (B)), Japan presented the next largest number to the U.S. and Germany. By main countries' shares of patent applications from 2008 to 2010, the U.S. share was about 25%, which is in first place. Germany's share was about 18%, while Japan's was around 15%. France (about 6%) and the U.K. (about 4%) followed them. Korea accounted for about 3% of applications in 2008–2010.

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 6% from 2008 to 2010 Korea has been steadily expanding its share. With about 5%, it was in fourth place, behind Germany, in 2008–2010.

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 averages.
Source: The WIPO, "Statistics on Patents" (last update: December 2011)

4.2.3 The patent applications by technological field

Next, the results of the analysis of parent applications by technological field are discussed. Applications to the EPO, patents granted by the USPTO and international PCT applications 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 EPO's Y01N classification was used. Patent applications to the EPO, USPTO patent registrations and PCT patent applications with the Y01N tag 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.

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 1998 to 2000; however, it was approximately 18% from 2008 to 2010. Japan's Biotechnology share of about 10% was smaller than its overall share. In Renewable energy, Japan's 30% share in 1998–2000 declined to about 12% in 2008–2010.

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 2008 to 2010 was about 26%. Its share in Renewable energy was about 29% in 1998–2000, but declined to 14% in 2008–2010.

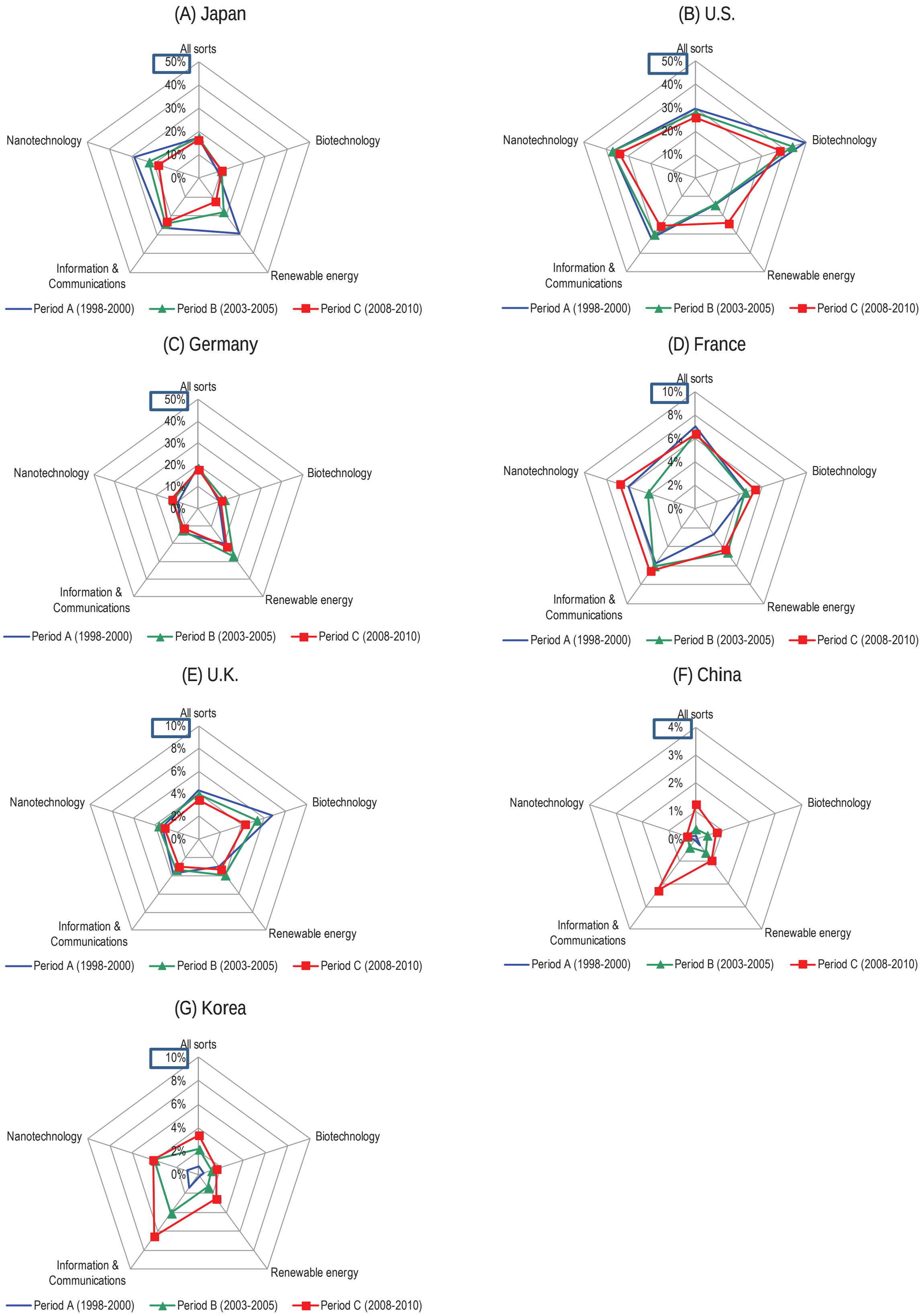
Germany has a relatively large share in Renewable energy, as does the U.K. in Biotechnology and Renewable energy. Regarding Korea, it is apparent that growth in its shares in Information and communication technology and Nanotechnology is especially large (Chart 4-2-5).

(3) International PCT patent applications by field

Turning next to international PCT applications, Japan's overall share has increased compared to 1998–2000. There are two methods for applying for a patent in foreign countries, applying directly to each country's patent agency or applying through an international PCT. Looking at international PCT applications from selected countries, applications from Japan quadrupled from 1998–2000 to 2008–2010. In contrast, applications from the U.S. grew 1.7 times as large, and those from Germany grew 1.8 times as large. There has thus been a larger increase in applications from Japan than there has been for applications from other countries. This is likely the reason that Japan's share is larger than it was in 1998–2000.

The portfolio structure is roughly identical to the state of applications to the EPO broken down by field. Japan's share of applications for Renewable energy patents is on a downward trend for the EPO, the USPTO and international PCT applications (Chart 4-2-6).

Chart 4-2-4: The situation of patent applications to the EPO by field



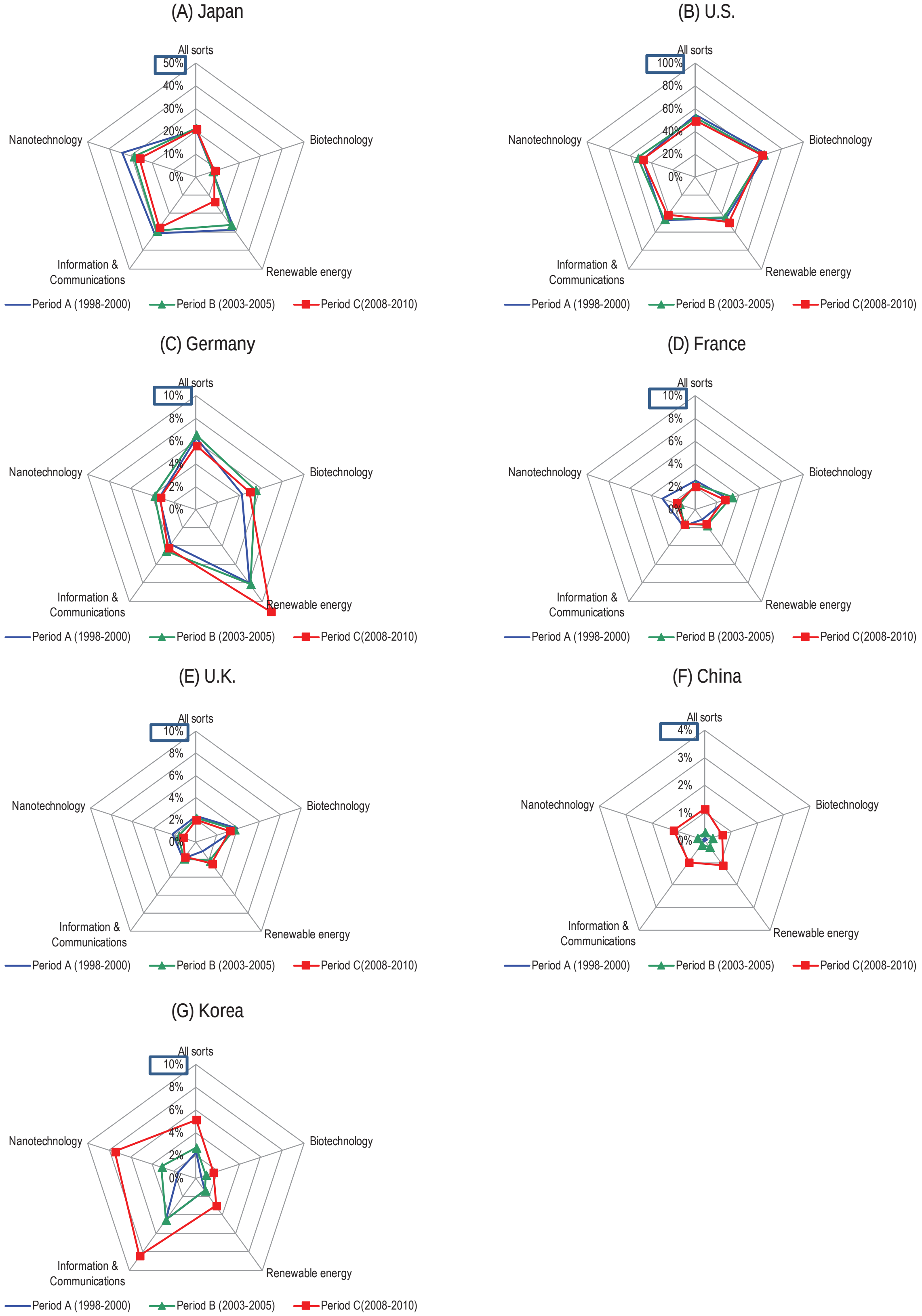
Note: 1) Counted unexamined publications (A1, A2) for the numbers of the applications. Counted by publication data. The share of main countries is the average over 3 years

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.

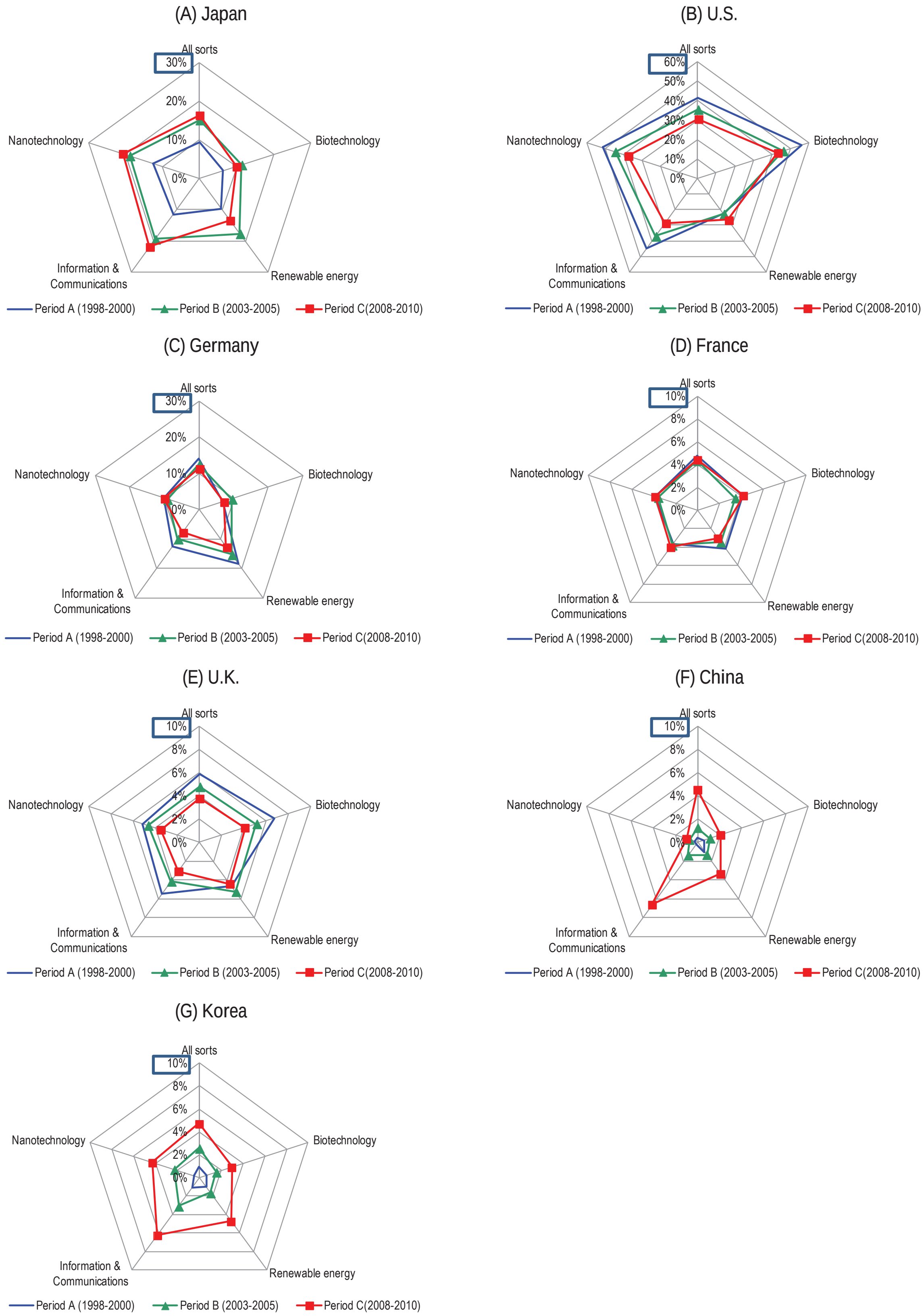
Source: Compiled by NISTEP based on PATSTAT (October 2011 version)

Chart 4-2-5**:** The situation of patent applications to the USPTO by field



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 (October 2011 version)

Chart 4-2-6: The situation of international PCT patent applications 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 for Information and communications, and Biotechnology. Y01N was used as the technological classification for Nanotechnology. Y02E10 was used as the technological classification for renewable energy..
3) The ratio of inventors was counted using fractional counting per inventor.
Source: Compiled by NISTEP based on PATSTAT (October 2011 version)

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 using the Y02E classification to examine the situations of various countries in technologies related to clean energy as seen through patent applications.

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 here are INPADOC (an EPO database of patents from around the world) patent families filed with the JPO, the EPO and the USPTO. The database used was the EPO's PATSTAT (October 2011 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 2007

As shown in Chart 4-2-7, 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 solar, wind, geothermal, hydropower oceanic, etc.

Chart 4-2-8 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 2007, the number of patent families in that classification was about 1,300. The number increased rapidly beginning in the mid-1990s. The 2007 figure was about 4.5 times that of the early 1990s. By comparison, the total number of patent families increased to roughly 1.6 times as much 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" (solar, wind, geothermal, hydropower, oceanic, etc.). In 2007, there were about 600 such patent families. Compared with the early 1990s, that was seven times as many patent families. At the subgroup level, energy generation through solar power accounted for the largest number of families.

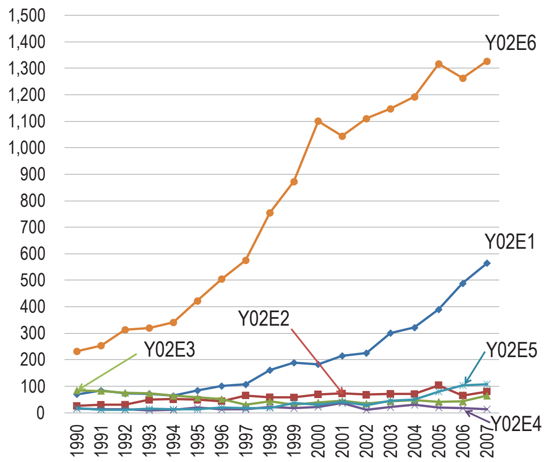
Turning to increases in the number of patent families, there were nine times as many "technologies for the production of fuel of non-fossil origin" (biofuels, fuels from waste, etc.) in 2007 as there were at the beginning of the 1990s, but the absolute number remains low (108 in 2007). The number of patent families in the "energy generation of nuclear origin" category showed no significant change.

Chart 4-2-7: 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,
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 (October 2011 version).

Chart 4-2-8: 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 (October 2011 version).

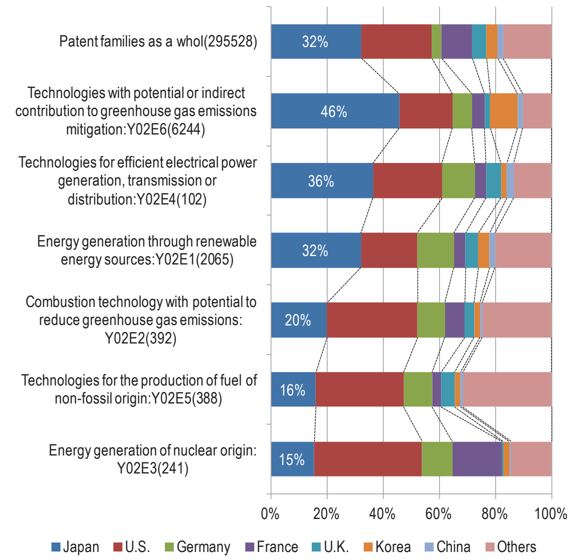
Next, countries' shares in terms of inventors were analyzed. This analysis covered patent families with priority date during the five years from 2003 to 2007. During the five years, the total number of patent families was about 300,000. Japan's share was 32%. Looking at Japan's share of each main group 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 4-2-9(A)).

Looking in detail at technologies with potential or indirect contribution to greenhouse gas emissions mitigation (see Chart 4-2-9(B)), Japan's shares were high in the subgroups of battery technology and storage technology (46%) and fuel cells (48%). The U.S. held the next highest share behind Japan for each of those technologies. Korea also held a share of more than 10% in battery technology and storage technology.

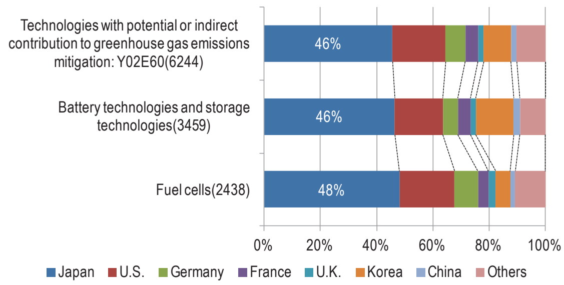
As for energy generation through renewable energy sources, Japan's share is the same as it is for the patent families as a whole. Viewed in more detail, however, there are differences depending on the type of technology (Chart 4-2-9(C)).

Chart 4-2-9: Selected countries' shares of patent families

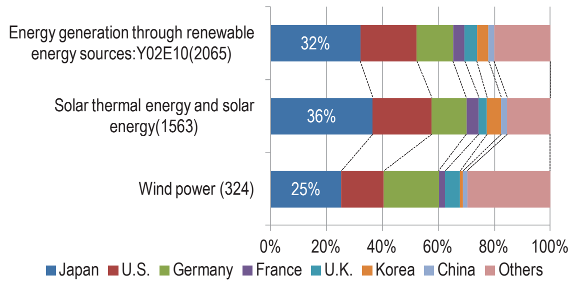
(A) Main groups of clean energy technologies



(B) Technologies with potential or indirect contribution to greenhouse gas emissions mitigation (details)



(C) Energy generation through renewable energy sources (details)



Note: 1) Same as Chart 4-2-8.
2) Some of the criteria for the Y02E tag changed during the previous year, so some results differ from those in "Science and Technology Indicators 2011."
Source: Same as Chart 4-2-7.

In solar thermal energy and solar energy, Japan's share was somewhat high at 36%, but it was relatively low at 25% in wind power. Germany also has the highest share (20%) 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 (2008–2009), 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. The drop in the share of solar thermal energy and solar energy (from 26% to 16%) is particularly striking. Japan's share for fuel cells is on an upward trend at the EPO.

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)

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. Next, 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 4.6 in 2010, with an export surplus continuing since 1993.

○Looking at technology trade exclusive of that between parent companies and subsidiaries, Japan's technical trade balance in 2010 was 1.7. It has had an export surplus since 2006. In the U.S., the balance was 3.9.

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. Because situations and conditions for technology trade differ in each country, simple comparisons are impossible. The focus here is therefore on changes over time and the correlation between the amounts of technology imports and exports for 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. 2,436.6 billion yen and that of technology imports was about 530.1 billion in FY 2010. The amount of technology imports has been decreasing since peaking in FY 2007.

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 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.

(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.

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 change over time, its amount of technology exports has tended to increase since the 1990s, while 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., caution is necessary when looking at change over time because the methods of gathering statistics changed in 1996 and again in 2009. Nevertheless, 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.

Looking at the technology trade balance (the amount of technology exports/the amount of technology imports) (Chart 5-1-1(B)), 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 2010 marked the high figure of 4.6.

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.

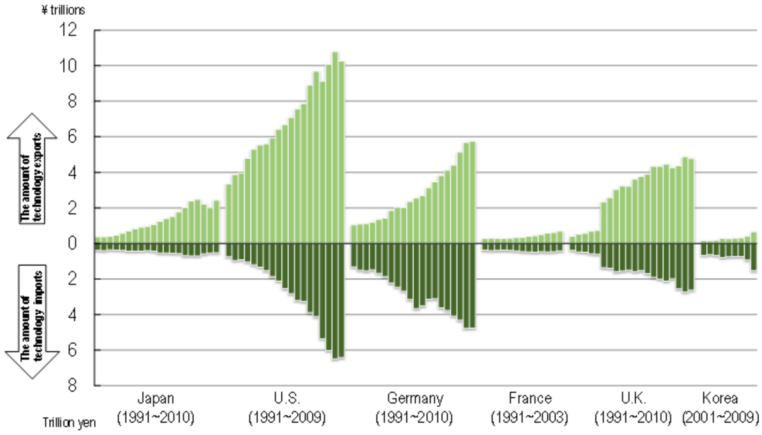
The technology trade balance of Germany passed 1 in 2003, and has been gradually increasing since then.

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.

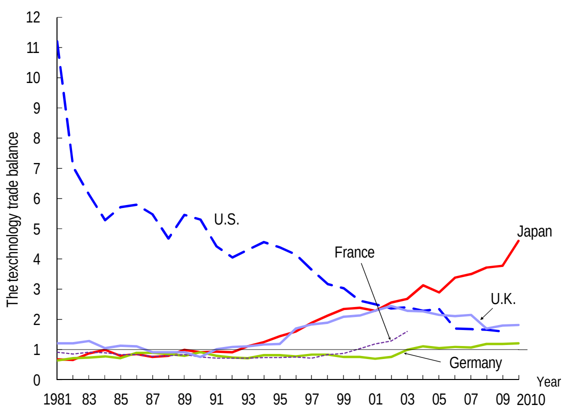
The U.K.'s technology trade balance began growing in the 1990s. It surpassed 2.3 in 2003, but has been slowly declining in recent years.

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. Figures for 2009 are provisional.
<Germany> West Germany until 1990. Until 1985 includes patents, licenses, know-how, trademarks, and design. From 1986, additionally included technical services, computer services and R&D in industrial fields. Figures for 2010 are provisional.
<U.K.> from 1984, included oil companies. From 1996, includes patents, inventions, licenses, know-how, trademarks, design and services related to technology and R&D. Data continuity with the previous year is impaired for 2009. Figures for 2010 are provisional.
<Korea> Figures for 2009 are provisional.
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 2011/2."

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 680.7 billion yen in FY2010, accounting for 27.9% of the whole. In FY 2001, they accounted for 43.3% of the total. Compared with FY 2010, technology exports exclusive of trade between parent companies and subsidiaries decreased by 15.4 percentage points. However, the amount of technology imports excluding that between parent companies and subsidiaries was 403.6 billion yen in FY 2010. It accounted for 76.1% for the total. That figure has declined by 6.5 percentage points since FY 2001.

In the data for the U.S., technology trade of "associated companies" is defined as 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 2010 was about 4,367.7 billion yen, accounting for 37.1% of the total.

Regarding the amount of technology imports, technology imports of companies excluding associated companies were about 1,123.5 billion yen in 2010, accounting for 30.1% of the total.

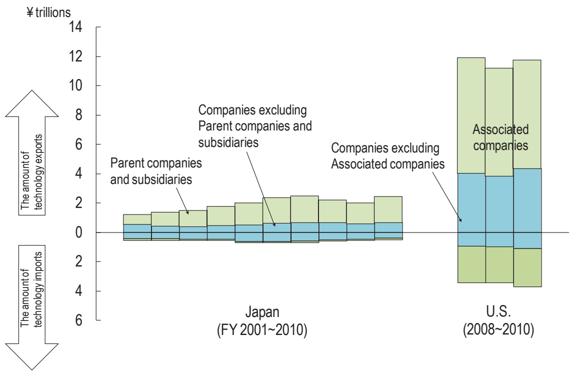
Also, looking at the technology trade balance of companies excluding parent companies, subsidiaries and affiliates (Chart 5-1-2 (B)), Japan has fluctuated around 1, while the U.S. has been around 4.

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.).

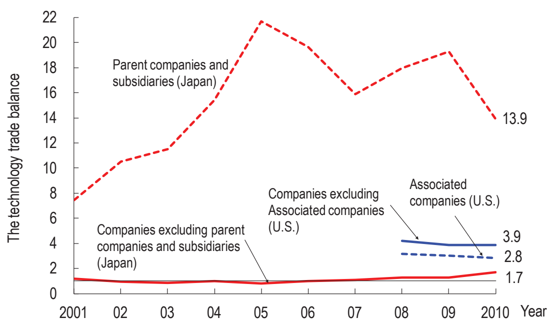
Chart 5-1-2: The change in the amount of technology trade in Japan and the U.S. (Technology trade among parent companies and subsidiaries, associated companies and others)

Attention to international comparison

(A) The amount of technology trade



(B) Technology trade balance



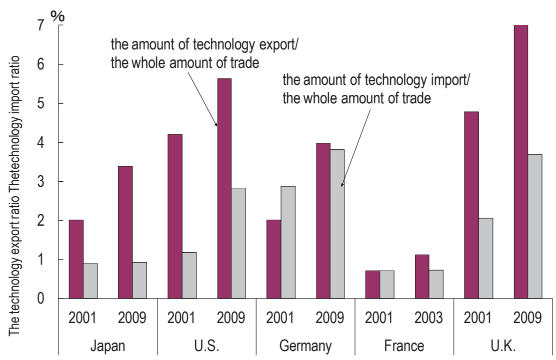
(2)Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development" was a survey conducted on the Source of the technology trade of Japan by dividing it into the amount of the technology trade of parent companies and subsidiaries, and that for companies excluding parent companies and subsidiaries, since the survey for the FY 2002.

(C) Definitions of parent companies and subsidiaries (associated companies) by capital ties, and the amount of technology trade

Capital ties	Japan (FY2010) Technology Exports	Japan (FY2010) Technology imports	U.S. (FY2010) Technology Exports	U.S. (FY2010) Technology imports	Capital ties
And/over 50% ↑	1.8	0.1	7.4	2.6	↑ And/over 10%
Under 50% ↓	0.7	0.4	4.4	1.1	↓ 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> Types of technology are the same as in Chart 5-1-1.
<U.S.> Types of technology trade are royalties and licenses only.
Source :<Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development."
<U.S.> U.S. Department of Commerce, Bureau of Economic Analysis, U.S. International Services

Chart 5-1-3: The ratio of the amount of technology trade against the whole amount of trade



Note: 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, "Aggregate National Accounts

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, at 7% in 2009. Its 2001 figure of 4.8% was also high, and it increased by 2.2 percentage points. Second-highest was the U.S. at 5.6% in 2009. This was a 1.4 point increase from its 2001 figure of 4.2%.

Japan's technology export ratio in 2009 was 3.4%, which was an increase of 1.4 points over the 2001 figure (2%). The U.S. in 2009 had a ratio of 5.6%, an increase of 1.4 points since 2001 (4.2%).

The U.K. had the highest technology import ratio (3.7% in 2009) as well. It increased by 1.6 points since 2001 (2.1%).

Next highest was Germany at 3.8% in 2009, which was about the same as its technology export ratio. The ratio for the U.S. in 2009 was 2.8%, more than double the 2001 figure (1.2%).

Japan's technology import ratio in 2001 was 0.9%; in 2009, it was virtually unchanged at 0.9%.

5.1.2 The Technology Trade of Japan

Key Points

○Looking at Japan's amount of technology exports by industry classification, "Transportation equipment manufacturing" had the largest amount during FY 2010. At 1.3 trillion yen, it accounted for 52.7% of all industries. It was followed by "Drugs and medicines" with 0.3 trillion yen (12.8% of all industries). The industry with the largest amount of technology imports during FY 2010 was "Information and communication electronics equipment." With 0.2 trillion yen, it accounted for 39.3% of technology imports in all industries.

○ About 80% of trade in "Transportation equipment manufacturing" was among parent companies and subsidiaries. In the case of "Drugs and medicines," the percentage has remained around 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. accounted for the largest amount in FY 2010, 0.9 trillion yen (35.4% of all technology exports). China had the next highest amount with 0.3 trillion yen (14%). Trade among parent companies and subsidiaries accounted for a large amount of exports from each country, but trade not among parent companies and subsidiaries accounted for a large amount in the U.K. and China.

(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 2010 was “Transportation equipment manufacturing.” The amount was approx. 1,284.4 billion yen and accounted for 52.7% of the entire industries. It was followed by “Drugs and medicines” (approx. 312.8 billion yen, 12.8%) and “Information and communication electronics equipment” (approx. 243.3 billion yen, 10%). Compared with FY 2005, there was a 3.5 percentage point decrease in the share of "Transportation equipment manufacturing," a 3.3 point increase in that of "Drugs and medicines" and a 0.4 point decrease in that of "Information and communication electronics equipment."

On the other hand, looking at in the FY 2010, the industry which had the large amount of technology imports was “Information and communication electronics equipment.” The amount was approx. 208.3 billion yen and accounted for 39.3% of the entire industries. It was followed by "Drugs and medicines" (63.4 billion yen, 12%) and "Transportation equipment manufacturing" (51.8 billion yen, 9.8%). Compared with FY 2005, the share accounted for by "Information and communication electronics equipment" increased by 2.1 percentage points, and that of "Information and communications" increased by 1.6 points.

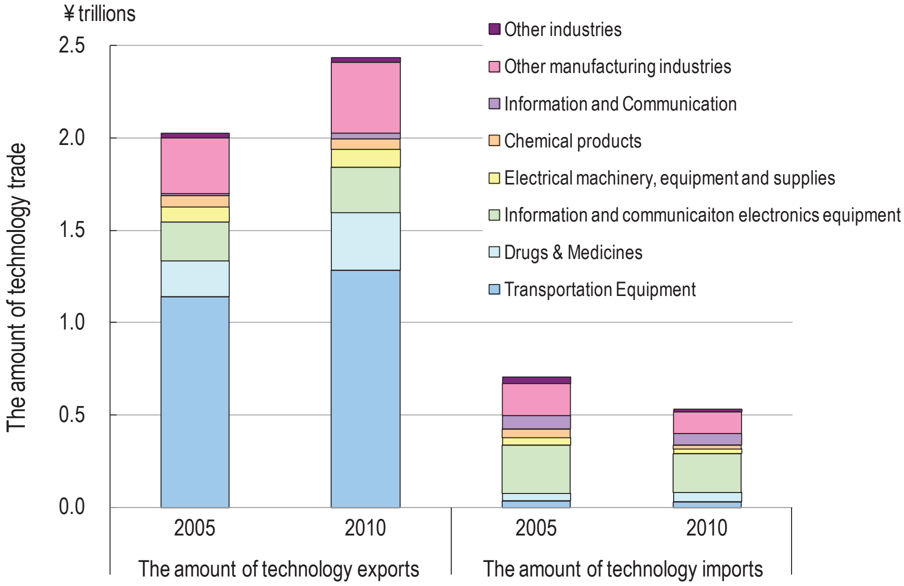
Looking by industry classification at the amount of technology trade of parent companies and subsidiaries and that of companies excluding parent companies and subsidiaries (Chart 5-1-4(B and, C)), in most industries, parent companies and subsidiaries have a larger amount for technology trade.

Trade among companies excluding parent companies and subsidiaries accounts for about 16.8% of the total in “transportation equipment manufacturing” which occupies the large amount of technology exports. In "Drugs and medicines," the percentage of trade outside parent companies and subsidiaries was large at 60.7%. In the case of "Information and communication electronics equipment," 49% of the trade was not among parent companies and subsidiaries.

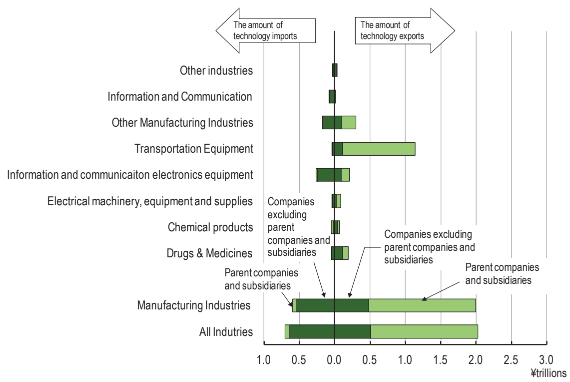
As for technology imports, the percentage of imports that were not among parent companies and subsidiaries was higher in almost every industry. Looking at the amount of technology imports, "Information and communication electronics equipment" was highest, followed by "Drugs and medicines." Almost all the trade in those industries was not among parent companies and subsidiaries.

Chart 5-1-4: The technology trade of Japan by industry classification

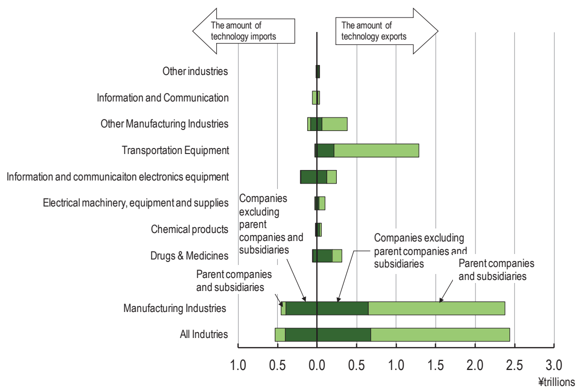
(A) The amount of technology trade



(B) The amount of technology trade of parent companies and subsidiaries, and that of companies excluding parent companies and subsidiaries (the FY 2005).



(C) The amount of technology trade of parent companies and subsidiaries, and that of companies excluding parent companies and subsidiaries (the FY 2010)



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 2005, 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 2010, used the industry classification of the Survey of Research and Development based on Japan Standard Industry Classification revised edition 2007 (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.

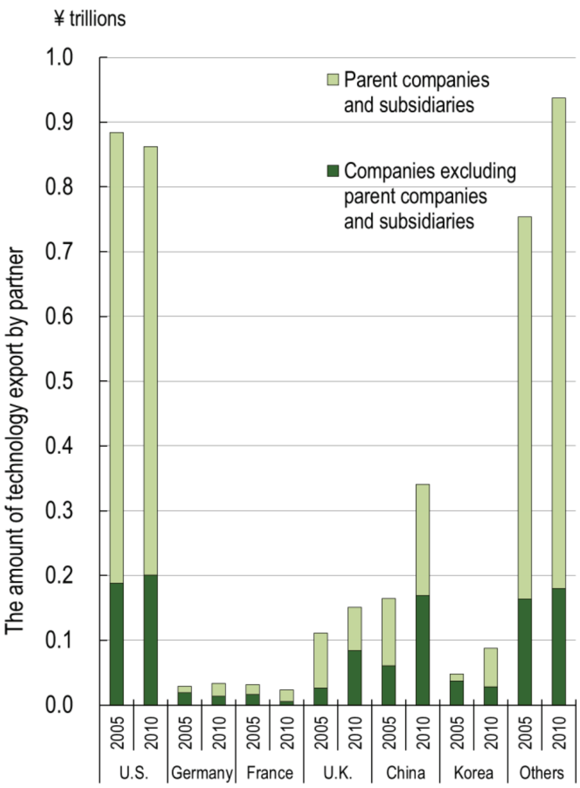
As shown in Chart 5-1-5(A), Japan's amount of technology exports in FY2010, i.e., the amount of value received from partner countries, was especially large from the U.S. It was 862.3 billion yen, accounting for 35.4% of the amount from all partner countries. Next largest was China at 341.1 billion yen (14% 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 2005, there were decreases in the U.S. and France, but all the other countries showed increases.

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 FY2010. It was 402.7 billion yen, accounting for 76% of the total for all countries. For each of the countries, technology imports not among parent companies and subsidiaries were larger.

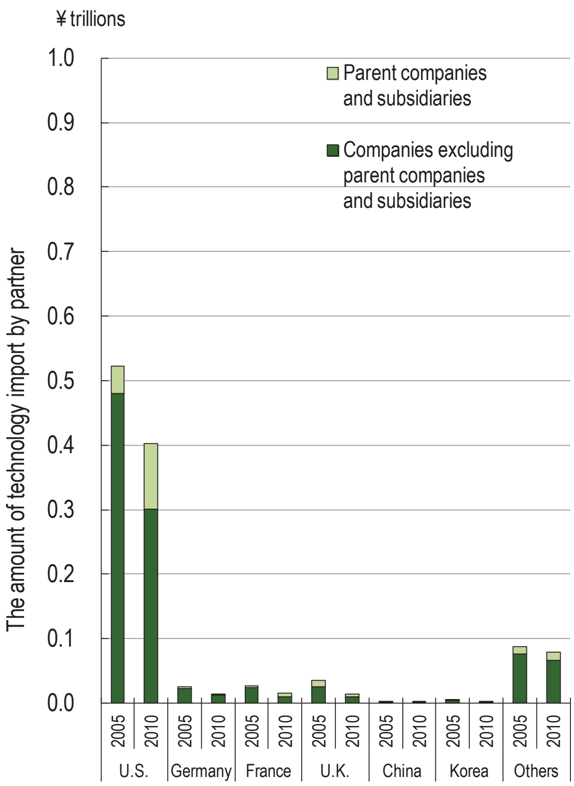
Out of the six countries shown in 5-1-5(B), only China showed an increase compared with FY 2005. The others all showed decreases. The amount of technology imports from countries other than those six also decreased.

Chart 5-1-5: The amount of technology trade of Japan by partner (FY 2005 and 2010)

(A) The amount of technology exports by partner



(B) The amount of technology imports by partner



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 had consistently increased, but it fell about 10% in 2009 compared with 2008. "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. High-technology trade declined in each country in 2009, but increased again in 2010.

○ Japan's high-technology trade balance ratio has been on a long-term downward trend since peaking in 1984. Japan was passed by Korea in 2003 and by China in 2009. However, its high-technology trade balance ratio has never fallen below 1.

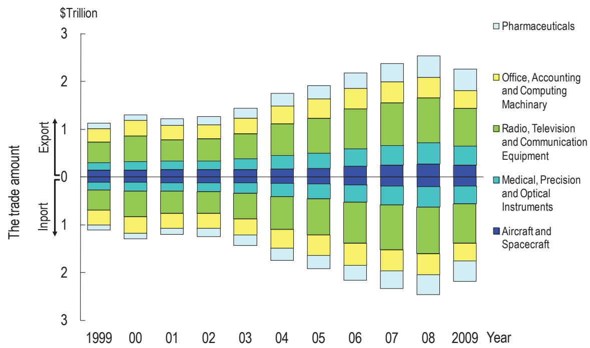
○Looking at it by field, the “Radio, Television and Communication Equipment” industry showed a large ratio, and particularly the amount of the imports and the exports of China have been larger than those of the U.S. in recent years.

○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 7 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 was smaller in 2009 than it was in the previous year, so total trade in high-technology industries can be considered to have declined. "Radio, Television and Communication Equipment" accounts for the largest share of trade at about 40%.

Chart 5-2-1: The change of the trade amount of the high-technology industry of 34 OECD member-countries and 7 Non-OECD countries and regions



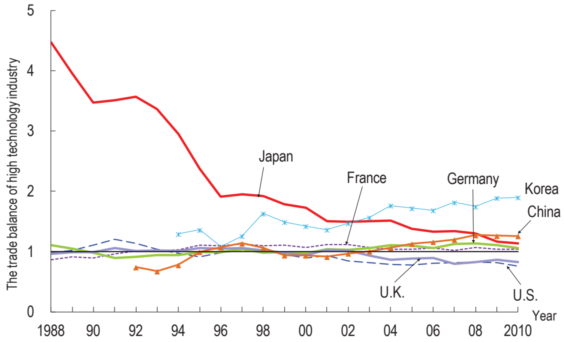
Note: The non-member countries and regions are Algeria, China, Russia, Singapore, Romania, South Africa and Taiwan.
Source : OECD, “ Main Science and Technology Indicators 2011/2”

(3) Algeria, China, Russia, Singapore, Romania, South Africa and Taiwan
(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 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 2000. In 2010, it was 0.76.

Chart 5-2-2: Changes in the trade balance ratios for high-technology industries in selected countries



Source: Same as Chart 5-2-3.

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 (Japan, the U.S., Germany, France, the U.K., China and Korea) in 2009, but increased again in 2010.

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 same was true of "Pharmaceuticals."

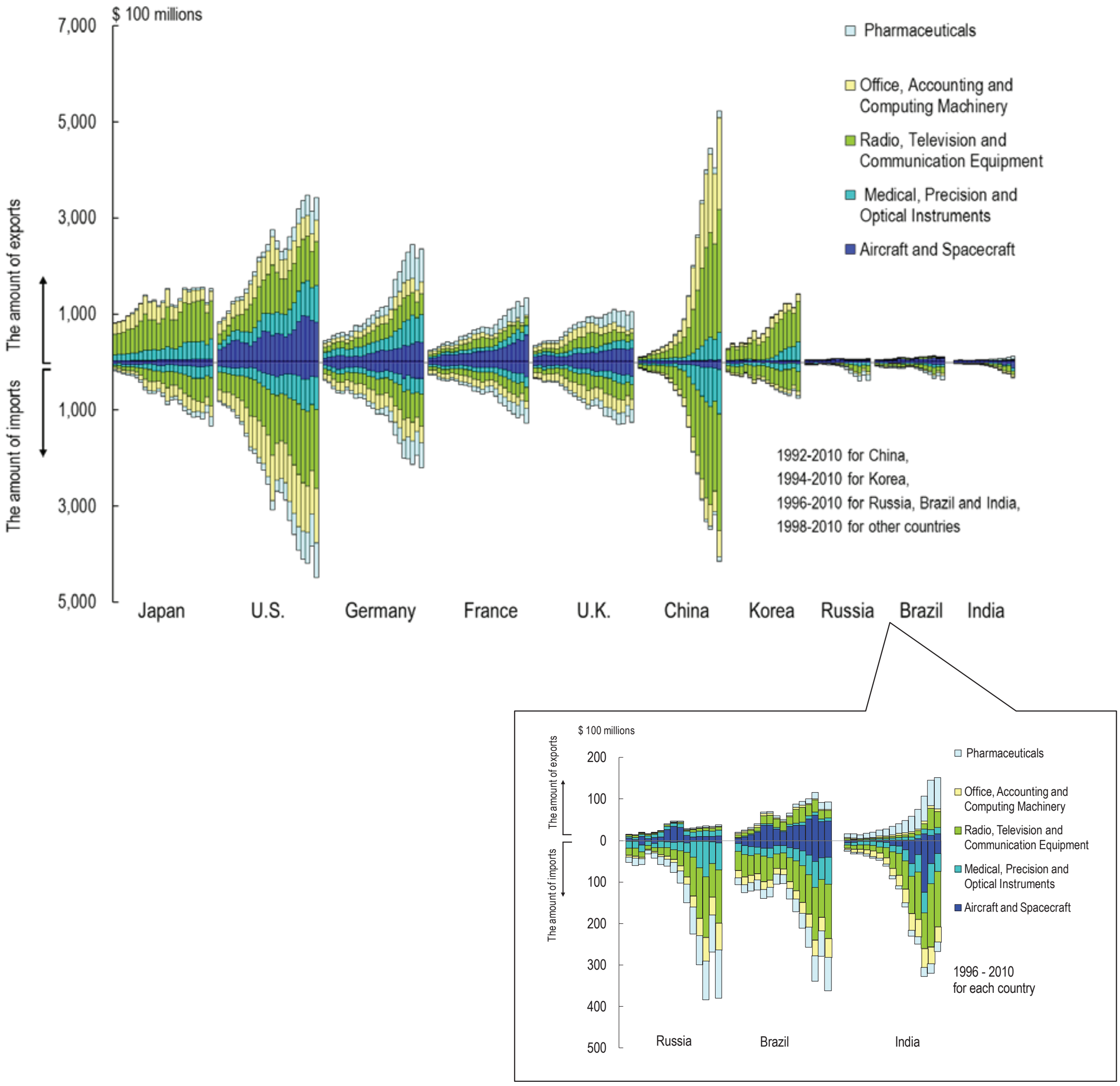
The U.K. has a large export amount in "Pharmaceuticals," in which it maintains a surplus. It also has a large export amount in "Aircraft and Spacecraft." However, its surplus in that industry has shifted to a deficit in recent years.

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.

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 2011/2"
<Brazil, India and Korea, 2010 values> OECD, "Bilateral Trade Database by Industry and End-use Category"

5.3 Trademark applications and trilateral patent families

Key Points

- ○The number of trademark applications is related to innovation in the form of new products and services, and to associated marketing activities. It can thus be considered data that reflect the relationship between innovation and markets. By examining that number along with the number of patent applications, which indicates the technical aspects of innovation, the nature of innovation in each country can be grasped.
- ○Looking at the number of transnational trademark applications and trilateral patent families (patents with the same content submitted in Japan, the U.S. and Europe) per million population, in 2007–2009, Japan, Germany and 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.

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 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 2007–2009, Japan had a large number of trilateral patent families, but a relatively small number of trademark applications. 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.

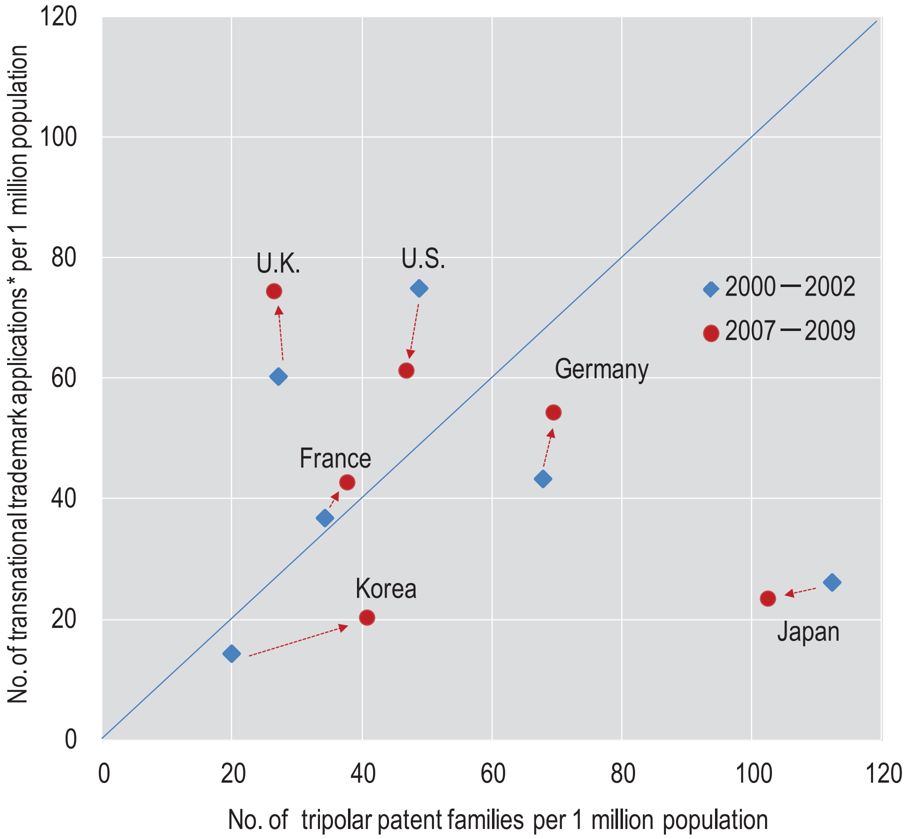
It is believed that countries with powerful manufacturing industries or those specializing in the information and communications industry tend to have more patent applications than trademark applications, while countries weighted towards service industries tend to have more trademark applications. Country 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 and 2007–2009, the number of trademark applications increased more than the number of trilateral patent families in Germany and the U.K.

The number of trilateral patent families increased more than the number of trademark applications in Korea. In France, the number of trademark applications and the number of trilateral patent families increased by about the same degree.

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: Transnational trademark applications and trilateral patent families per million population



Note: 1) *Transnational trademarks refer to the following.
For the number of trademarks in Japan, Germany, France, the U.K. and 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, December 2011"
OECD, "Main Science and Technology Indicators 2011/2"

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, innovation related to new services is realized at a lower rate than innovation related to products and process innovation, regardless of the size of R&D expenditures.

○In the case of U.S. business enterprises that carry out R&D activities, innovation related to new services has a lower rate of innovation than innovation related to products 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

Note: 1) Companies that had R&D expenditures, whether internal or external, during FY 2006–2008 are considered companies that 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 and (iii) process innovation (Chart 5-4-2).

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.

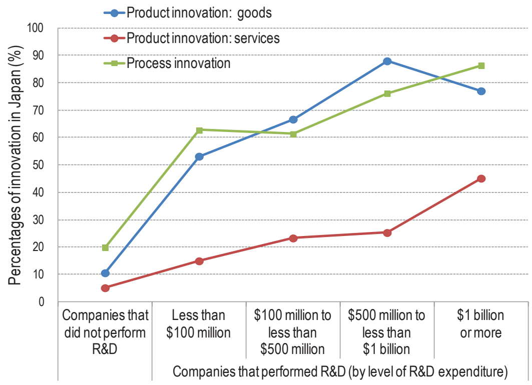
In the U.S. as in Japan, business enterprises with higher R&D expenditures tended to have higher rates of innovation.

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.

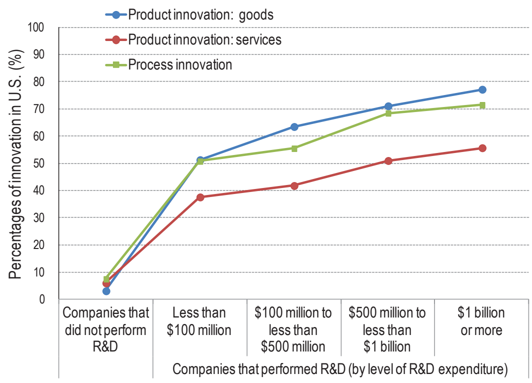
For all three types of innovation activities, businesses with at least 1 billion dollars in R&D expenditures had the highest rate of innovation. For "process innovation," however, the rate for businesses utilizing 500 million dollars to less than 1 billion dollars was 69%, while that for businesses with 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

○Total Factor Productivity (TFP) is used as an indicator that shows the contribution of technological progress to economic growth. Although Japan had the lowest TFP growth rate of any of the selected developed countries during the 1990s, since 2001 it has had a relatively high growth rate. However, the TFP growth rate has been falling in all those countries, including Japan, since the late 2000s.

Total Factor Productivity (TFP) is an indicator showing that portion of economic growth that cannot be explained by the contributions of increased investment in capital and labor. TFP indicates the degree to which improved production efficiency contributes to economic growth (GDP increase). This is likely to include the effects not only of technological progress, but also of factors such as improvements in management and organizational efficiency, the development of divisions of labor, the achievement of economies of scale and the preservation of excess labor and capital due to recession. Thus, although TFP is not an indicator that directly measures technological progress, over the long term such progress has a relatively powerful effect on it. TFP is therefore widely used as an indicator of the contribution of technological progress on economic growth.

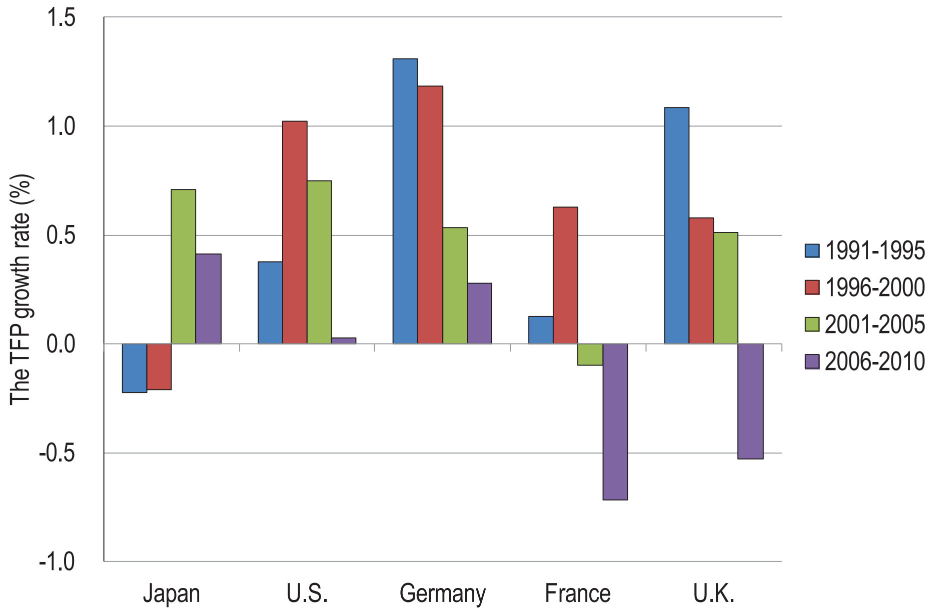
Chart 5-5 shows an example of TFP measurement of entire national economies on a macro basis. This is based on a methodology that has come into general use in recent years (the so-called KLEMS methodology), which aims to measure productivity improvement as accurately as possible by taking improvements in the quality of labor and capital service into account.

Japan had the lowest TFP growth rate of any of the selected developed countries during the 1990s, but since 2001 it has had a high growth rate.

The U.S. had a high TFP growth rate from the late 1990s through the early 2000s. In contrast, Germany, France and the U.K. had high TFP growth rates during the 1990s, but they fell during the 2000s.

The TFP growth rate has been lower than before in all the selected developed countries, including Japan, since the late 2000s.

Chart 5-5 Change in the TFP growth rates in major countries



Note: The TFP growth rate for each period is the average annual rate for that period. (For example, for 1991–1995 it is the average of the year-on-year growth rates for 1991, 1992, 1993, 1994 and 1995.)
Source: Created from the Conference Board Total Economy Database™, January 2012, http://www.conference-board.org/data/economydatabase/.

Reference materials

Reference Materials: Indicators for the regions

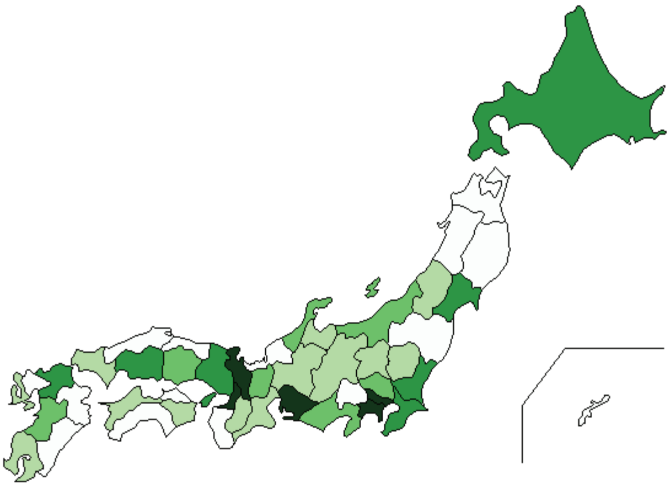
Here, regarding the following 7 items representing the situation of the output of scientific technology activities, the distributions or the changes in the values for the prefecture of Japan indicated are given.

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 2009–2011

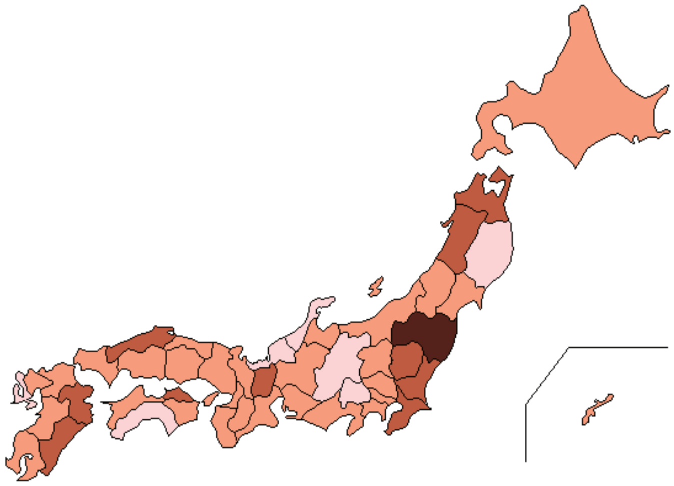


Legend	Classification			The number of prefectures
	5.00% or over	~		5
	2.00%	~	under 5.00%	7
	1.00%	~	2.00%	7
	0.50%	~	1.00%	13
		~	0.50%	15

Top 5	Share	Low rank 5	Share
Tokyo	26.82%	Miyazaki	0.29%
Osaka	6.76%	Shimane	0.30%
Kyoto	6.63%	Akita	0.31%
Aichi	5.82%	Wakayama	0.32%
Kanagawa	5.57%	Kagawa	0.35%

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 2004–2006 and 2009–2011



Legend	Classification			The number of prefectures
	1.15 or over	~		1
	1.05	~	under 1.15	10
	0.95	~	1.05	29
	0.85	~	0.95	7
		~	0.85	0

Top 5	Share	Low rank 5	Share
Fukushima	1.19	Kochi	0.90
Akita	1.15	Nagano	0.91
Tochigi	1.13	Yamanashi	0.91
Saga	1.12	Fukui	0.91
Oita	1.10	Ishikawa	0.94

Source: MEXT, “School Basic Survey”

[Key Points]

- Prefectures with large cities have more graduate students. Tokyo Prefecture has far more than any other prefecture (Chart 1-1).
- Looking at the rate at which shares increased from 2004–2006 to 2009–2011, Fukushima Prefecture had the highest rate at 1.19, followed by Akita Prefecture at 1.15. On the other hand, there were seven prefectures with share increase rates below 0.95 (Chart 1-2).

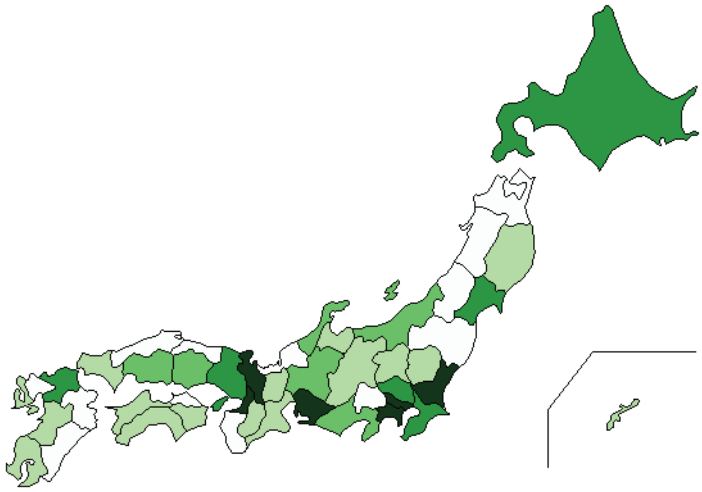
Table 1: The number of graduate students in national, public and private universities and colleges

Prefectures	3-year moving average				The growth rate of the share (B)/(A)
	2004-2006 Unit: case	2009-2011 Unit: case	2004-2006 Share (A)	2009-2011 Share (B)	
Hokkaido	8,961	9,379	3.54%	3.48%	0.984
Aomori	917	1,030	0.36%	0.38%	1.056
Iwate	1,328	1,341	0.52%	0.50%	0.949
Miyagi	7,829	7,950	3.09%	2.95%	0.955
Akita	692	845	0.27%	0.31%	1.148
Yamagata	1,430	1,509	0.56%	0.56%	0.992
Fukushima	834	1,055	0.33%	0.39%	1.188
Ibaraki	6,502	7,463	2.57%	2.77%	1.079
Tochigi	1,777	2,140	0.70%	0.79%	1.132
Gunma	1,837	2,003	0.73%	0.74%	1.025
Saitama	4,634	5,128	1.83%	1.90%	1.040
Chiba	8,856	9,913	3.50%	3.68%	1.052
Tokyo	66,532	72,236	26.28%	26.82%	1.021
Kanagawa	14,437	15,015	5.70%	5.57%	0.978
Niigata	4,406	4,792	1.74%	1.78%	1.022
Toyama	1,287	1,348	0.51%	0.50%	0.985
Ishikawa	4,134	4,131	1.63%	1.53%	0.939
Fukui	1,184	1,150	0.47%	0.43%	0.913
Yamanashi	1,206	1,171	0.48%	0.43%	0.913
Nagano	2,321	2,240	0.92%	0.83%	0.907
Gifu	2,121	2,158	0.84%	0.80%	0.957
Shizuoka	2,562	2,720	1.01%	1.01%	0.998
Aichi	14,483	15,671	5.72%	5.82%	1.017
Mie	1,373	1,387	0.54%	0.52%	0.950
Shiga	2,502	2,968	0.99%	1.10%	1.115
Kyoto	17,228	17,856	6.80%	6.63%	0.974
Osaka	17,910	18,215	7.07%	6.76%	0.956
Hyogo	9,542	9,912	3.77%	3.68%	0.976
Nara	2,330	2,403	0.92%	0.89%	0.969
Wakayama	779	862	0.31%	0.32%	1.040
Tottori	1,118	1,174	0.44%	0.44%	0.987
Shimane	710	814	0.28%	0.30%	1.077
Okayama	4,320	4,399	1.71%	1.63%	0.957
Hiroshima	5,932	6,078	2.34%	2.26%	0.963
Yamaguchi	1,915	1,961	0.76%	0.73%	0.963
Tokushima	2,380	2,425	0.94%	0.90%	0.958
Kagawa	839	948	0.33%	0.35%	1.063
Ehime	1,349	1,372	0.53%	0.51%	0.957
Kouchi	1,092	1,042	0.43%	0.39%	0.897
Fukuoka	11,611	12,377	4.59%	4.60%	1.002
Saga	947	1,047	0.37%	0.39%	1.039
Nagasaki	1,644	1,657	0.65%	0.62%	0.948
Kumamoto	2,567	2,850	1.01%	1.06%	1.044
Oita	978	1,145	0.39%	0.43%	1.101
Miyazaki	670	772	0.26%	0.29%	1.083
Kagoshima	1,987	2,043	0.78%	0.76%	0.967
Okinawa	1,193	1,241	0.47%	0.46%	0.978
Whole	253,184	269,336	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 2009–2011

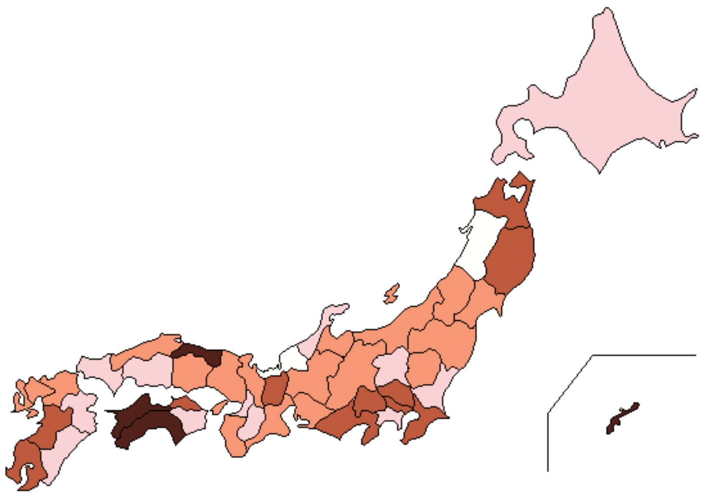


Legend	Classification			The number of prefectures
	5.00% or over	~		6
	2.00%	~	under 5.00%	6
	1.00%	~	2.00%	6
	0.50%	~	1.00%	14
		~	0.50%	15

Top 5	Share	Low rank 5	Share
Tokyo	20.02%	Wakayama	0.33%
Osaka	7.66%	Miyazaki	0.34%
Ibaraki	7.10%	Shimane	0.36%
Kanagawa	6.66%	Oita	0.36%
Kyoto	6.00%	Fukushima	0.38%

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: Science)"

Chart 2-2: The share increase rate of the number of papers (all fields)
The comparisons of the average value between 2004–2006 and 2009–2011



Legend	Classification			The number of prefectures
	1.15 or over	~		4
	1.05	~	under 1.15	11
	0.95	~	1.05	18
	0.85	~	0.95	12
		~	0.85	2

Top 5	Share	Low rank 5	Share
Okinawa	1.28	Fukui	0.84
Tottori	1.24	Akita	0.85
Ehime	1.20	Yamaguchi	0.85
Kochi	1.15	Mara	0.88
Shiga	1.15	Gunma	0.92

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: 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, Table 2).
- The five prefectures with the highest shares of the number of papers were not necessarily in the top 5 in terms of share increase rate. On the other hand, there were 14 prefectures whose shares decreased and whose share increase rate was less than 0.95 (Chart 2-2).

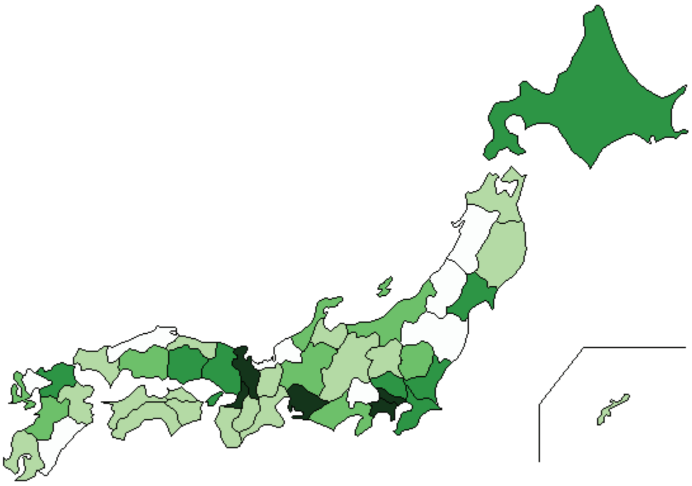
Table 2: The number of the papers (all fields)

Prefectures	3-year moving average				
	2004-2006 Unit case	2009-2011 Unit case	2004-2006 Share (A)	2009-2011 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	3,139	2,926	4.05%	3.84%	0.949
Aomori	317	342	0.41%	0.45%	1.098
Iwate	399	421	0.52%	0.55%	1.072
Miyagi	3,315	3,198	4.28%	4.20%	0.982
Akita	349	290	0.45%	0.38%	0.846
Yamagata	361	357	0.47%	0.47%	1.008
Fukushima	296	290	0.38%	0.38%	0.996
Ibaraki	5,898	5,403	7.61%	7.10%	0.932
Tochigi	582	569	0.75%	0.75%	0.996
Gunma	644	582	0.83%	0.76%	0.920
Saitama	2,234	2,317	2.88%	3.04%	1.056
Chiba	2,740	2,935	3.54%	3.85%	1.090
Tokyo	14,711	15,248	18.98%	20.02%	1.055
Kanagawa	5,479	5,073	7.07%	6.66%	0.942
Niigata	904	852	1.17%	1.12%	0.960
Toyama	530	541	0.68%	0.71%	1.039
Ishikawa	1,039	968	1.34%	1.27%	0.949
Fukui	368	302	0.47%	0.40%	0.836
Yamanashi	283	305	0.37%	0.40%	1.096
Nagano	658	678	0.85%	0.89%	1.048
Gifu	803	781	1.04%	1.03%	0.990
Shizuoka	1,165	1,212	1.50%	1.59%	1.059
Aichi	4,444	4,155	5.73%	5.46%	0.952
Mie	483	471	0.62%	0.62%	0.992
Shiga	519	585	0.67%	0.77%	1.146
Kyoto	4,687	4,570	6.05%	6.00%	0.992
Osaka	6,273	5,834	8.09%	7.66%	0.947
Hyogo	2,186	2,200	2.82%	2.89%	1.024
Nara	674	580	0.87%	0.76%	0.876
Wakayama	264	251	0.34%	0.33%	0.968
Tottori	298	363	0.38%	0.48%	1.240
Shimane	289	274	0.37%	0.36%	0.966
Okayama	1,257	1,223	1.62%	1.61%	0.991
Hiroshima	1,456	1,344	1.88%	1.76%	0.939
Yamaguchi	533	446	0.69%	0.59%	0.853
Tokushima	619	570	0.80%	0.75%	0.938
Kagawa	316	354	0.41%	0.46%	1.139
Ehime	435	512	0.56%	0.67%	1.197
Kouchi	340	385	0.44%	0.51%	1.155
Fukuoka	3,215	3,294	4.15%	4.33%	1.043
Saga	338	338	0.44%	0.44%	1.019
Nagasaki	607	605	0.78%	0.79%	1.015
Kumamoto	667	746	0.86%	0.98%	1.139
Oita	301	277	0.39%	0.36%	0.936
Miyazaki	275	256	0.36%	0.34%	0.946
Kagoshima	432	460	0.56%	0.60%	1.085
Okinawa	309	390	0.40%	0.51%	1.282
Unknown	74	74	0.10%	0.10%	1.014
Whole	77,505	76,149	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 (SCIE, CPCI: 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 2009–2011

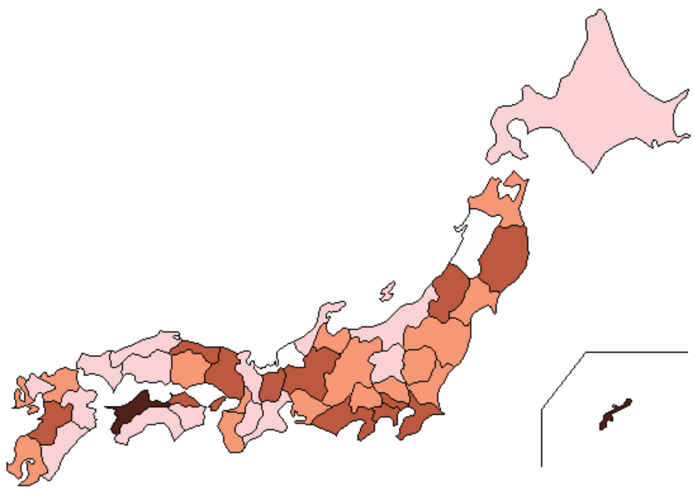


Legend	Classification			The number of prefectures
	5.00% or over	～		5
	2.00%	～	under 5.00%	8
	1.00%	～	2.00%	8
	0.50%	～	1.00%	18
		～	0.50%	8

Top 5	Share	Low rank 5	Share
Tokyo	20.86%	Saga	0.37%
Osaka	7.57%	Fukui	0.39%
Kanagawa	5.34%	Shimane	0.44%
Aichi	5.07%	Akita	0.44%
Kyoto	5.01%	Yamanashi	0.45%

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: Science)"

Chart 3-2: Share increase rate for number of papers (Life sciences)
Comparison of average values for 2004–2006 and 2009–2011



Legend	Classification			The number of prefectures
	1.15 or over	～		2
	1.05	～	under 1.15	12
	0.95	～	1.05	16
	0.85	～	0.95	15
		～	0.85	2

Top 5	Share	Low rank 5	Share
Okinawa	1.18	Fukui	0.74
Ehime	1.16	Akita	0.75
Shiga	1.15	Mie	0.85
Iwate	1.13	Gunma	0.85
Kumamoto	1.09	Yamaguchi	0.86

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: 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% (18). 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 Kanagawa Prefecture had a relatively high share of papers in both 2004–2006 and 2009–2011, as well as the sixth-highest rate of increase. On the other hand, there were 17 prefectures whose shares decreased and whose share increase rate was less than 0.95 (Chart 3-2, Table 3).

Table 3: The number of papers (the field of Life sciences)

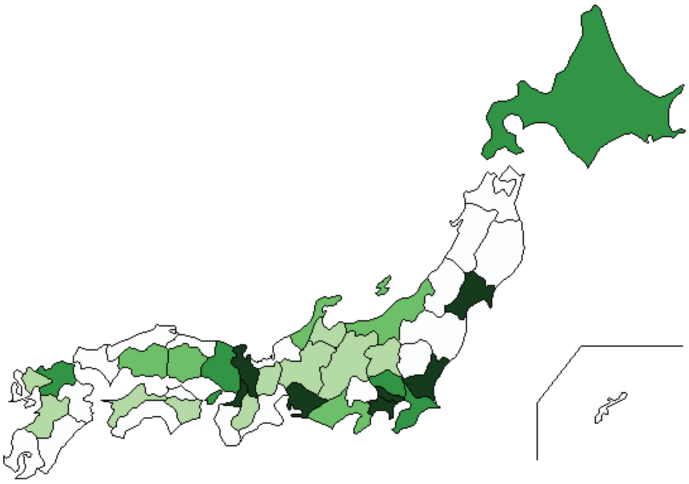
Prefectures	3-year moving average				
	2004-2006 Unit case	2009-2011 Unit case	2004-2006 Share (A)	2009-2011 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,802	1,661	5.01%	4.42%	0.883
Aomori	237	243	0.66%	0.65%	0.980
Iwate	242	286	0.67%	0.76%	1.132
Miyagi	982	979	2.73%	2.61%	0.955
Akita	211	165	0.59%	0.44%	0.750
Yamagata	156	173	0.43%	0.46%	1.066
Fukushima	172	181	0.48%	0.48%	1.005
Ibaraki	1,527	1,569	4.24%	4.18%	0.984
Tochigi	432	442	1.20%	1.18%	0.979
Gunma	387	345	1.08%	0.92%	0.855
Saitama	1,012	1,088	2.81%	2.90%	1.030
Chiba	1,245	1,380	3.46%	3.67%	1.061
Tokyo	7,053	7,834	19.60%	20.86%	1.064
Kanagawa	1,773	2,007	4.93%	5.34%	1.085
Niigata	478	467	1.33%	1.24%	0.936
Toyama	302	303	0.84%	0.81%	0.961
Ishikawa	563	532	1.57%	1.42%	0.906
Fukui	187	145	0.52%	0.39%	0.743
Yamanashi	159	170	0.44%	0.45%	1.021
Nagano	343	361	0.95%	0.96%	1.007
Gifu	390	432	1.08%	1.15%	1.061
Shizuoka	680	751	1.89%	2.00%	1.059
Aichi	1,805	1,906	5.02%	5.07%	1.011
Mie	338	301	0.94%	0.80%	0.854
Shiga	237	283	0.66%	0.75%	1.145
Kyoto	1,903	1,883	5.29%	5.01%	0.948
Osaka	2,863	2,843	7.96%	7.57%	0.951
Hyogo	998	1,128	2.77%	3.00%	1.083
Nara	374	349	1.04%	0.93%	0.894
Wakayama	196	198	0.54%	0.53%	0.969
Tottori	208	230	0.58%	0.61%	1.062
Shimane	177	164	0.49%	0.44%	0.886
Okayama	799	795	2.22%	2.12%	0.952
Hiroshima	724	681	2.01%	1.81%	0.901
Yamaguchi	300	271	0.83%	0.72%	0.865
Tokushima	367	360	1.02%	0.96%	0.941
Kagawa	225	253	0.63%	0.67%	1.078
Ehime	244	295	0.68%	0.79%	1.159
Kouchi	231	215	0.64%	0.57%	0.891
Fukuoka	1,624	1,755	4.51%	4.67%	1.035
Saga	150	140	0.42%	0.37%	0.894
Nagasaki	463	474	1.29%	1.26%	0.981
Kumamoto	404	460	1.12%	1.22%	1.091
Oita	221	211	0.62%	0.56%	0.915
Miyazaki	201	186	0.56%	0.50%	0.889
Kagoshima	324	345	0.90%	0.92%	1.019
Okinawa	222	272	0.62%	0.73%	1.177
Unknown	55	53	0.15%	0.14%	0.935
Whole	35,985	37,564	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 (SCIE, CPCI: 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 2009–2011

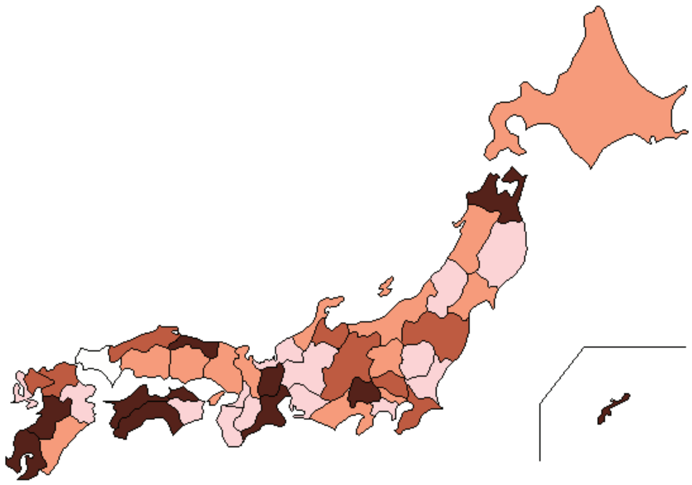


Legend	Classification			The number of prefectures
	5.00% or over	~		7
	2.00%	~	under 5.00%	5
	1.00%	~	2.00%	5
	0.50%	~	1.00%	10
		~	0.50%	20

Top 5	Share	Low rank 5	Share
Tokyo	18.96%	Wakayama	0.13%
Ibaraki	10.05%	Oita	0.17%
Kanagawa	8.00%	Miyazaki	0.18%
Osaka	7.78%	Aomori	0.26%
Kyoto	6.94%	Kagawa	0.26%

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: Science)"

Chart 4-2: The share increase rate of the number of papers (fields other than Life sciences)
A comparison of average values between 2004–2006 and 2009–2011



Legend	Classification			The number of prefectures
	1.15 or over	~		11
	1.05	~	under 1.15	8
	0.95	~	1.05	13
	0.85	~	0.95	14
		~	0.85	1

Top 5	Share	Low rank 5	Share
Kochi	1.63	Yamaguchi	0.79
Tottori	1.56	Oita	0.86
Aomori	1.37	Gifu	0.88
Okinawa	1.36	Tochigi	0.89
Mie	1.27	Nara	0.89

Source: Compiled by NISTEP based on Thomson Reuters Scientific, "Web of Science (SCIE, CPCI: 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, a large number of prefectures (20) have shares from 0 to 0.5% (Chart 4-1). The top five prefectures did not change between 2004–2006 and 2009–2011 (Table 4).
- Looking at the share increase rate, a relatively large number of prefectures (11) had rates of at least 1.15. There were also many prefectures (14) with share increase rates from 0.85 to less than 0.95 (Chart 4-2).

Table 4: The number of papers (fields other than Life sciences)

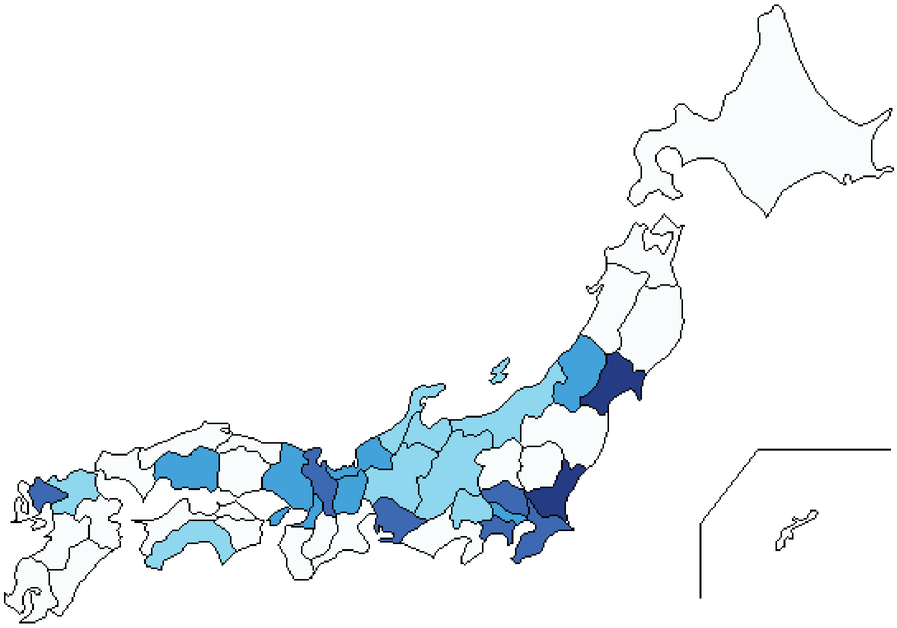
Prefectures	3-year moving average				
	2004-2006 Unit case	2009-2011 Unit case	2004-2006 Share (A)	2009-2011 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,223	1,233	3.21%	3.27%	1.018
Aomori	72	97	0.19%	0.26%	1.367
Iwate	148	133	0.39%	0.35%	0.904
Miyagi	2,192	2,197	5.75%	5.82%	1.012
Akita	126	122	0.33%	0.32%	0.982
Yamagata	197	181	0.52%	0.48%	0.930
Fukushima	100	108	0.26%	0.29%	1.085
Ibaraki	4,127	3,792	10.83%	10.05%	0.928
Tochigi	136	119	0.36%	0.32%	0.887
Gunma	231	233	0.61%	0.62%	1.018
Saitama	1,120	1,202	2.94%	3.19%	1.084
Chiba	1,403	1,533	3.68%	4.06%	1.103
Tokyo	6,917	7,155	18.15%	18.96%	1.045
Kanagawa	3,396	3,019	8.91%	8.00%	0.898
Niigata	390	378	1.02%	1.00%	0.980
Toyama	212	235	0.56%	0.62%	1.118
Ishikawa	424	426	1.11%	1.13%	1.013
Fukui	170	156	0.45%	0.41%	0.928
Yamanashi	114	134	0.30%	0.36%	1.188
Nagano	295	312	0.78%	0.83%	1.066
Gifu	394	343	1.03%	0.91%	0.881
Shizuoka	448	450	1.17%	1.19%	1.014
Aichi	2,377	2,203	6.24%	5.84%	0.936
Mie	131	166	0.34%	0.44%	1.274
Shiga	258	294	0.68%	0.78%	1.153
Kyoto	2,549	2,619	6.69%	6.94%	1.038
Osaka	3,144	2,936	8.25%	7.78%	0.943
Hyogo	1,093	1,036	2.87%	2.75%	0.957
Nara	252	223	0.66%	0.59%	0.893
Wakayama	55	51	0.15%	0.13%	0.927
Tottori	83	129	0.22%	0.34%	1.555
Shimane	100	110	0.26%	0.29%	1.104
Okayama	425	423	1.12%	1.12%	1.006
Hiroshima	681	648	1.79%	1.72%	0.962
Yamaguchi	214	168	0.56%	0.45%	0.792
Tokushima	221	204	0.58%	0.54%	0.933
Kagawa	81	98	0.21%	0.26%	1.217
Ehime	180	213	0.47%	0.56%	1.192
Kouchi	105	170	0.28%	0.45%	1.634
Fukuoka	1,435	1,509	3.77%	4.00%	1.062
Saga	172	193	0.45%	0.51%	1.136
Nagasaki	129	121	0.34%	0.32%	0.948
Kumamoto	241	283	0.63%	0.75%	1.184
Oita	75	63	0.20%	0.17%	0.856
Miyazaki	70	68	0.18%	0.18%	0.981
Kagoshima	96	112	0.25%	0.30%	1.177
Okinawa	82	110	0.21%	0.29%	1.356
Unknown	17	20	0.05%	0.05%	1.157
Whole	38,104	37,727	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 (SCIE, CPCI: 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	～		2	The number of non-Life sciences is very large (Approximately over twice)
	1.100	～	under 1.500	6	The number of non-Life sciences is slightly large
	0.900	～	1.100	7	The number of non-Life sciences and Life sciences are fifty-fifty split
	0.750	～	0.900	8	The number of Life sciences is slighly large
		～	0.750	24	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 (SCIE, CPCI: 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 2009–2011 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, only eight prefectures with at least 1% of the share of papers in fields other than Life sciences had a balance above 1. They included Ibaraki Prefecture (2.41), Miyagi Prefecture (2.23), Kanagawa Prefecture (1.50) and Kyoto Prefecture (1.39).

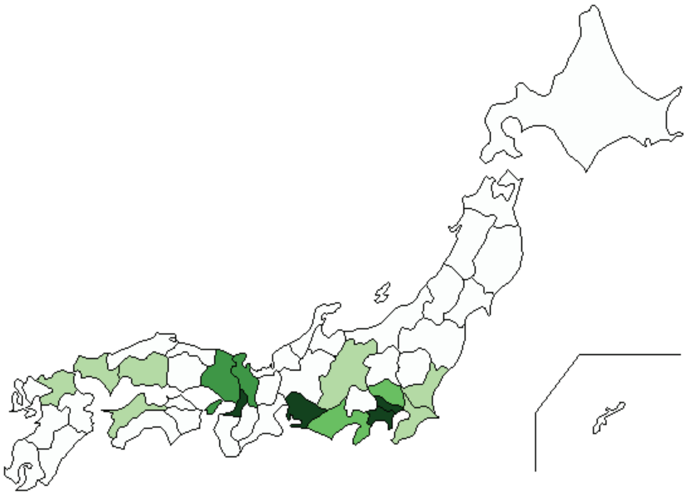
Table 5: Shares of and balance between papers in Life science fields and fields other than Life sciences

Prefectures	Non-Life sciences 3-year moving average			Life sciences 3-year moving average			Balance
	2004-2006 Share (A)	2009-2011 Share (B)	The growth rate of the share (B)/(A)	2004-2006 Share (C)	2009-2011 Share (D)	The growth rate of the share (D)/(C)	non-Life sciences (B)/ Life sciences (D)
Hokkaido	3.21%	3.27%	1.02	5.01%	4.42%	0.883	0.739
Aomori	0.19%	0.26%	1.37	0.66%	0.65%	0.980	0.400
Iwate	0.39%	0.35%	0.90	0.67%	0.76%	1.132	0.462
Miyagi	5.75%	5.82%	1.01	2.73%	2.61%	0.955	2.234
Akita	0.33%	0.32%	0.98	0.59%	0.44%	0.750	0.739
Yamagata	0.52%	0.48%	0.93	0.43%	0.46%	1.066	1.041
Fukushima	0.26%	0.29%	1.09	0.48%	0.48%	1.005	0.592
Ibaraki	10.83%	10.05%	0.93	4.24%	4.18%	0.984	2.407
Tochigi	0.36%	0.32%	0.89	1.20%	1.18%	0.979	0.269
Gunma	0.61%	0.62%	1.02	1.08%	0.92%	0.855	0.673
Saitama	2.94%	3.19%	1.08	2.81%	2.90%	1.030	1.101
Chiba	3.68%	4.06%	1.10	3.46%	3.67%	1.061	1.106
Tokyo	18.15%	18.96%	1.04	19.60%	20.86%	1.064	0.909
Kanagawa	8.91%	8.00%	0.90	4.93%	5.34%	1.085	1.498
Niigata	1.02%	1.00%	0.98	1.33%	1.24%	0.936	0.807
Toyama	0.56%	0.62%	1.12	0.84%	0.81%	0.961	0.772
Ishikawa	1.11%	1.13%	1.01	1.57%	1.42%	0.906	0.796
Fukui	0.45%	0.41%	0.93	0.52%	0.39%	0.743	1.071
Yamanashi	0.30%	0.36%	1.19	0.44%	0.45%	1.021	0.788
Nagano	0.78%	0.83%	1.07	0.95%	0.96%	1.007	0.861
Gifu	1.03%	0.91%	0.88	1.08%	1.15%	1.061	0.792
Shizuoka	1.17%	1.19%	1.01	1.89%	2.00%	1.059	0.596
Aichi	6.24%	5.84%	0.94	5.02%	5.07%	1.011	1.151
Mie	0.34%	0.44%	1.27	0.94%	0.80%	0.854	0.548
Shiga	0.68%	0.78%	1.15	0.66%	0.75%	1.145	1.035
Kyoto	6.69%	6.94%	1.04	5.29%	5.01%	0.948	1.385
Osaka	8.25%	7.78%	0.94	7.96%	7.57%	0.951	1.028
Hyogo	2.87%	2.75%	0.96	2.77%	3.00%	1.083	0.915
Nara	0.66%	0.59%	0.89	1.04%	0.93%	0.894	0.635
Wakayama	0.15%	0.13%	0.93	0.54%	0.53%	0.969	0.255
Tottori	0.22%	0.34%	1.56	0.58%	0.61%	1.062	0.556
Shimane	0.26%	0.29%	1.10	0.49%	0.44%	0.886	0.666
Okayama	1.12%	1.12%	1.01	2.22%	2.12%	0.952	0.530
Hiroshima	1.79%	1.72%	0.96	2.01%	1.81%	0.901	0.948
Yamaguchi	0.56%	0.45%	0.79	0.83%	0.72%	0.865	0.618
Tokushima	0.58%	0.54%	0.93	1.02%	0.96%	0.941	0.564
Kagawa	0.21%	0.26%	1.22	0.63%	0.67%	1.078	0.385
Ehime	0.47%	0.56%	1.19	0.68%	0.79%	1.159	0.718
Kouchi	0.28%	0.45%	1.63	0.64%	0.57%	0.891	0.787
Fukuoka	3.77%	4.00%	1.06	4.51%	4.67%	1.035	0.856
Saga	0.45%	0.51%	1.14	0.42%	0.37%	0.894	1.372
Nagasaki	0.34%	0.32%	0.95	1.29%	1.26%	0.981	0.254
Kumamoto	0.63%	0.75%	1.18	1.12%	1.22%	1.091	0.612
Oita	0.20%	0.17%	0.86	0.62%	0.56%	0.915	0.299
Miyazaki	0.18%	0.18%	0.98	0.56%	0.50%	0.889	0.361
Kagoshima	0.25%	0.30%	1.18	0.90%	0.92%	1.019	0.323
Okinawa	0.21%	0.29%	1.36	0.62%	0.73%	1.177	0.401
Unknown	0.05%	0.05%	1.16	0.15%	0.14%	0.935	0.367
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 (SCIE, CPCI: Science)"

6. The number of patent applications

Chart 6-1: The share of the number of the patent applications
The average value between and 2008–2010

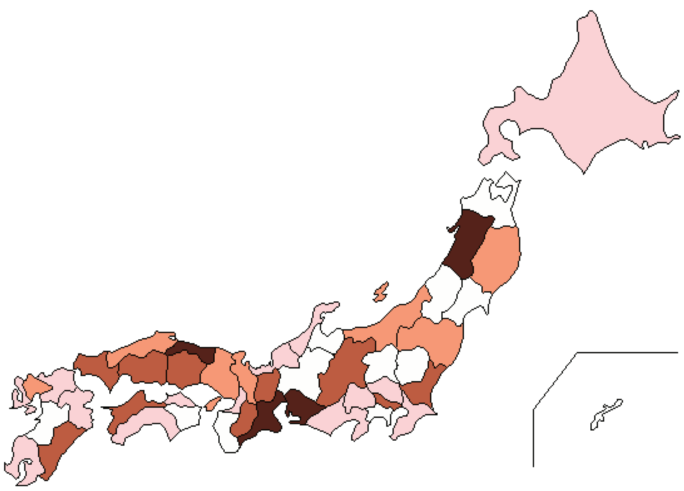


Legend	Classification			The number of prefectures
	5.00% or over	~		4
	2.00%	~	under 5.00%	2
	1.00%	~	2.00%	2
	0.50%	~	1.00%	7
		~	0.50%	32

Top 5	Share	Low rank 5	Share
Tokyo	51.72%	Aomori	0.04%
Osaka	15.50%	Tottori	0.05%
Aichi	9.01%	Okinawa	0.05%
Kanagawa	5.60%	Oita	0.05%
Kyoto	2.94%	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 2003–2005 and 2008–2010



Legend	Classification			The number of prefectures
	1.15 or over	~		4
	1.05	~	under 1.15	10
	0.95	~	1.05	7
	0.85	~	0.95	14
		~	0.85	12

Top 5	Share	Low rank 5	Share
Akita	1.60	Yamagata	0.53
Tottori	1.31	Wakayama	0.58
Aichi	1.20	Gunma	0.67
Mie	1.18	Aomori	0.68
Yamaguchi	1.14	Tokushima	0.72

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 51.72%. 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 2003–2005 to 2008–2010, the growing prefectures included Akita and Tottori Prefectures. However, looking at the whole, there were 26 prefectures whose share increase rate was less than 0.95% and which represents over half of all prefectures (Chart 6-2).

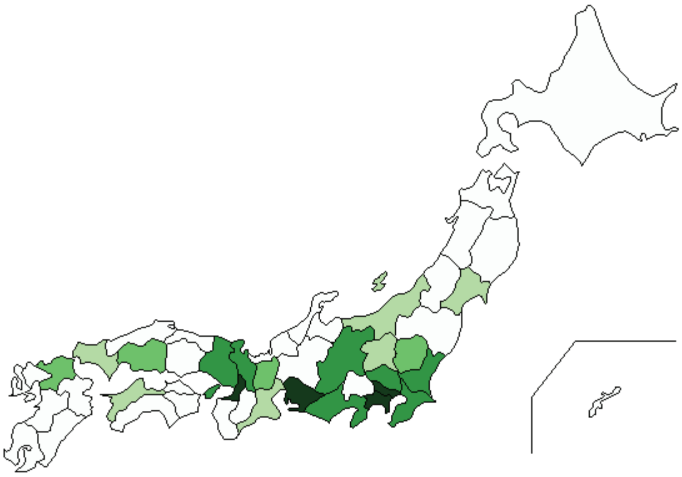
Table 6: The number of patent applications

Prefectures	3-year moving average				
	2003-2005 Unit case	2008-2010 Unit case	2003-2005 Share (A)	2008-2010 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,153	831	0.31%	0.27%	0.87
Aomori	238	134	0.06%	0.04%	0.68
Iwate	287	246	0.08%	0.08%	1.03
Miyagi	1,454	878	0.40%	0.29%	0.73
Akita	206	274	0.06%	0.09%	1.60
Yamagata	481	213	0.13%	0.07%	0.53
Fukushima	332	265	0.09%	0.09%	0.96
Ibaraki	2,050	1,890	0.56%	0.62%	1.11
Tochigi	671	469	0.18%	0.15%	0.84
Gunma	2,514	1,410	0.69%	0.46%	0.67
Saitama	5,679	4,237	1.55%	1.39%	0.90
Chiba	3,315	2,537	0.90%	0.83%	0.92
Tokyo	179,955	157,845	49.12%	51.72%	1.05
Kanagawa	27,068	17,087	7.39%	5.60%	0.76
Niigata	1,297	1,050	0.35%	0.34%	0.97
Toyama	1,030	698	0.28%	0.23%	0.81
Ishikawa	873	646	0.24%	0.21%	0.89
Fukui	874	649	0.24%	0.21%	0.89
Yamanashi	850	630	0.23%	0.21%	0.89
Nagano	2,645	2,323	0.72%	0.76%	1.05
Gifu	1,480	936	0.40%	0.31%	0.76
Shizuoka	5,644	4,081	1.54%	1.34%	0.87
Aichi	27,410	27,488	7.48%	9.01%	1.20
Mie	1,406	1,385	0.38%	0.45%	1.18
Shiga	938	871	0.26%	0.29%	1.12
Kyoto	10,255	8,967	2.80%	2.94%	1.05
Osaka	61,582	47,313	16.81%	15.50%	0.92
Hyogo	7,475	6,212	2.04%	2.04%	1.00
Nara	566	504	0.15%	0.17%	1.07
Wakayama	972	467	0.27%	0.15%	0.58
Tottori	139	152	0.04%	0.05%	1.31
Shimane	416	335	0.11%	0.11%	0.97
Okayama	1,418	1,262	0.39%	0.41%	1.07
Hiroshima	3,132	2,859	0.85%	0.94%	1.10
Yamaguchi	1,617	1,537	0.44%	0.50%	1.14
Tokushima	580	347	0.16%	0.11%	0.72
Kagawa	592	447	0.16%	0.15%	0.91
Ehime	1,799	1,652	0.49%	0.54%	1.10
Kouchi	240	171	0.07%	0.06%	0.86
Fukuoka	3,093	2,435	0.84%	0.80%	0.95
Saga	238	195	0.07%	0.06%	0.98
Nagasaki	245	184	0.07%	0.06%	0.90
Kumamoto	418	254	0.11%	0.08%	0.73
Oita	203	160	0.06%	0.05%	0.95
Miyazaki	254	228	0.07%	0.07%	1.08
Kagoshima	276	200	0.08%	0.07%	0.87
Okinawa	226	156	0.06%	0.05%	0.83
Others	779	56	0.21%	0.02%	0.09
Whole	366,362	305,169	100.00%	100.00%	1.000

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 2010

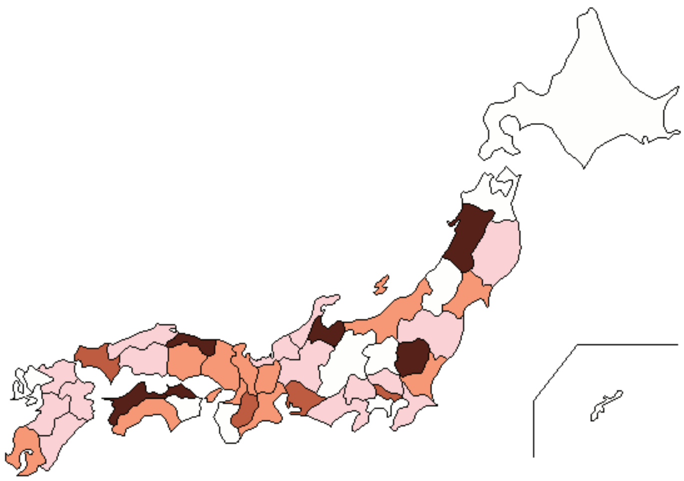


Legend	Classification			The number of prefectures
	5.00% or over	～		4
	2.00%	～	under 5.00%	7
	1.00%	～	2.00%	4
	0.50%	～	1.00%	6
		～	0.50%	26

Top 5	Share	Low rank 5	Share
Tokyo	34.22%	Okinawa	0.04%
Osaka	13.35%	Aomori	0.05%
Kanagawa	10.34%	Nagasaki	0.06%
Aichi	9.31%	Saga	0.06%
Ibaraki	3.48%	Kochi	0.06%

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 2010



Legend	Classification			The number of prefectures
	1.15 or over	～		6
	1.05	～	under 1.15	4
	0.95	～	1.05	11
	0.85	～	0.95	15
		～	0.85	11

Top 5	Share	Low rank 5	Share
Tottori	1.63	Nagasaki	0.32
Kagawa	1.35	Okinawa	0.56
Akita	1.32	Yamagata	0.61
Ehime	1.27	Saga	0.64
Tochigi	1.26	Tokushima	0.68

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. Comparison of 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), found that many prefectures with large shares of inventors are among the prefectures with the largest shares of patent applications and they are also widely distributed in neighboring prefectures.
- The prefectures with high shares of inventors also had high shares of patent applications. Tokyo and Aichi Prefectures had high share rate increases. There were 26 prefectures whose shares decreased and whose share increase rate was less than 0.95 in 2010 (Chart 7-2).

Table 7: The number of inventors

Prefectures	The number of inventors (Unit: people)		Share		
	2005	2010	2005 (A)	2010 (B)	The growth rate (B)/(A)
Hokkaido	3,503	2,147	0.44%	0.33%	0.754
Aomori	629	349	0.08%	0.05%	0.683
Iwate	774	576	0.10%	0.09%	0.915
Miyagi	4,348	3,621	0.55%	0.56%	1.024
Akita	816	875	0.10%	0.14%	1.319
Yamagata	1,518	754	0.19%	0.12%	0.611
Fukushima	2,175	1,631	0.27%	0.25%	0.922
Ibaraki	26,312	22,452	3.31%	3.48%	1.050
Tochigi	7,154	7,328	0.90%	1.14%	1.260
Gunma	8,514	5,700	1.07%	0.88%	0.824
Saitama	28,292	21,705	3.56%	3.36%	0.944
Chiba	19,699	14,135	2.48%	2.19%	0.883
Tokyo	247,803	220,840	31.22%	34.22%	1.096
Kanagawa	98,900	66,715	12.46%	10.34%	0.830
Niigata	4,101	3,384	0.52%	0.52%	1.015
Toyama	2,572	2,594	0.32%	0.40%	1.241
Ishikawa	2,319	1,756	0.29%	0.27%	0.931
Fukui	1,938	1,465	0.24%	0.23%	0.930
Yamanashi	2,452	1,736	0.31%	0.27%	0.871
Nagano	20,108	13,614	2.53%	2.11%	0.833
Gifu	3,326	2,471	0.42%	0.38%	0.914
Shizuoka	23,255	16,711	2.93%	2.59%	0.884
Aichi	66,501	60,078	8.38%	9.31%	1.111
Mie	6,072	5,100	0.76%	0.79%	1.033
Shiga	10,906	8,995	1.37%	1.39%	1.015
Kyoto	15,537	13,190	1.96%	2.04%	1.044
Osaka	109,008	86,128	13.73%	13.35%	0.972
Hyogo	21,727	17,673	2.74%	2.74%	1.001
Nara	2,121	1,964	0.27%	0.30%	1.139
Wakayama	3,089	1,888	0.39%	0.29%	0.752
Tottori	979	1,294	0.12%	0.20%	1.626
Shimane	984	701	0.12%	0.11%	0.876
Okayama	3,408	2,749	0.43%	0.43%	0.992
Hiroshima	11,228	7,859	1.41%	1.22%	0.861
Yamaguchi	4,652	4,008	0.59%	0.62%	1.060
Tokushima	1,690	937	0.21%	0.15%	0.682
Kagawa	1,624	1,784	0.20%	0.28%	1.351
Ehime	5,620	5,809	0.71%	0.90%	1.271
Kouchi	527	418	0.07%	0.06%	0.976
Fukuoka	10,295	7,665	1.30%	1.19%	0.916
Saga	758	397	0.10%	0.06%	0.644
Nagasaki	1,469	383	0.19%	0.06%	0.321
Kumamoto	1,148	805	0.14%	0.12%	0.863
Oita	936	721	0.12%	0.11%	0.948
Miyazaki	763	566	0.10%	0.09%	0.913
Kagoshima	1,779	1,439	0.22%	0.22%	0.995
Okinawa	534	241	0.07%	0.04%	0.555
Whole	793,853	645,351	100.00%	100.00%	1.000

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: 1,000 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	343,383	-
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	349,512	-
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	370,343	-
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	477,874
1996	125,859	269,667	81,896	59,624	58,164	1,223,890	45,525	373,284	478,563
1997	126,157	272,912	82,052	59,831	58,314	1,236,260	45,954	374,226	479,233
1998	126,472	276,115	82,029	60,047	58,475	1,247,610	46,287	375,048	479,792
1999	126,667	279,295	82,087	60,315	58,684	1,257,860	46,617	376,107	480,583
2000	126,926	282,385	82,188	60,725	58,886	1,267,430	47,008	377,955	482,184
2001	127,291	285,309	82,340	61,163	59,113	1,276,270	47,357	379,670	483,600
2002	127,435	288,105	82,482	61,605	59,323	1,284,530	47,622	381,676	485,746
2003	127,689	290,820	82,520	62,038	59,557	1,292,270	47,859	383,912	487,745
2004	127,790	293,463	82,501	62,491	59,846	1,299,880	48,039	386,281	489,921
2005	127,768	296,186	82,464	62,958	60,238	1,307,560	48,138	388,655	492,130
2006	127,901	298,996	82,366	63,393	60,584	1,314,480	48,297	390,755	494,068
2007	128,033	302,004	82,263	63,781	60,986	1,321,290	48,456	393,123	496,319
2008	128,084	304,798	82,120	64,142	61,398	1,328,020	48,607	395,387	498,529
2009	128,032	307,439	81,875	64,496	61,792	1,334,740	48,747	397,004	500,112
2010	128,057	308,746	81,757	64,848	62,181	1,341,414 b	48,875	398,421	501,426
2011	127,799	-	-	-	-	-	-	-	-

Note: a: Break in series with previous year for which data is available.
b: Calculated estimates of OECD Secretariat based on the materials of each country.
<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 2011" (Web site).
<Germany, France, U.K., China, Korea, EU> OECD, "Economic Indicators for MSTI "".

Statistical Reference B　Labor force population of the main countries

(Unit: 1,000 people))

Year	Japan	U.S.	Germany	France	U.K.	China	Korea	EU-15	EU-27
1981	57,070	108,670	28,305	24,266	26,740	-	14,683	147,304	-
1982	57,740	110,204	28,558	24,433	26,678	-	15,032	148,253	-
1983	58,890	111,550	28,605	24,355	26,610	-	15,118	149,112	-
1984	59,270	113,544	28,298	24,539	27,235	-	14,997	150,052	-
1985	59,630	115,461	28,434	24,688	27,486	-	15,592	150,829	-
1986	60,200	117,834 a	28,768	24,958	27,491	-	16,116	152,196	-
1987	60,840	119,865	29,036	24,901	27,943	-	16,873	153,659	-
1988	61,660	121,669	29,220	24,936	28,345	-	17,305	155,210	-
1989	62,700	123,869	29,624	25,102	28,764	-	18,023	156,523	-
1990	63,840	125,840 a	30,771	25,174	28,909	651,320	18,539	158,742	-
1991	65,050	126,346	39,577 a	25,050	28,545	658,430	19,109	167,269 a	-
1992	65,780	128,105	39,490	25,226	28,306	665,160	19,499	167,221	-
1993	66,150	129,200	39,557	25,395	28,103	672,280	19,806	167,358	-
1994	66,450	131,056 a	39,492	25,417	28,052	679,310	20,353	167,619	-
1995	66,660	132,304	39,376	25,393	28,024	685,850	20,845	167,994	217,791
1996	67,110	133,943	39,550	25,674	28,134	695,030	21,288	169,242	218,394
1997	67,870	136,297 a	39,804	25,627	28,252	703,970	21,782	170,236	219,219
1998	67,930	137,673 a	40,131	25,782	28,223	712,080	21,428	171,878	220,663
1999	67,790	139,368 a	39,614	25,984	28,508	719,690	21,666	172,811	221,587
2000	67,660	142,583 a	39,533	26,260	28,740	726,800	22,134	174,726	223,561
2001	67,520	143,734	39,686	26,432	28,774	737,060	22,471	175,588	224,380
2002	66,890	144,863	39,641	26,741	29,030	745,100	22,921	177,397	225,170
2003	66,660	146,510 a	39,507	26,972	29,235	752,320	22,957	178,883	225,844
2004	66,420	147,401 a	39,948	27,187	29,369	760,270	23,417	180,812	228,003
2005	66,500	149,320 a	40,928	27,381	30,062	766,640	23,743	183,927	231,252
2006	66,570	151,428 a	41,429	27,551	30,575	772,470	23,978	186,510	234,041
2007	66,690	153,124 a	41,590	27,775	30,715	778,200	24,216	188,281	235,839
2008	66,500	154,287 a	41,677	27,962	31,084	783,660	24,347	190,291	238,122
2009	66,170	154,142 a	41,699	28,235	31,240	788,810	24,394	190,847	238,859
2010	65,900	-	41,684	28,347	31,366	-	24,748	191,258	239,625

Note: a: Break in series with previous year for which data is available.
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, "Economic Indicators for MSTI "

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	501.4	256.3	489.2	49,305.7	3,442.4	-
1982	276,162.8	3,253.2	860.2	575.7	281.0	532.3	56,676.8	3,688.1	-
1983	288,772.7	3,534.6	898.3	639.4	307.2	596.3	66,685.1	3,900.5	-
1984	308,238.4	3,930.9	942.0	695.0	329.9	720.8	76,523.5	4,146.8	-
1985	330,396.8	4,217.5	984.4	744.5	361.8	901.6	85,699.1	4,381.6	-
1986	342,266.4	4,460.1	1,037.1	800.9	389.1	1,027.5	100,254.1	4,603.5	-
1987	362,296.7	4,736.4	1,065.1	841.1	428.7	1,205.9	117,938.2	4,872.8	-
1988	387,685.6	5,100.4	1,123.3	909.2	478.5	1,504.3	140,524.8	5,257.3	-
1989	415,885.2	5,482.1	1,200.7	979.4	525.3	1,699.2	158,620.1	5,656.7	-
1990	451,683.0	5,800.5	1,306.7	1,032.8	570.3	1,866.8	191,382.8	6,048.8	-
1991	473,607.6	5,992.1	1,534.6 [a]	1,071.2	598.7	2,178.1	231,428.2	6,505.5 [a]	-
1992	483,255.6	6,342.3	1,648.4	1,108.0	622.1	2,692.3	263,993.2	6,739.4	-
1993	482,607.6	6,667.4	1,696.9	1,119.8	654.2	3,533.4	298,761.6	6,863.7	-
1994	495,612.2	7,085.2	1,782.2	1,157.9	693.0	4,819.8	349,972.6	7,201.6	-
1995	504,594.3	7,414.7	1,848.5	1,196.2	733.3	6,079.4	409,653.6	7,539.2	8,359.1
1996	515,943.9	7,838.5	1,875.0	1,226.6	781.7	7,117.7	460,952.6	7,834.7	8,702.6
1997	521,295.4	8,332.4	1,912.6	1,264.8	830.1	7,897.3	506,313.6	8,205.4	9,109.2
1998	510,919.2	8,793.5	1,959.7	1,321.1	879.1	8,440.2	501,027.2	8,579.7	9,519.7
1999	506,599.2	9,353.5	2,000.2	1,367.0	928.7	8,967.7	549,005.0	8,925.6	9,900.9
2000	510,834.7	9,951.5	2,047.5	1,439.6	976.5	9,921.5	603,236.0	9,544.7	10,579.3
2001	501,710.6	10,286.2	2,101.9	1,495.6	1,021.8	10,965.5	651,415.3	10,046.4	11,156.4
2002	498,008.8	10,642.3	2,132.2	1,542.9	1,075.6	12,033.3	720,539.0	10,448.5	11,639.8
2003	501,889.1	11,142.2	2,147.5	1,587.9	1,139.7	13,582.3	767,113.7	10,700.9	11,958.6
2004	502,760.8	11,853.3	2,195.7	1,655.6	1,203.0	15,987.8	826,892.7	11,229.1	12,593.7
2005	505,349.4	12,623.0	2,224.4	1,718.0	1,254.1	18,493.7	865,240.9	11,755.1	13,210.8
2006	509,106.3	13,377.2	2,313.9	1,798.1	1,328.4	21,631.4	908,743.8	12,745.6	14,363.5
2007	513,023.3	14,028.7	2,428.5	1,886.8	1,404.8	26,581.0	975,013.0	13,484.2	15,275.0
2008	489,520.1	14,291.5	2,473.8	1,933.2	1,445.6	31,404.5	1,026,451.8	14,017.8	15,965.7
2009	473,859.2	13,939.0	2,374.5	1,889.2	1,395.0	34,050.7	1,065,036.8	13,658.3	15,600.2
2010	479,204.6	14,526.5	2,476.8	1,932.8	1,455.4	39,798.3	1,172,803.4	13,947.0	15,933.7
2011	-	-	2,569.8 [b]	1,993.8 [b]	1,500.8 [b]	46,999.1 [b]	1,239,611.2	14,460.0	16,539.5

(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	729,759.9	183,137.0	135,118.3	118,743.9	-	25,053.3	803,420.3	-
1982	276,162.8	726,802.4	185,254.8	140,539.9	123,249.3	73,732.1	27,553.1	823,972.5	-
1983	288,772.7	766,568.4	189,888.2	143,571.9	128,967.0	82,524.2	31,192.2	845,927.1	-
1984	308,238.4	835,982.9	198,652.8	148,258.4	134,747.2	96,715.0	34,865.0	881,898.1	-
1985	330,396.8	879,103.0	205,320.7	152,160.1	141,033.8	110,874.2	37,846.4	913,317.2	-
1986	342,266.4	925,494.9	213,748.6	158,357.3	149,301.7	122,678.7	43,233.4	955,260.0	-
1987	362,296.7	953,815.1	216,514.9	161,966.9	155,946.8	136,732.0	48,484.7	981,278.0	-
1988	387,685.6	996,109.2	225,287.9	170,090.4	164,338.4	152,695.8	54,318.2	1,026,742.2	-
1989	415,885.2	1,054,557.2	239,278.0	181,159.2	171,830.3	162,460.5	59,276.9	1,088,150.8	-
1990	451,683.0	1,098,595.1	257,555.5	190,116.0	177,090.9	172,469.4	66,255.3	1,145,625.2	-
1991	473,607.6	1,124,596.8	301,073.6 [a]	197,097.4	179,175.2	193,192.3	74,584.7	1,220,945.6 [a]	-
1992	483,255.6	1,181,175.6	311,702.7	203,186.9	182,287.8	224,146.9	80,137.5	1,255,133.0	-
1993	482,607.6	1,220,364.3	309,928.9	202,713.8	187,153.7	256,741.9	85,582.4	1,256,302.6	-
1994	495,612.2	1,271,725.8	317,954.9	207,508.0	195,388.8	290,694.1	93,196.6	1,292,613.0	-
1995	504,594.3	1,297,328.5	321,678.7	210,702.8	200,351.0	320,775.1	101,014.7	1,319,120.6	1,462,560.8
1996	515,943.9	1,337,253.3	322,240.3	211,740.9	207,975.0	350,643.2	107,589.0	1,336,612.5	1,484,667.0
1997	521,295.4	1,404,190.8	325,786.8	218,993.9	220,516.8	385,312.0	114,400.5	1,382,791.7	1,535,095.6
1998	510,919.2	1,464,826.7	330,539.0	227,655.6	227,099.8	415,232.8	107,826.6	1,429,214.2	1,585,800.3
1999	506,599.2	1,515,601.3	332,448.7	230,763.7	230,581.1	440,864.3	117,842.4	1,446,262.5	1,604,291.6
2000	510,834.7	1,540,015.1	327,738.1	237,272.8	237,652.2	466,393.0	125,102.1	1,477,057.3	1,637,170.0
2001	501,710.6	1,537,379.1	328,673.3	243,262.5	243,611.0	498,755.3	128,473.3	1,501,538.1	1,667,445.6
2002	498,008.8	1,530,088.2	325,474.1	245,127.7	246,385.6	532,003.0	134,578.7	1,502,222.5	1,673,509.2
2003	501,889.1	1,556,501.6	326,849.0	236,441.5	248,351.9	580,767.1	134,916.0	1,494,852.6	1,670,550.8
2004	502,760.8	1,593,228.1	329,173.7	236,739.6	255,635.1	631,489.8	139,629.0	1,509,324.4	1,692,750.5
2005	505,349.4	1,635,334.3	332,430.0	241,057.3	255,379.6	694,866.5	142,084.9	1,522,897.1	1,711,489.2
2006	509,106.3	1,668,406.8	344,665.6	248,468.5	264,404.5	778,608.2	146,278.3	1,589,634.4	1,791,414.0
2007	513,023.3	1,687,818.5	351,932.2	254,336.2	262,028.0	882,941.0	152,612.4	1,622,303.0	1,837,763.0
2008	489,520.1	1,669,901.9	356,130.0	256,036.9	259,524.9	960,347.9	152,645.9	1,637,923.7	1,865,523.7
2009	473,859.2	1,605,684.6	339,985.1	250,553.6	245,653.4	1,042,089.2	152,573.8	1,573,344.1	1,797,047.2
2010	479,204.6	1,619,047.3	340,900.5	246,808.1	246,111.5	1,124,102.7	158,523.7	1,554,460.0	1,775,889.3
2011	-	-	344,127.0 [b]	245,788.9 [b]	243,336.5 [b]	1,203,782.6 [b]	161,022.7	1,545,433.0	1,767,686.9

Note: a: Continuity of these data with the previous fiscal year is impaired.
b: Calculated estimates of OECD Secretariat based on the materials of each country.
<Japan> Data is for the fiscal year in each case. FY 2000 is used as the base value through FY 1993, and FY 2005 from FY 1994 on.
<Germany> Until 1990, data is for the former West Germany. After 1991, data is for the unified Germany.

Source :<Japan> Economic and Social Research Institute, Cabinet Office, "System of National Accounts (93SNA)" (website).
<U.S.> Bureau of Economic Analysis, "National Economic Accounts" (Web site).
<Germany, France, U.K., Korea,, China, EU> OECD, "Economic Indicators for MSTI".

Statistical Reference D　Gross Domestic Product (GDP) deflator of the main countries

Year	Japan	U.K.	Germany	France	U.K.	China	Korea
1981	94.3	52.2	62.9	48.1	39.4	26.1	31.5
1982	95.7	55.4	65.8	53.9	42.3	26.0	33.4
1983	96.6	57.6	67.6	59.2	44.6	26.3	35.0
1984	98.3	59.8	69.0	63.4	46.6	27.6	36.6
1985	99.3	61.6	70.4	66.8	49.4	30.4	38.1
1986	101.1	63.0	72.5	70.3	51.0	31.8	39.7
1987	100.9	64.8	73.5	72.1	53.8	33.5	41.6
1988	101.3	67.0	74.7	74.4	57.2	37.5	44.4
1989	103.5	69.6	76.9	77.0	61.3	40.7	47.0
1990	105.9	72.3	79.5	79.1	66.1	43.1	51.9
1991	108.6	74.8	81.9 a	81.2	70.3	46.3	57.2
1992	110.4	76.6	86.3	82.8	73.0	50.1	61.7
1993	110.9	78.3	89.8	84.2	75.1	57.8	65.6
1994	111.0	79.9	92.0	85.2	76.3	69.7	70.7
1995	110.4	81.6	93.9	86.2	78.3	79.2	75.9
1996	109.7	83.1	94.5	87.5	81.2	84.3	79.7
1997	110.3	84.6	94.7	88.3	83.4	85.6	82.8
1998	110.3	85.6	95.3	89.2	85.3	84.8	86.9
1999	108.8	86.8	95.5	89.3	87.1	83.7	86.0
2000	107.0	88.7	94.8	90.7	88.1	85.4	86.8
2001	105.6	90.7	95.9	92.6	90.0	87.2	90.2
2002	104.0	92.2	97.3	94.6	92.7	87.7	93.1
2003	102.3	94.1	98.3	96.5	95.6	90.0	96.4
2004	101.2	96.8	99.4	98.1	98.0	96.2	99.3
2005	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2006	99.1	103.2	100.3	102.1	103.1	103.8	99.9
2007	98.4	106.2	101.9	104.8	106.1	111.7	101.9
2008	97.4	108.6	102.7	107.4	109.3	120.4	104.9
2009	97.0	109.7	103.9	108.0	110.9	119.7	108.5
2010	95.0	111.0	104.6	108.8	114.1	126.8	112.5
2011	93.0 b	113.4 b	105.3 b	110.5 b	116.6 b	137.0 b	114.8 b
2012	92.4 b	115.5 b	106.7 b	112.1 b	118.9 b	144.9 b	117.6 b

Note: 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.
<Germany> Until 1990, data is for the former West Germany.　After 1991, data is for the unified Germany.
Source: OECD, "Economic Indicators for MSTI"

Statistical Reference E　Purchasing Power Parity of the main countries

Year	Japan [yen/yen]	U.S. [yen/dollar]	Germany [yen/euro]	France [yen/euro]	U.K. [yen/pound]	China [yen/yuan]	Korea [yen/wan]
1981	1.0000	233.3887	221.7719	269.4684	463.3383	-	0.5081
1982	1.0000	223.4115	215.3600	244.1259	438.5723	138.5068	0.4861
1983	1.0000	216.8756	211.3932	224.5260	419.8049	138.4018	0.4678
1984	1.0000	212.6696	210.8841	213.3084	408.4327	134.1764	0.4556
1985	1.0000	208.4417	208.5724	204.3884	389.8567	122.9745	0.4416
1986	1.0000	207.5054	206.0962	197.7191	383.6620	119.3932	0.4312
1987	1.0000	201.3798	203.2755	192.5729	363.7964	113.3895	0.4111
1988	1.0000	195.3002	200.5607	187.0868	343.4378	101.5074	0.3865
1989	1.0000	192.3637	199.2887	184.9665	327.1250	95.6082	0.3737
1990	1.0000	189.3966	197.1068	184.0818	310.5316	92.3886	0.3462
1991	1.0000	187.6799	196.1903	184.0014	299.2918	88.6956	0.3223
1992	1.0000	186.2377	189.0941	183.3842	293.0295	83.2533	0.3036
1993	1.0000	183.0345	182.6442	181.0215	286.0820	72.6616	0.2865
1994	1.0000	179.4905	178.4059	179.2135	281.9516	60.3127	0.2663
1995	1.0000	174.9671	174.0215	176.1463	273.2310	52.7645	0.2466
1996	1.0000	170.6007	171.8615	172.6232	266.0459	49.2638	0.2334
1997	1.0000	168.5218	170.3371	173.1392	265.6528	48.7903	0.2259
1998	1.0000	166.5806	168.6682	172.3223	258.3316	49.1969	0.2152
1999	1.0000	162.0357	166.2077	168.8097	248.2757	49.1613	0.2146
2000	1.0000	154.7521	160.0675	164.8182	243.3632	47.0085	0.2074
2001	1.0000	149.4604	156.3696	162.6571	238.4071	45.4840	0.1972
2002	1.0000	143.7742	152.6471	158.8717	229.0757	44.2110	0.1868
2003	1.0000	139.6943	152.1997	148.9018	217.9011	42.7592	0.1759
2004	1.0000	134.4122	149.9174	142.9957	212.5058	39.4981	0.1689
2005	1.0000	129.5520	149.4470	140.3089	203.6426	37.5731	0.1642
2006	1.0000	124.7202	148.9544	138.1827	199.0454	35.9943	0.1610
2007	1.0000	120.3118	144.9175	134.7982	186.5174	33.2170	0.1565
2008	1.0000	116.8458	143.9607	132.4424	179.5300	30.5799	0.1487
2009	1.0000	115.1937	143.1818	132.6220	176.0970	30.6041	0.1433
2010	1.0000	111.4547	137.6375	127.6945	169.1027	28.2450	0.1352
2011	1.0000	106.8766	133.9132	123.2762	162.1365	25.6129 b	0.1299
2012	1.0000	104.1568 b	131.1935 b	120.6067 b	157.8140 b	24.0318 b	0.1258 b

Note: b: Calculated estimates of OECD Secretariat based on the materials of each country.
Source: OECD, "Economic Indicators for MSTI"

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 *- A Systematic Analysis of Science and Technology Activities in Japan -*	NISTEP REPORT No. 37
1997	Third edition	Science and Technology Indicators: 1997 *- A Systematic Analysis of Science and Technology Activities in Japan -*	NISTEP REPORT No. 50
2000	Forth edition	Science and Technology Indicators: 2000 *- A Systematic Analysis of Science and Technology Activities in Japan -*	NISTEP REPORT No. 66
2001		Science and Technology Indicators: 2000 *Data Update (2001)*	NISTEP REPORT No. 66-2
2002		Science and Technology Indicators 2000 *Data Updated in 2002*	Research Material - 88
2004	Fifth edition	Science and Technology Indicators 2004 *A Systematic Analysis for Science and Technology Activities in Japan*	NISTEP REPORT No. 73
2005		Science and Technology Indicators 2004 *- Data Updated in 2005 -*	Research Materials - 117
2006		Science and Technology Indicators *- Data Updated in 2006 for 5th edition -*	Research Materials - 126
2007		Science and Technology Indicators *- Data Updated in 2007 for 5th edition -*	Research Materials - 140
2008		Science and Technology Indicators *- 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
2012		Science and Technology Indicators 2012	Research Materials – 214

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