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National Institute of Science and Technology Policy
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Summary

1. R&D expenditure

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

- The total Japan's R&D expenditure was approximately 18.8 trillion yen in FY 2008. This amount is the equivalent of approximately 17.8 trillion yen on a full time equivalent (FTE) basis, the highest ever ratio against GDP (3.8% and 3.4%, respectively).
- Out of all the performing sectors, the business enterprise sector accounted for the highest ratio of the total R&D expenditure in each country. The proportions of R&D expenditure by the business enterprise sector in Japan, U.S. and Germany were approximately 70%; however, those in France and U.K. were approximately 60%.
- The proportion of R&D expenditure by the university and college sector in U.K. is increasing while that in Japan and Germany remains flat.

(2) Government budgets

- With regard to the GBAORD (government budget appropriations or outlays for Science & Technology), only in Japan was the growth rate lower during the 2000s than in the 1990s. In all the other countries, the growth rate was higher during the 2000s than in the 1990s.
- Japan's initial government budget (the government budget appropriation for S&T) in FY 2010 was 3.6 trillion yen.

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

- The ratio of R&D expenditure against GDP in the business enterprise sector was 2.74% in Japan followed by 2.45% in Korea, and each value was an all time high in the corresponding country. The ratio was 2.00% in U.S., and has recently been gradually increasing.
- 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 U.S. France, U.K., etc., and the latter accounts for a large proportion in the in Japan, Canada, etc., respectively.

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

- The R&D expenditure in the university and college sector was 3445.0 billion yen (FY 2008), which is the equivalent of 2,236.1 billion (FY 2007) yen if the labor cost is multiplied by FTE factor.
- With regard to the annual average growth rate of R&D expenditure by real value (2000 base, national currency), Japan, U.S. and France showed a lower rise in the 1990s than in the 2000s. However, U.S. was still relatively high at 3.9%.
- Looking at the share of universities and colleges R&D expenditure covered by governments, more than 80% is covered in Germany and France, while about 70% is covered in U.S., U.K. and, in recent years, Korea. In Japan, the figure is about 50%.

- 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.

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

- Among the countries studied, in France, the proportion of R&D expenditure for basic research in the latest available year was 25.1%. In contrast, the proportion of R&D expenditure for the basic research was smallest in China at 4.7%. In Japan and U.S., the values were 13.7% and 17.4%, respectively.
- With regard to R&D expenditure by type of R&D in the business enterprise sector, the expenditure for development accounts for 70% or more in Japan, U.S., China and Korea. Expenditure for applied research for approximately 40% in France and U.K.

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

- The definition and measurement of researchers in each country are conducted in line with the Frascati Manual. However, the actual methods used for the investigations are often different in each country. In particular, the university and college sector are excluded from the coverage of R&D statistical surveys in some countries. Also some countries set special conditions regarding the scope of the range of the surveys. Also there are countries which apply the full-time equivalent (FTE) method in surveying the number of researchers. And there are other countries which apply actual head counting for this purpose. Therefore, it could be said that there are many contributing factors which reduce the performance of the international comparability. In addition, in U.S., the number of researchers belonging to some sectors is not reported to the OECD. This forces the OECD to utilize estimated figures as a substitute. For the reasons given above, it is necessary to be careful in making international comparisons and trend comparisons of the number of researchers.
- In 2009, the number of researchers in Japan was a total of about 660,000, if the number of researchers working at universities and colleges is calculated by using the FTE method. The number is about 890,000 with the head count method. In recent years, the number of researchers in China has greatly increased. But the number of researchers per capita still lags behind compared to the other selected countries.

(2) Researchers by sector

- The numbers of researchers in the business enterprise sector has tended to increase over the long term for both Japan and U.S. and has recently increased sharply in China. The numbers for Germany and U.K. have been flat. 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 U.S. was approximately 60% to 40%. The trends of both countries are different in this way.
- The number of researchers in the university and college sector in Japan in accordance with the statistics by the OECD was extremely large compared to other countries (180,000 people (2006) in Japan, while 190,000 people (1999) in U.S.). But if the number of researchers in the university and college sector is measured using the statistics for education, the value is not necessarily extremely large (250,000 people in Japan compared to 740,000 people in U.S. (both in 2006)).

(3) Research assistants

- With regard to the number of research assistants per researcher by sector, the value is large in the public organization sector and small in the university and college sector in almost all the countries. Especially in Japan, the number of research assistants is so small that the value is approximately a half of that in Germany and France.

- Out of the number of research assistants in the university and college sector in Japan, the number of "assistant research workers" has been flat while that of "clerical and other supporting human resources" is increasing in number.

3. Higher Education

(1) The status of students in Higher Education institutions

- The number of newly enrolled undergraduates in Japan has been roughly unchanged since about 2000, and that for the FY 2009 is about 609,000. The numbers newly enrolled in private universities and colleges is high, and constitutes about 80% of the total. When classified by field, the students who major in “Natural science and engineering” are about 30% of the total. Of these, the students who study in national universities and colleges are about 30%, and those in private universities and colleges are about 60%.
- The numbers newly enrolled in master’s programs has been roughly unchanged since about 2005 and that for the FY 2009 is about 78,000. The numbers newly enrolled in national universities and colleges constitutes about 60% of the total. When classified by field, the students who major in “Natural science and engineering” are about 60% of the total. Of these, the students who study in national universities and colleges are about 60%, and those in private universities and colleges are about 30%.
- The number newly enrolled in doctoral programs has been decreasing since peaking in 2003 and was about 16,000 for the FY 2009. The numbers newly enrolled in national universities and colleges is high and constitutes about 70% of the total. When classified by field, the students who major in “Natural science and engineering” are about 70% of the total. Of these, about 70% of the students study in national universities and colleges, and the students who study in private universities and colleges are about 20%.

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

- Looking at career options for undergraduate students in “Natural sciences and engineering” after graduation, students who enter employment are about 60% and those who proceed to higher education are about 40%. When it comes to master’s students, those who enter employment are about 90% and those who go on to the next stage of education are about 10%. The percentage of students who head into the workforce has increased during recent years.
- Looking at those who enter employment among the graduates of “Natural sciences and engineering” by industrial classification, in case of undergraduates, the “Manufacturing industry”, “Service type industries” and “Others” comprise one-third each. And in the case of master’s students, the percentage of students who enter employment in the “Manufacturing industry” is about 60%, and the percentage of students who find employment in “Service type industries” is about 20%.

(3) The number of degree-awarded

- Looking at the number of persons who have degrees per one million of the population, bachelor’s degree awarded in Japan are about 4,400. This is less than U.S. and U.K., however, it greatly surpasses Germany and France. Meanwhile, the number of doctoral degree awarded is about 140, which is half as many as that in U.K. and Germany and falls below that of U.S. and France.

- When the rate of increase of the number of doctoral degree awarded per one million of the population is compared with the rate of increase during the 10 years from 1995, U.K. has been enlarged 1.61 times, which has reached approximately the same level as Germany. During these years, Japan has enlarged to 1.29 times, which is a higher increase than U.S. and Germany.

4. The output of R&D

(1) Scientific Papers

- 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 international co-authorship 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 2007–2009), in terms of the "degree of participation in the production of papers in the world" Japan is ranked fifth in the world, after U.S., China, U.K. and Germany. Meanwhile, although in terms of the "degree of contribution to the production of papers in the world" Japan ranks third, behind U.S. and China, it outranks U.K. and Germany.
- China has increased both in terms of the "degree of participation in the production of papers in the world" and the "degree of contribution to the production of papers in the world" since the late 1990s, holding second place in the world during the latter half of the 2000s.
- Looking at the balance of the fields in Japan, the share of Chemistry has decreased and that of Clinical medicine has increased.
- On the other hand, looking at the field portfolios in main countries by world share, Japan has more weight on Chemistry, Material science and Physics, and less weight on Computer science/Mathematics, Environment/Geoscience, Basic life sciences and Clinical medicine. In U.S. and U.K., there is much weight placed on Basic life sciences and Clinical medicine.
- The percentage of international co-authorship for 2009 was 50% for Germany, 51% for U.K. and 51% for France, while U.S. was 32% and Japan was 26%.

(2) Patents

- The numbers of patent applications had been increasing with an annual average growth rate of about 5% since the mid 1990s, and reached 1.85 million for 2007.
- The numbers of patent applications to the Japan Patent Office (hereinafter "JPO") have been about 400,000 over these past several years. The numbers of patent applications to U.S. Patent and Trademark Office (hereinafter "USPTO") have been rapidly increasing, and it was more than that to JPO in 2006. The applications to JPO from Non-Residents have been increased, and accounted for over 15% of all in 2006. However, this ratio is small compared with that of USPTO, about a half of whose applications are from Non-Residents.
- All main countries including Japan have increased their numbers of patent applications. However, there has been a slight leveling off over the past few years. Even under these circumstances, Patent applications from China have steadily increased. Many Chinese applications, however, are

to the State Intellectual Property Office of the P.R.C. (hereinafter SIPO), and China's presence in the world is still small. Korea has been applying for patents to patent offices in main country and has strengthened its world presence.

- Looking at the numbers of patent applications to JPO, USPTO and The European Patent Office (hereinafter EPO), Japan has shown a big presence since 10 years ago. Looking at the applications by technical field, Japan has a big share in Nanotechnology and Information and communication technology.

  The relation between patents and scientific papers has been getting stronger. The Science Linkage, which indicates the degree to which patent literature cites scientific literature, has been increasing. From 1996-1998 to 2006–2008, the Science Linkage in all fields increased from 1.9 to 3.1. The value of Medical and chemical manufacturing is highest. Science Linkage has recently increased in "Petroleum/Coal product manufacturing."

5. The outcome of R&D

(1) Technology trade

- Japan’s technology trade balance was 3.71 in 2008, with an export surplus continuing since 1993. Technology trade exclusive of trade with overseas affiliates, i.e., that between parent companies and subsidiaries, can be considered a more appropriate indicator of technology strength. Using that criterion, Japan’s technology trade balance in 2008 was 1.3, which represents a slight rise from 2001.
- Looking at the amount of technology exports of Japan, “Transportation equipment manufacturing” ac-counts for about 50% of all industries, and it is followed by “Drugs and medicines”, which accounts for about 10% of all industries. Regarding “Transportation equipment manufacturing”, the ratio of parent companies and subsidiaries is approximately 90%. However, that of “Drugs and medicines” remains at approximately 50%. “Drugs and medicines” can be said to be an industry involving more international technology transfer for technology exports in Japan, many of which transactions are made among parent companies and subsidiaries.
- Most transactions for technology imports in Japan are made in companies excluding parent companies and subsidiaries.
- Looking at the partners of technology exports from Japan, U.S. accounts for 36.7% of them all, which is first, and China follows it at 12.1%. U.K. accounts for 5.6%, which is third place. On the other hand, regarding technology imports, U.S. accounts for 68.9% of the total, and Germany, France and U.K. follow it with about 5% each.

(2) The High Technology Industry Trade

- The high-technology industry trade of the entire world increased by 70 percent in the past six years. Especially, the “Radio, Television and Communication Equipment” industry was the largest, which ac-counted for about 40% of the total.
- Looking by country, the trade scale of U.S. was large and is tending to expand. However, China has in-creased its trade amount rapidly during recent years and to the value of its exports has surpassed that of U.S. The trade amount of Germany has also rapidly expanded. Japan has followed it, and is in fourth place.
- The trade balance of Japan’s high-technology industry had an export surplus of over 3 in the early 1990s. After that, the trade balance tended to decrease and it was an export surplus of over 1.3 in 2008. Korea has been on an upward trend in recent years and passed Japan in 2003. China’s 2008 figure was even with Japan’s at 1.3. Europe has moved around 1 since 1990s, and U.S. has shifted to less than 1 since 2000, which means it now has an import surplus.
- Looking at it by field, the “Radio, Television and Communication Equipment” industry showed a large ratio, and particularly the amount of the imports and the exports of China have been larger than those of 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 “Aircraft and Spacecraft” industry of U.S. has an export surplus, and the “Pharmaceuticals,” “Medical, Precision and Optical Instruments” and “Aircraft and Spacecraft” industries of Germany have an export surplus

(3) Total Factor Productivity (TFP)

- The contribution of Total Factor Productivity (TFP) to economic growth during 2002–2006 was highest in U.S. (1.2%). Following U.S. were France (0.77%) and Germany (0.73%) at levels roughly equal to each other. Japan (0.55%) and U.K. (0.54%) were also roughly equal to one another.

Notes concerning Science and Technology Indicators 2010

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 international co-authorship 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 type of input data for R&D activities, is reviewed. R&D expenditure is the expenditure used for conducting R&D operations in an organization. Expenditure which is internally used for R&D at an organization is called intramural R&D expenditure, and expenditure for outsourcing or commissioning R&D is called extramural R&D expenditure. Because this chapter deals with only intramural R&D expenditure, the simpler expression of R&D expenditure is used to refer to intramural R&D expenditure. 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

- ○The total Japan’s R&D expenditure was approximately 18.8 trillion yen in FY 2008. This amount is the equivalent of approximately 17.8 trillion yen on a full time equivalent (FTE) basis, the highest ever ratio against GDP (3.8% and 3.4%, respectively).
- ○Out of all the performing sectors, the business enterprise sector accounted for the highest ratio of the total R&D expenditure in each country. The proportions of R&D expenditure by the business enterprise sector in Japan, U.S. and Germany were approximately 70%; however, those in France and U.K. were approximately 60%.
- ○The proportion of R&D expenditure by the university and college sector in U.K. is increasing while that in Japan and Germany remains flat.

1.1.1 Trend of R&D expenditure in each country

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

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

Japan’s R&D expenditures are shown with two types of values. One of such values was obtained from the Survey of Research and Development conducted and published by the Ministry of Public Management, Home Affairs, Posts and Telecommunications. And the other values were obtained from materials published by the OECD. The difference between both the values is how to obtain labor costs in the university and college sector. In the Survey of Research and Development, the expenditures in the university and college sector were measured on the basis of a head count (HC) of researchers, due to the background that the strict separation of expenditure for research and that for education in the university and college sector is difficult. Accordingly, R&D expenditure in the university and college sector amounts to the total cost of labor including duties other than research carried out by universities’ teaching staffs. As for the OECD(1), the total R&D expenditure in Japan’s university and college sector is

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(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 31 member countries, and gathers statistics, economic and social data which can be internationally compared, and also conducts prediction and analysis.

provided on the 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 2000). (C) and (D) are the nominal values and real values (on 2000 base) represented by the national currencies of each country respectively.

Japan’s total R&D expenditure was approximately 18,800 billion yen in FY 2008(2). Because R&D expenditure is greatly influenced by the size of the country’s economy, U.S. is in the dominant position followed by Japan, China, and Germany. France, U.K. and Korea are at approximately same level.

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

Next, the investment status of each country was examined by comparing the annual average growth rate of R&D expenditure in the 1990s (1991 to 2000) and the 2000s (2000 to the latest available year) on the basis of each national currency.

According to the comparison of the annual average growth rate of R&D expenditure (nominal values) between the 1900s and the 2000s, the growth rate increased more in the 2000s than in the 1990s in France, U.K. and China. Of these countries, the growth rate increased the most rapidly in China. In Japan, the growth rate in the 2000s was 1.81%, lower than in the other countries (Chart 1-1-1 (C)).

The annual average growth rate of R&D expenditure (real values) which was on a 2000 base to reduce the influence of conditions related to price also increased more in the 2000s than in the 1990s in Japan, U.K., China and Korea. China and Korea were particularly outstanding in their growth surge. Japan also showed growth at 2.99% (Chart 1-1-1(D)).

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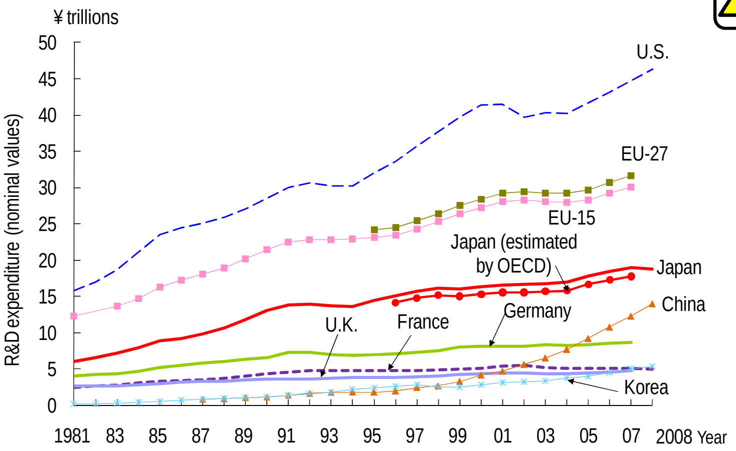
(2) Since the period covered to collect yearly total domestic R&D expenditure data differs depending on the country, this report in principle uses the calendar year for international comparison. However, fiscal years may sometimes be used for certain types of data for convenience.

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

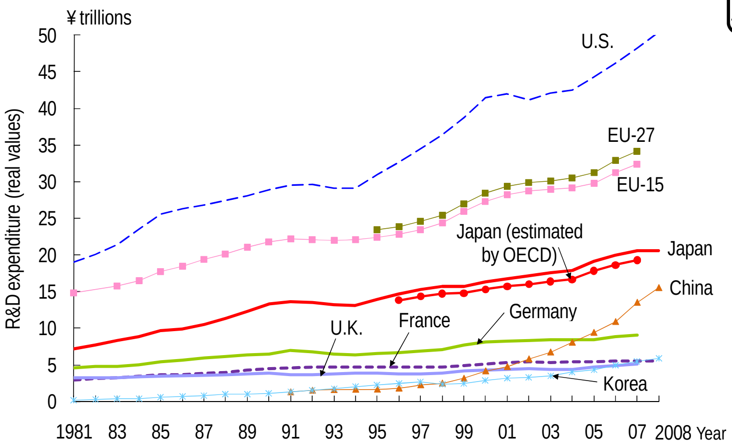
(A) Nominal values (OECD purchasing power parity equivalent)

Attention to international comparison



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

Attention to international comparison



(C) Nominal values (national currency)

National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	'00→Latest year
Japan (¥ trillions)	13.8	16.3	18.8 (2008)	1.88%	1.81%
Japan (estimated by OECD) (¥ trillions)	14.2 (1996)	15.3	17.8 (2007)	0.87% ('96→'00)	2.15%
U.S. ($ billions)	161	267	398 (2008)	5.80%	5.09%
Germany (€ billions)	37.8	50.6	61.5 (2007)	3.28%	2.82%
France (€ billions)	24.9	31.0	39.4 (2008)	2.46%	3.07%
U.K. (£ billions)	12.0	17.7	25.4 (2007)	4.41%	5.28%
China (¥ billions)	15.9	89.6	457 (2008)	21.1%	22.6%
Korea (₩ trillions)	4.16	13.8	34.5 (2008)	14.3%	12.1%

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

National currency	1991	2000	Latest year with available data	Annual average growth rate '91→'00	'00→Latest year
Japan (¥ trillions)	13.6	16.3	20.6 (2008)	2.03%	2.99%
Japan (estimated by OECD) (¥ trillions)	13.8 (1996)	15.3	19.3 (2007)	1.14% ('96→'00)	3.37%
U.S. ($ billions)	191	267	325 (2008)	3.82%	2.47%
Germany (€ billions)	43.4	50.6	56.9 (2007)	1.72%	1.68%
France (€ billions)	27.8	31.0	33.2 (2008)	1.19%	0.90%
U.K. (£ billions)	15.1	17.7	21.2 (2007)	1.83%	2.57%
China (¥ billions)	28.3	89.6	626 (2008)	13.7%	27.5%
Korea (₩ trillions)	6.45	13.8	41.6 (2008)	8.85%	14.7%

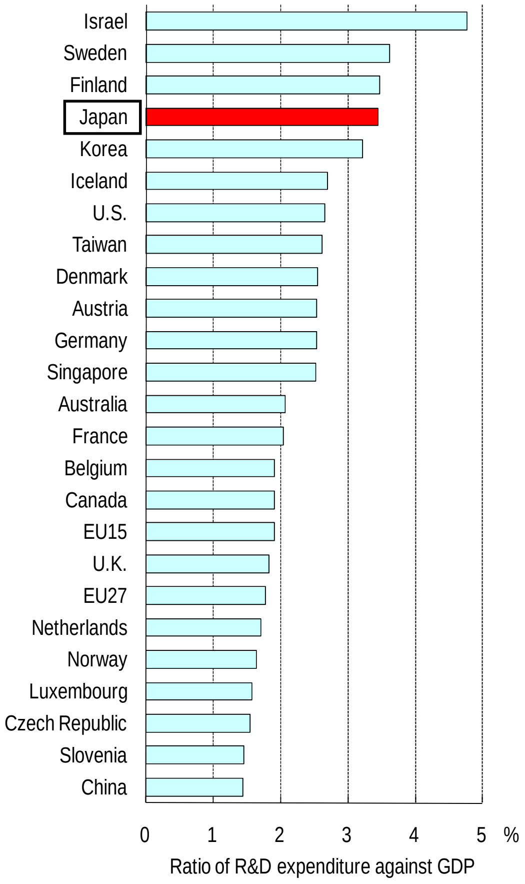
Note: 1) The total R&D expenditure is the sum of each sector's expenditure, and the definition of each sector occasionally differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected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

Sources: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "National Patterns of R&D Resources 2008 Data Update"
<Germany> Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2008"; OECD, "Main Science and Technology Indicators 2009/2" for information since 2007
<Japan (estimated by the OECD), France and EU> OECD, "Main Science and Technology Indicators 2009/2"
<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 2008 (website)
<Korea> KISTEP, Statistical DB (website)

Next, the “Ratio of R&D expenditure against GDP (gross domestic product)” is shown below for the comparison of R&D expenditures considering the influence by the size of economy (Chart 1-1-2).

The ratio of R&D expenditure against GDP in Japan was fourth among the listed countries and regions, and stands at a high level.

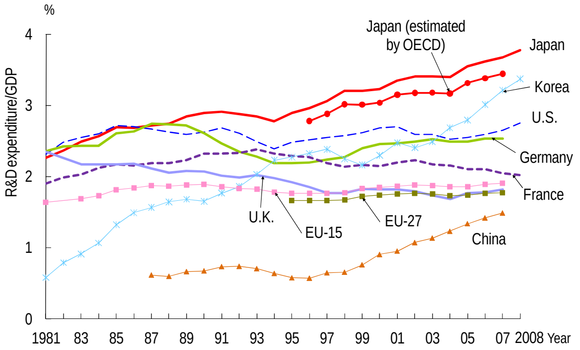
Chart 1-1-2: Ratio of the total R&D expenditure against GDP in each country (2007)



Note: 1) Defense expenditure in Israel was excluded.
2) The values for Israel, France, Netherlands, Luxemburg and Slovenia were preliminary.
3) Capital expenditure in U.S. was almost all excluded.
4) Secretariat estimate or projection based on national sources was used with regard to EU15 and 27.
5) Value for Australia is from 2006.
Source: OECD, “Main Science and Technology Indicators 2009/2”

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

⚠ Attention to international comparison



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

Also, trends in R&D expenditure in selected countries are shown in another chart, by examining the change in the ratio of R&D expenditure against GDP (Chart 1-1-3).

In Japan, the ratio against GDP exceeded 3% in 1997, continued increasing, and reached a record high 3.8% in FY 2008. In accordance with the estimate by OECD, the ratio in Japan went beyond 3% in 1998, and has been increasing since then.

The value in Korea went beyond 3% in 2006 for the first time. Its 2008 figure of 3.4% almost equaled Japan's

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

In China, which has recently been experiencing rapid industrial development, the ratio has been increasing since the upturn in 1996. The ratio gap between China and other selected countries is still wide, but is being narrowed.

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

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

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

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

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

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

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

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

In Japan, the proportion used by the public organization sector is gradually decreasing while that by the business enterprise sector tends to be increasing in the long run. The significant decrease in the non-profit institution sector since 2001 was due to a change in classification method for statistics.

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

In Germany, the data of public organization sector and the non-profit institution sector are integrated because these have not been classified. The proportion of these sectors has not fluctuated remarkably over time, and the entire status is considered to be influenced by the status of the business enterprises section.

In France, the proportion of the public organization sector is always relatively large. This proportion has been decreasing in the long term and has recently leveled off.

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

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

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

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

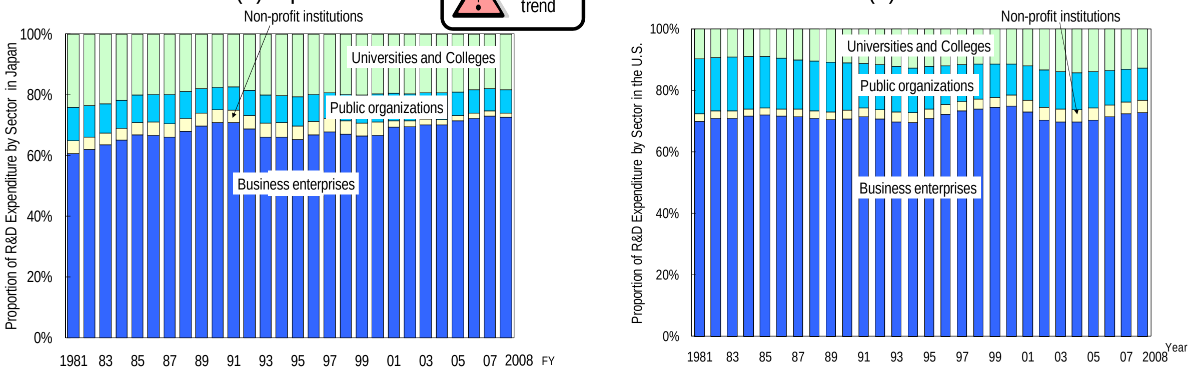
Chart 1-1-5: Trends in the proportion of R&D expenditure by performing sector in selected countries

Attention to international comparison

(A) Japan

Attention to trend

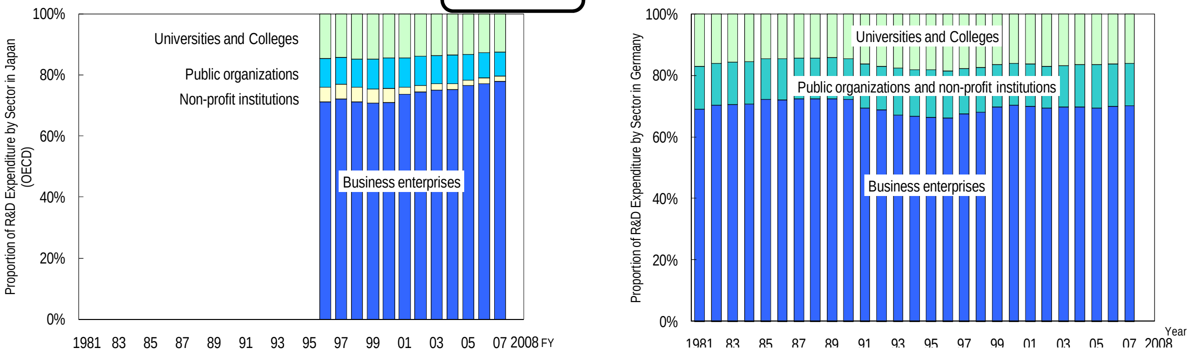
(C) U. S.



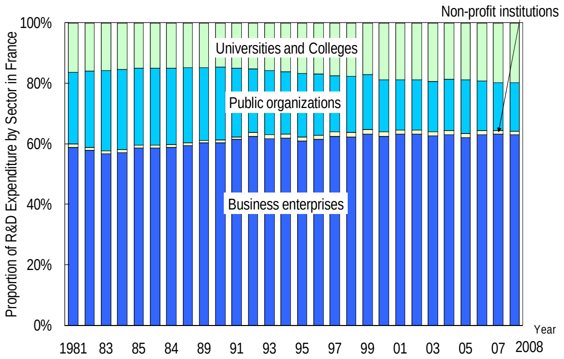
(B) Japan (estimated by OECD)

Attention to trend

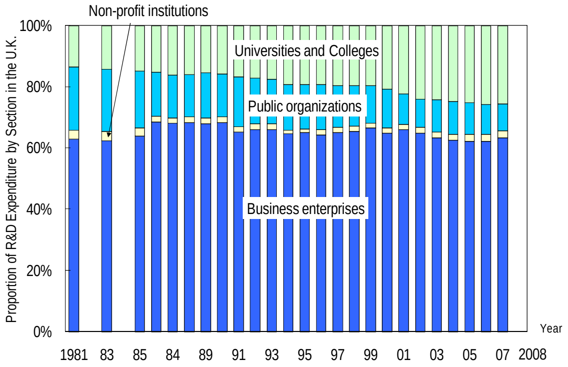
(D) Germany



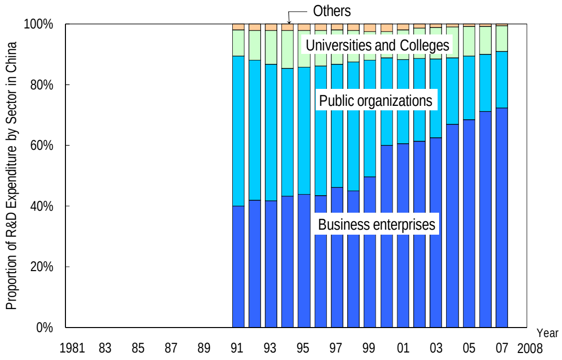
(E) France



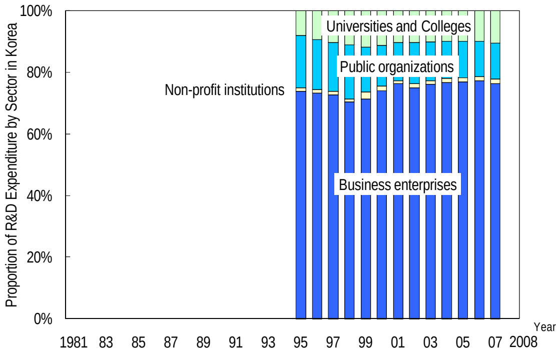
(F) U.K.



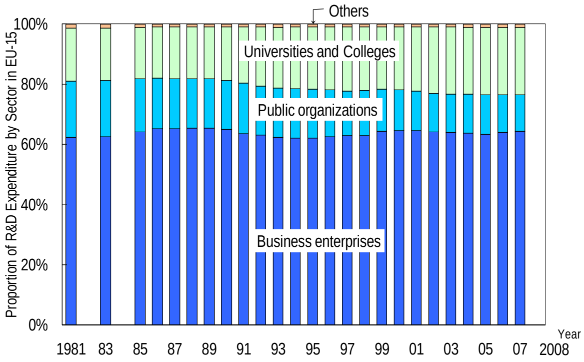
(G) China



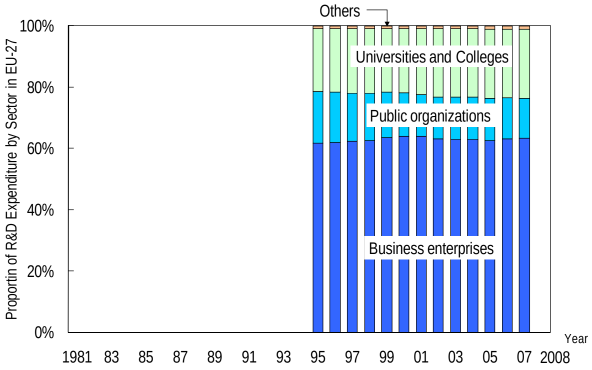
(H) Korea



(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, beginning in 2007).
3) For Japan (OECD estimate), France, 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 2001, a part of non-profit institutions moved into the business enterprise sector.
<Japan (estimated by the OECD)> The total R&D expenditure in which labor cost consisting a part of R&D expenditure in the university and college sector was converted to FTE. The value was corrected and estimated by the OECD.
<Germany>Former West Germany until 1990, and the unified Germany since 1991, respectively.

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development; OECD, "Main Science and Technology Indicators 2009/2"
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004,2006"; "Bundesbericht Forschung und Innovation 2008"; OECD, "Main Science and Technology Indicators 2009/2" for 2007 or later
<U.K.>National Statistics website: www.statistics.gov.uk
<China>OECD, "Main Science and Technology Indicators 2009/2"; Ministry of Science and Technology of the People's Republic of China, "S&T Statistics Data Book 2007" (Web site) for 2004 or later
<France, Korea and EU> OECD, "Main Science and Technology Indicators 2009/2"

1.2 Government budgets

Key points

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

○Japan's initial government budget (the government budget appropriation for S&T) in FY 2010 was 3.6 trillion yen.

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

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

1.2.1 GBAORD in each country

Chart 1-2-1(A), "Total GBAORD (OECD purchasing power parity equivalent) in selected countries," shows that Japan's amount of appropriations or outlays is approximately a fifth of U.S.'s amount (2009). With regard to change over time, Japan's GBAORD have had a tendency to increase, but recently became flat. In the case of U.S., the budget rose significantly between 2000 and 2004, but since then has shown little change.

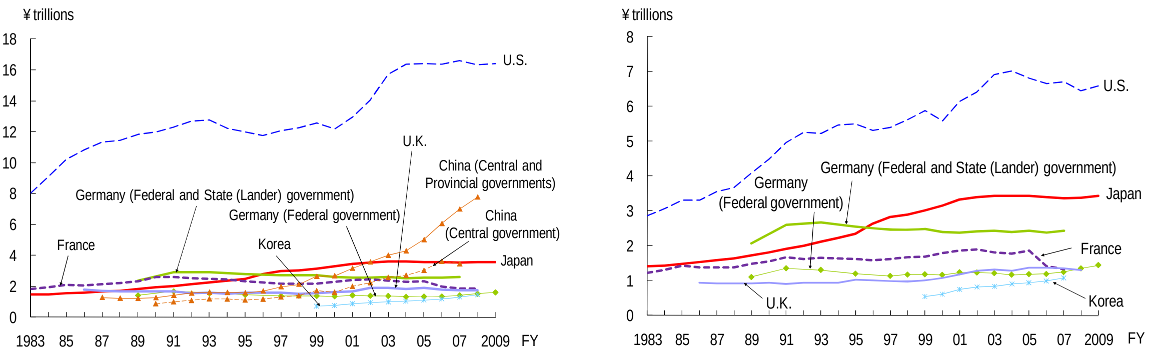
In international comparisons of GBAORD, defense-related expenses are frequently removed. In many cases, it is appropriate to remove such expenses, especially when comparing Japan and other countries, because the expenses for the purpose of defense and others are different in character. Chart 1-2-1(B)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

The ratios of the non-defense GBAORD against the GBAORD in Japan and U.S. accounted for 95.2% (2009) and only 41.4% (2009) respectively. As a result of the comparison of the non-defense GBAORD, Japan's amount of appropriations or outlays jumps up to a half of U.S.'s amount.

From the perspective of change over time, in the 1990s (1991 to 2000), Japan and China had the highest annual average growth rates of the total GBAORD using national currency. On the other hand, the growth rates in Germany (Federal Government) and France were negative. In the 2000s (2000 to the latest available year of each country), annual average growth rate of the total GBAORD was strikingly high in China and Korea. Japan's growth rate was 0.91%, while that of U.S. was high at 6.83%. U.K. also demonstrated a high growth rate in the 2000s, with 5.04% (Chart 1-2-1(C)).

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

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



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

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

(C) Nominal values (national currency)

National Currencies	Government Budget Appropriations or Outlays for R&D	1991	2000	2009	Annual Average Growth Rate	
					'91→'00	'00→'09
Japan (¥ trillions)	Total	2.02	3.29	3.56	5.54%	0.91%
	Non-defense	1.91	3.15	3.43	5.73%	0.96%
	Defense	0.12	0.14	0.13	1.88%	-0.36%
U.S. ($ billions)	Total	65.9	78.7	143	1.99%	6.83%
	Non-defense	26.6	36.1	57.2	3.46%	5.26%
	Defense	39.3	42.6	85.3	0.89%	8.02%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	15.1	16.3	18.4 ('07)	0.85%	1.39% (→'07)
	Non-defense	13.4	15.0	17.3 ('07)	1.25%	1.59% (→'07)
	Defense	1.65	1.27	1.13 ('07)	-2.92%	-1.25% (→'07)
Germany(Federal Govenment) (€ billions)	Total	8.62	8.48	11.9	-0.18%	3.82%
	Non-defense	6.99	7.29	10.7	0.47%	4.32%
	Defense	1.63	1.19	1.22	-3.43%	0.24%
France (€ billions)	Total	14.2	13.8	14.6 ('08)	-0.28%	0.70% ('08)
	Non-defense	9.08	10.9	10.6 ('08)	2.04%	-0.35% ('08)
	Defense	5.12	2.96	4.06 ('08)	-5.90%	4.03% ('08)
U.K. (£ billions)	Total	5.58	6.69	9.92 ('08)	2.04%	5.04% ('08)
	Non-defense	3.02	4.45	7.32 ('08)	4.40%	6.40% ('08)
	Defense	2.56	2.24	2.60 ('08)	-1.46%	1.88% ('08)
China (Central and Provincial governments) (¥ billions)	Total	16.1	57.6	254 ('08)	15.2%	20.4% ('08)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	11.54	34.96	104 ('07)	13.1%	14.6% ('07)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	-	3.75	10.6	-	12.27%
	Non-defense	-	2.98	8.80	-	12.78%
	Defense	-	0.77	1.83	-	10.10%

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

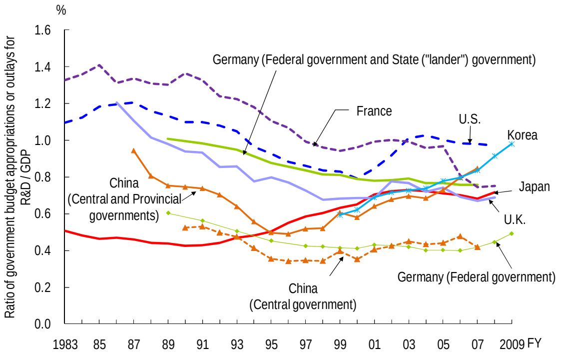
National Currencies	Government Budget Appropriations or Outlays for R&D	1991	2000	2009	Annual Average Growth Rate	
					'91→'00	'00→'09
Japan (¥ trillions)	Total	2.00	3.29	3.91	5.69%	1.95%
	Non-defense	1.88	3.15	3.77	5.88%	2.00%
	Defense	0.11	0.14	0.14	2.03%	0.67%
U.S. ($ billions)	Total	78.0	78.7	115	0.09%	4.31%
	Non-defense	31.5	36.1	46.2	1.54%	2.78%
	Defense	46.6	42.6	68.8	-0.99%	5.48%
Germany (Federal and State (Lander) Governments) (€ billions)	Total	17.3	16.3	17.0 ('07)	-0.67%	0.52% (→'07)
	Non-defense	15.4	15.0	16.0 ('07)	-0.29%	0.71% (→'07)
	Defense	1.90	1.27	1.03 ('07)	-4.39%	-2.27% (→'07)
Germany(Federal Govenment) (€ billions)	Total	9.89	8.48	10.7	-1.69%	2.65%
	Non-defense	8.02	7.29	9.63	-1.05%	3.14%
	Defense	1.87	1.19	1.10	-4.90%	-0.89%
France (€ billions)	Total	15.9	13.8	12.2 ('08)	-1.52%	-1.42% ('08)
	Non-defense	10.2	10.9	8.92 ('08)	0.77%	-2.45% ('08)
	Defense	5.73	2.96	3.43('08)	-7.07%	1.84% ('08)
U.K. (£ billions)	Total	7.04	6.69	8.08 ('08)	-0.55%	2.24% ('08)
	Non-defense	3.81	4.45	5.96 ('08)	1.75%	3.57% ('08)
	Defense	3.22	2.24	2.12 ('08)	-3.97%	-0.83% ('08)
China (Central and Provincial governments) (¥ billions)	Total	28.5	57.6	185 ('08)	8.14%	15.7% ('08)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
China (Central government) (¥ billions)	Total	20.5	35.0	76.1 ('07)	6.14%	10.2% ('08)
	Non-defense	-	-	-	-	-
	Defense	-	-	-	-	-
Korea (₩ billions)	Total	-	3.75	8.57	-	9.62%
	Non-defense	-	2.98	7.09	-	10.1%
	Defense	-	0.77	1.48	-	7.50%

Note: <Japan>Data for all the fiscal years are of initial budget amounts.
<U.S.>The value for FY 2009 is a preliminary budget amount. The value for 2010 is the requested amount.
<Germany>Estimation for the value of the federal government and local governments ("lander governments") in 2007, and for the federal government in 2008 and 2009.
<France>Data for 1984, 1986, 1992, 1997 breaks in series with previous year for which data is available. Data for 2008 are estimates.
<U.K.>Data for FY 2006 are estimates. Data for FY 2007 and 2008 are planned values by cross cutting review.
Reference statistics E was used for the conversion to obtain purchasing power parity equivalent.
Source: <Japan>MEXT, "Indicators of Science and Technology"
<U.S.>NSF, "Federal R&D Funding by Budget Function Fiscal Years 2008–2010"
<Germany>Bundesministerium für Bildung und Forschung, "Faktenbericht Forschung 2002", "Bundesbericht Forschung 2004, 2006", "Research and Innovation in Germany 2005, 2007 and 2008
<France and Korea>OECD, "Main Science and Technology Indicators 2009/2"
<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 started increasing in the 1990s, but has been flat in recent years. Since the 2000s, growth in Korea and China (central and provincial governments) has been remarkable. The ratio in each other country has been flat or falling. It has declined continuously in France.

The ratios for the latest available year were 0.72% in Japan, 0.97% in U.S., 0.76% or 0.49% in Germany with or without including the local governments ("Lander governments") respectively, 0.75% in France and 0.69% in U.K. Korea had the highest ratio at 0.98% (2009 figure). China also showed remarkably high growth. The rates in 2007 reach to 0.42% for the central government only and 0.85% with provincial governments included.

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



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

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

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

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

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

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

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

According to Chart 1-2-4, the ratios for most countries were on the decrease trends until about 2000. Since then, France's ratio has been flat, while those of U.S. and U.K. have fluctuated widely but been flat overall. The ratio in Japan is the lowest among the seven countries. In 2008, the ratio of government expenditure in Japan was 17.8%. Germany and China have shown an ongoing decreasing trend. Korea, on the other hand, has shown a slight but continuous upward trend.

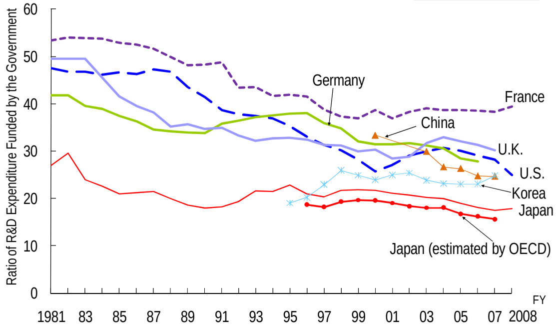
Chart 1-2-3: Definition of "the government" as a source of expenditure in selected countries

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

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

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

Attention to international comparison



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

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

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

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

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

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

<France>The government refers to public research institutes.

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

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

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

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

<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006"; "Bundesbericht Forschung und Innovation 2008"

<Japan (OECD estimate), France and Korea> OECD, "Research & Development Statistics 2009"

<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 2007 (website)

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

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.

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

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

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

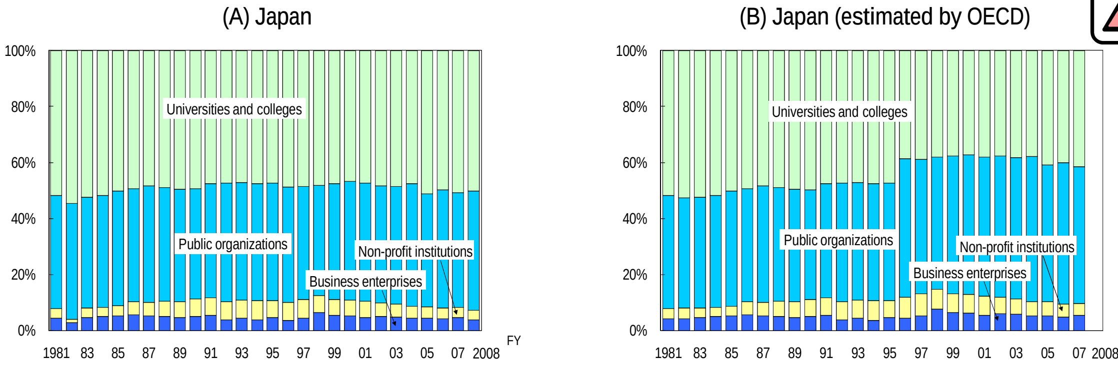
In U.K., spending for the university and college sector is sharply on the rise. Spending for the business enterprise sector tended to decrease from 1981 to 1996, and was followed by continuous fluctuation. The proportion for the business enterprise sector has gradually been declining since the latter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

In summary, in each country, the spending of R&D expenditure by the public organization sector for the business enterprise sector is in a declining trend, while that for the university and college sector is in a rising trend.

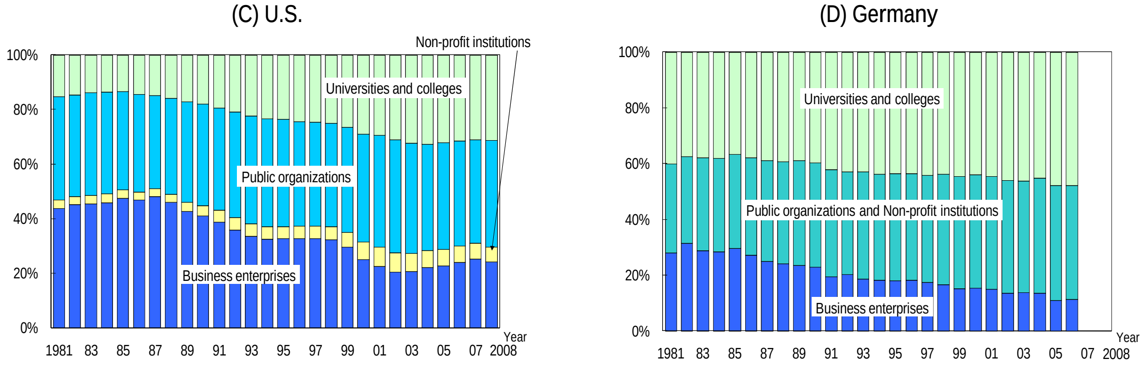
Attention to international comparison

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

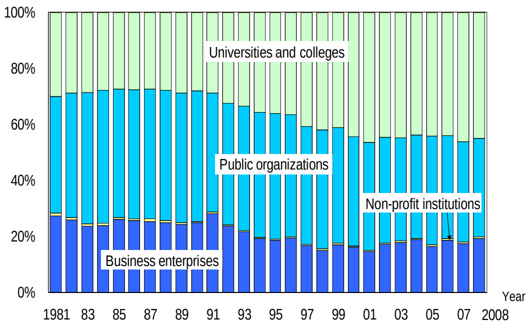
Attention to trend


(A) Japan

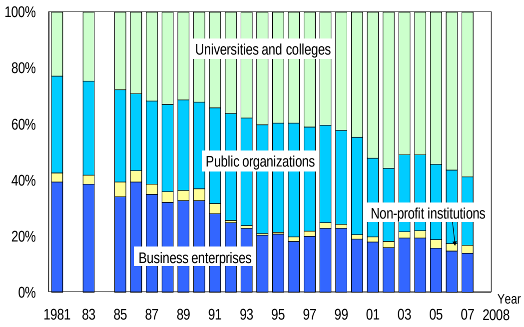
(B) Japan (estimated by OECD)


(C) U.S.

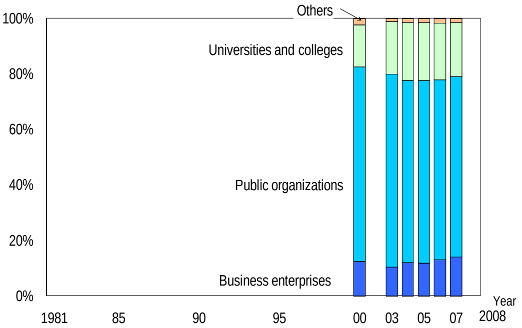
(D) Germany



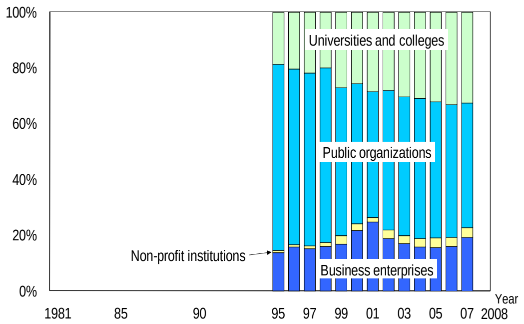
(E) France



(F) U.K.



(G) China



(H) Korea

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

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

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

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

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

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

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

<France> The government refers to public research institutes.

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

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

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

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

<Germany>Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 2004, 2006”; “Bundesbericht Forschung und Innovation 2008”

<France, Korea>OECD, “Research & Development Statistics 2009”

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

<China>Ministry of Science and Technology of the People’s Republic of China, S&T Statistics Data Book 2008 (website); "Science and technology index of the People's Republic of China"

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

In Japan, the Cabinet decided on the “Science and Technology Basic Plan” in July 1996 (hereinafter referred to as the “First Science and Technology Basic Plan”). This First Science and Technology Basic Plan explicitly stated that “with regard to short-term doubling of government R&D investments, the ratio of such funds against GDP is intended to be raised to the level of U.S. and major European countries at the beginning of the 21st Century. In this connection, it has been strongly required to double the amount within the period of the plan. If this is the case, the size of the total government budget appropriations for S&T from FY 1996 to FY 2000 needs to be approximately 17 trillion yen.”

Approximately 17 trillion yen, the target stated in the Basic Plan, was achieved when the total of the government budget appropriation for S&T during the five years from FY 1996 to FY 2000 of the First Science and Technology Basic Plan became approximately 17.6 trillion yen in actuality. Looking at the trend over the five years, the amount in FY 1998 was substantial. This was largely due to a supplementary budget which was compiled as a measure for boosting the economy.

After that, the Cabinet decided on the “Second Science and Technology Basic Plan” for the five years from FY 2001 to FY 2005 (hereinafter referred to as the “Second Science and Technology Basic Plan”). The Second Science and Technology Basic Plan clearly stated that “in order to continuously make efforts to promote science and technology under the First Science and Technology Basic Plan, it is required to continue to maintain the level of government R&D investment against GDP at least to the same level as U.S. and major selected European countries during the period of the Second Science and Technology Basic Plan too.” In this case, the size of the total government R&D investment during FY 2001 to FY 2005 would have needed to be approximately 24 trillion yen. The actual sum of the budgets during the corresponding period was approximately 21.1 trillion yen in total, which was composed of approximately 18.8 trillion yen of the budget of the central government and approximately 2.3 trillion yen of the budget of the local governments.

Also, in the “Third Science and Technology Basic Plan” (hereinafter referred to as the “Third Science and Technology Basic Plan”), the size of the total budget for five years from FY 2006 to FY 2010 is considered to be approximately 25 trillion yen (under the condition that the ratio of government investigation for R&D against GDP during the period of the Third Science and Technology Basic Plan is 1%, and the average nominal growth rate of GDP during the same period is 3.1%).

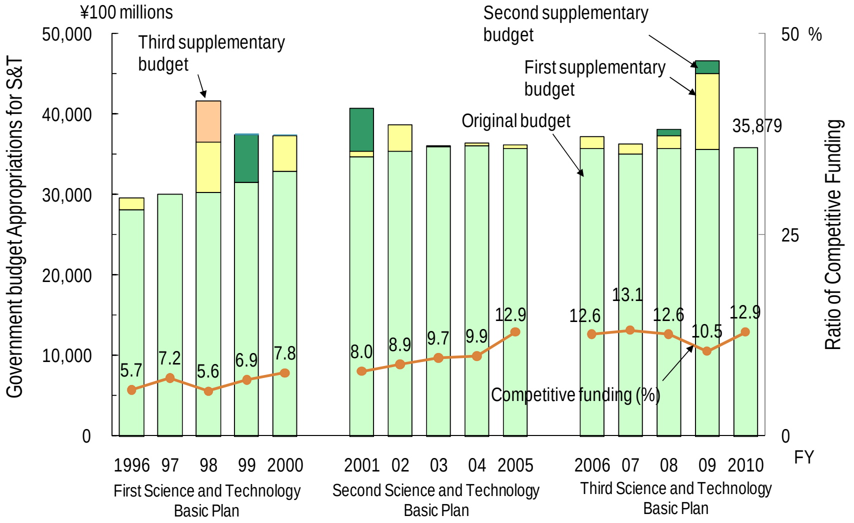
The initial budget of government budget appropriation for S&T for FY 2009 was approximately 3.6 trillion yen, but it was adjusted to the substantial amount of approximately 5 trillion yen by the first supplementary budget of approximately 1.3 trillion yen. Subsequently, implementation of the first supplemental budget was suspended through a review, leading to the subtraction of 400 billion yen. A second supplementary budget added 200 billion yen. The initial budget in FY2010 is approximately 3.6 trillion yen (Chart 1-2-6).

Next, some basic indexes associated with the government budget appropriations for S&T by the Japanese government are shown.

The annual growth rate of appropriations for S&T has been lower than that for general expenditure since FY 2007. Moreover, the FY 2010 budget was sharply reduced in reaction to the large 2009 supplemental budgets (Chart 1-2-7).

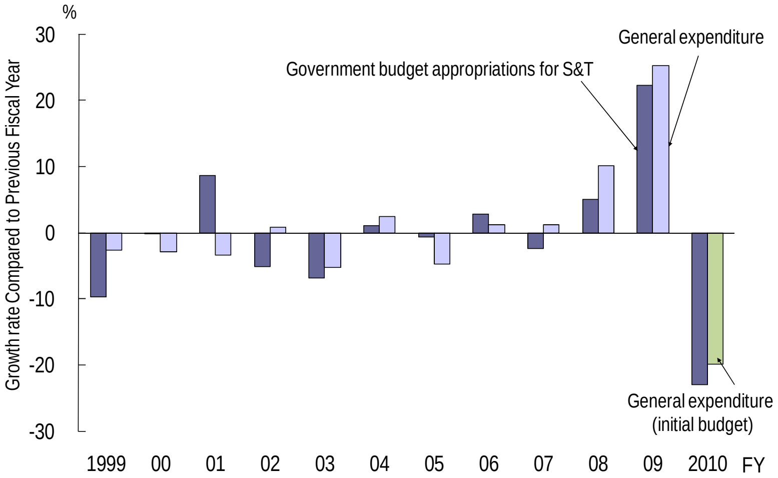
With regard to the government budget appropriations for S&T in FY 2010, the ratio of the general account to the special accounts is 7 to 1 (Chart 1-2-8). The general account is composed of the cost for national universities and public research institutes, “Funds for promoting science and technology” which consists of several grants and other research related costs, etc. In contrast, of the special accounts, the accounts for supply and demand of energy (special accounts for the measures for structural improvement of petroleum and energy supply and demand) and the accounts for promotion of power development (special accounts for electric power development promotion measures) account for a large proportion.

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



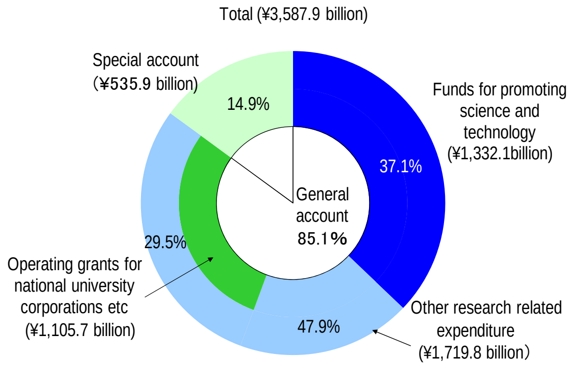
Note: 1) The supplementary budgets were composed of only additional amounts.
2) In accordance with the formulation of the science and technology basic plans (from the first to the third) , the range of targeted costs were reviewed in FY 1996, 2001 and 2006.
Source: Data from the Ministry of Education,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

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) In accordance with the formulation of the science and technology basic plans (the first and the second), the range of targeted costs were reviewed in FY 1996 and 2001.
2) With regard to the amount for national university corporations out of the general account, until FY 2006, the budget appropriation was calculated in accordance with the sum of operating grants, and self income (by hospital income, tuition fees and commission projects, etc.) . (This amount was the equivalent of the government budget appropriation for S&T in special account for national institutions prior to the time when national universities, etc. were turned to 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; the Ministry of Finance; the Ministry of Finance: web, "Monthly finance review"

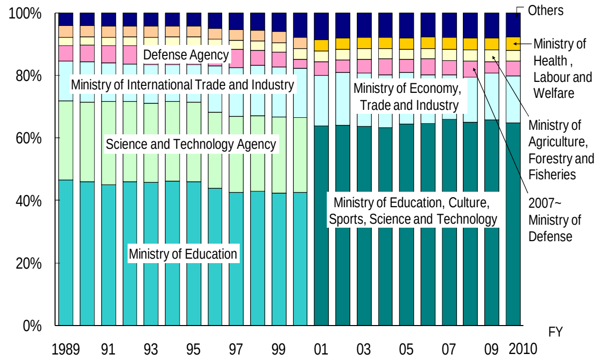
Chart 1-2-8: Breakdown of Japanese government budget appropriations for S&T (FY 2010)



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

With regard to the breakdown of the government appropriations for S&T by ministry and agency, the proportion has not significantly varied, except for the case of FY 1996, when the scope of the costs which is entitled to the government budget appropriation for S&T was reviewed, and the case of FY 2001, when ministries and agencies were reorganized. Out of all the ministries and agencies, the proportion of 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 in and before FY 2000) accounted for the highest, 64.8%, in FY 2010, followed by the Ministry of Economy, Trade and Industry (15.0%), the Ministry of Defense (4.8%), the Ministry of Health, Labour and Welfare (4.5%) and the Ministry of Agriculture, Forestry and Fisheries (3.5%) (Chart 1-2-9).

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



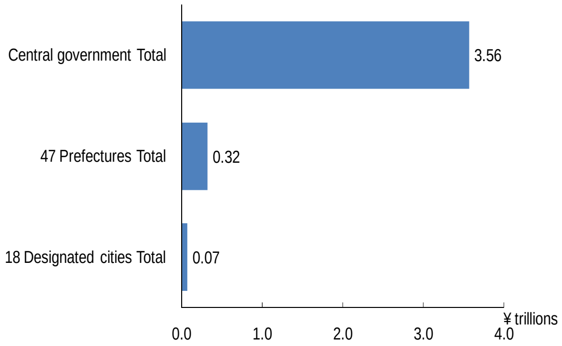
Note: 1) Data for each fiscal year is for initial budgets.
2) In accordance with the formulation of the science and technology basic plans (from the first to the third) , the range of targeted costs were reviewed in FY 1996, 2001 and 2006.
3) Until FY 2000, the expenditure on the Japan Key Technology 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 18 designated cities was approximately 388.3 billion yen in FY 2009. This amount was the equivalent of 10.9% out of the original government budget appropriation for S&T allocated by the national government (approximately 3,563.9 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 2009)



Note: 1) The amount is the initial budget.
2) The national treasury disbursements were not included in the budget for local governments.

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

1.3 R&D expenditure by sector

1.3.1 R&D expenditure in the public organization sector

Key points

○The growth rate of Japan's R&D expenditure (real values) in the public organization sector in the 1990s was high at 4.32% but reduced to 0.6% in the 2000s.

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

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

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

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

In 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.

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 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 on Page 18) 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 1.45 trillion yen in FY 2008. Since the 2000s, the trend has been flat. Although R&D expenditure has remained flat in many countries since the 1990s, China started rapidly increasing its R&D expenditure during the middle of the 1990s. Its growth rate rose beyond that of Japan in 2002, and is currently in second position, following U.S.

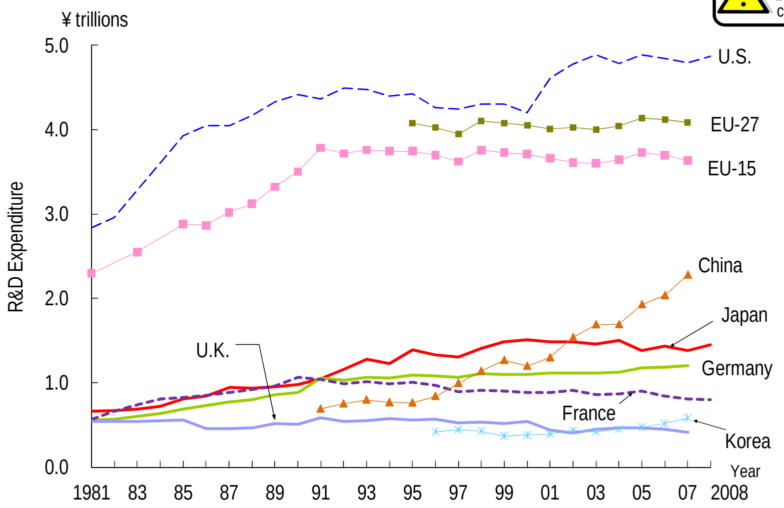
Chart 1-3-1(B) shows the annual average growth rate of R&D expenditure (nominal values) in each country on a national currency basis. Looking at the average annual growth rate in the 2000s (2000 to the latest available year in each country), the growth rates in Japan and U.K. were negative, while those of all the other countries were positive.

Furthermore, from a comparison of real values which are adjusted to remove the influence of high prices on a national currency basis, countries in which the growth rate increased in the 1990s were Japan, Germany and China. The other countries showed negative growth in the 1990s. Countries in which the growth rate was more increased in the 1990s than in the 2000s were U.S., Germany, China and Korea. The country with the most negative growth at the beginning of the 2000s was U.K. (Chart 1-3-1(C)).

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	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	1.05	1.51	1.45 (2008)	4.18%	-0.56%
U.S. ($ billions)	23.3	27.1	41.8 (2008)	1.68%	5.54%
Germany (€ billions)	5.46	6.87	8.54 (2007)	2.60%	3.15%
France (€ billions)	5.63	5.36	6.33 (2008)	-0.55%	2.10%
U.K. (£ billions)	1.95	2.24	2.24 (2007)	1.58%	-0.01%
China (¥ billions)	7.90	25.8	68.8 (2007)	14.1%	15.0%
Korea (₩ trillions)	1.60 (1995)	1.84	3.65 (2007)	1.58% ('95→'00)	10.2%

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

National Currency	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	1.03	1.51	1.59 (2008)	4.32%	0.60%
U.S. ($ billions)	27.7	27.1	34.1 (2008)	-0.22%	2.91%
Germany (€ billions)	6.26	6.87	7.90 (2007)	1.04%	2.01%
France (€ billions)	6.30	5.36	5.34 (2008)	-1.78%	-0.21%
U.K. (£ billions)	2.44	2.24	1.86 (2007)	-0.93%	-2.58%
China (¥ billions)	14.0	25.8	53.8 (2007)	7.03%	11.1%
Korea (₩ trillions)	2.49 (1995)	1.84	3.11 (2007)	-3.26% ('95→'00)	7.75%

Note 1) The definition of the public organization sector differs depending on the country. Therefore it is necessary to be careful when making international comparisons. Refer to Chart 1-1-4 for the definition of sectors in each selected country.
2) Includes expenditures in the field of social sciences and humanities (until 2006, only natural sciences in Korea)
3) For Japan (OECD estimate), France, Korea and EU, non-profit institution totals minus the business enterprises, universities and colleges and public organization sectors
4) Purchasing power parity is the same as Reference Statistics E.
<Japan and Japan (OECD estimate)> In 2001, part of non-profit institutions was moved to the business enterprise sector.
"Germany" represents the former West Germany until 1990 and unified Germany since 1991.
Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; OECD, "Main Science and Technology Indicators 2009/2"
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<Germany>Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006", "Bundesbericht Forschung und Innovation 2008; OECD, "Main Science and Technology Indicators 2009/2" since 2007
<U.K.>National Statistics website: www.statistics.gov.uk
<China>OECD, "Main Science and Technology Indicators 2009/2"; since 2004, S&T Statistics Data Book (website)
<France, Korea, and EU> OECD, "Main Science and Technology Indicators 2009/2"

(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.

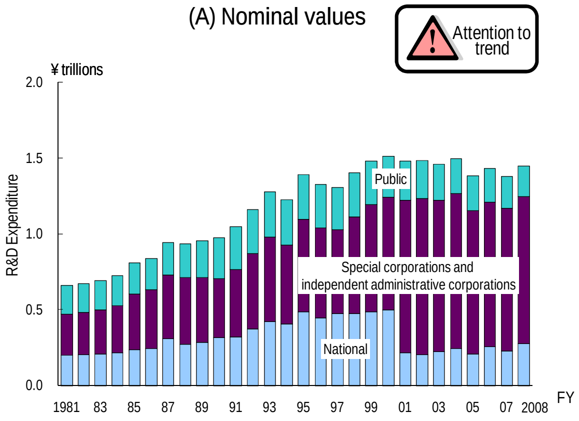
From 1991 to 2000, the annual average growth rate of R&D expenditure in public institutes run by local governments showed a decrease of -0.24%, while that in the other public organizations showed an increase of 5.67%.

From 2000 to 2008, the annual average growth rate of R&D expenditure in public institutes run by local governments was -2.53%, showing further dwindling, while that in the other public organizations was 1.22%, showing a shrinking rise.

As a result of the examination of the trend of R&D expenditure between 1996, the starting year of the First Science and Technology Basic Plan, and 2008, R&D expenditure in public institutes run by local governments was reduced by approximately 20%, and that in other public organizations was increased by approximately 30%. For the rise in the latter case, the increase of R&D expenditure from the middle to the latter half of the 1990s contributed greatly.

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

(A) Nominal values



(B) Real values (2000 base)

¥ trillions	1991	2000	2008	Annual average growth rate	
				91→'00	00→08
Public institutes (run by local government)	0.28	0.27	0.22	-0.24%	-2.53%
Public organizations other than public institutes	0.75	1.24	1.37	5.67%	1.22%
Total public organizations	1.03	1.51	1.59	4.32%	0.61%

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

○The ratio of R&D expenditure against GDP in the business enterprise sector was 2.74% in Japan followed by 2.45% in Korea, and each value was an all time high in the corresponding country. The ratio was 2.00% in U.S., and has recently been gradually increasing.

○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 U.S. France, U.K., etc., and the latter accounts for a large proportion in the in Japan, Canada, etc., respectively.

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

R&D expenditure in the business enterprise sector accounts for the dominant proportion of the total R&D expenditure of each country. Accordingly, fluctuations in the amount in the business enterprise sector have a significant influence on a country's R&D expenditure.

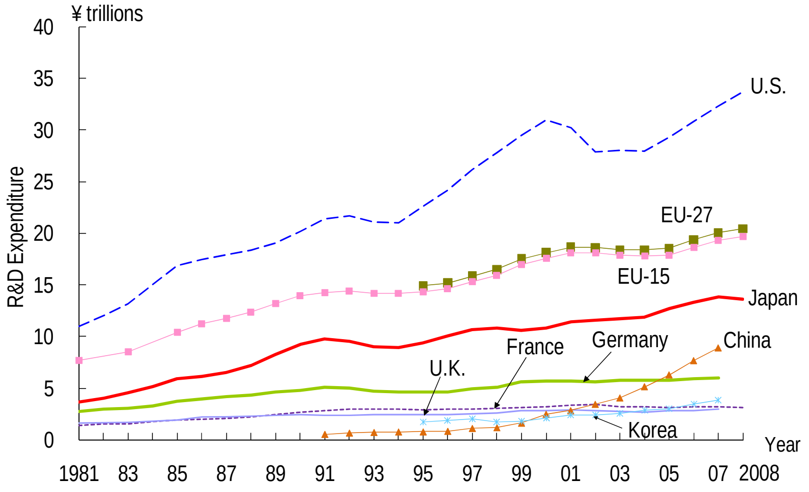
By examining the R&D expenditure in the business enterprise sector for selected countries with OECD purchasing power parity equivalents, it is found that the expenditure is increasing in every country in the long term. In addition, while growth in China has been remarkable since around 2000, major European countries have not shown any obvious change (Chart 1-3-3(A)).

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

Also the annual average growth rate of the real values (2000 base, national currency), which are adjusted considering the commodity price trend in each country, show that the growth rate is higher in the 2000s than in the 1990s for Japan, U.K., China and Korea. Of these, Japan demonstrated an especially sharp rise, from 1.35% to 4.08% (Chart 1-3-3(C)).

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

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



(B) Nominal values (national currency)

National Currency	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	9.74	10.9	13.6 (2008)	1.21%	2.88%
U.S. ($ billions)	115	200	289 (2008)	6.37%	4.72%
Germany (€ billions)	26.2	35.6	43.0 (2007)	3.45%	2.74%
France (€ billions)	15.3	19.3	24.8 (2008)	2.65%	3.17%
U.K. (£ billions)	7.84	11.5	16.1 (2007)	4.36%	4.92%
China (¥ billions)	6.4	53.7	268 (2007)	26.8%	25.8%
Korea (₩ trillions)	6.96 (1995)	10.3	23.9 (2007)	4.40% ('95→'00)	12.8%

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

National Currency	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	9.62	10.9	15.0 (2008)	1.35%	4.08%
U.S. ($ billions)	136	200	236 (2008)	4.38%	2.11%
Germany (€ billions)	30.1	35.6	39.8 (2007)	1.88%	1.60%
France (€ billions)	17.1	19.3	20.9 (2008)	1.38%	1.00%
U.K. (? billions)	9.82	11.5	13.4 (2007)	1.78%	2.22%
China (¥ billions)	11.3	53.7	210 (2007)	19.0%	21.5%
Korea (₩ trillions)	10.8 (1995)	10.3	20.3 (2007)	-0.58% ('95→'00)	10.3%

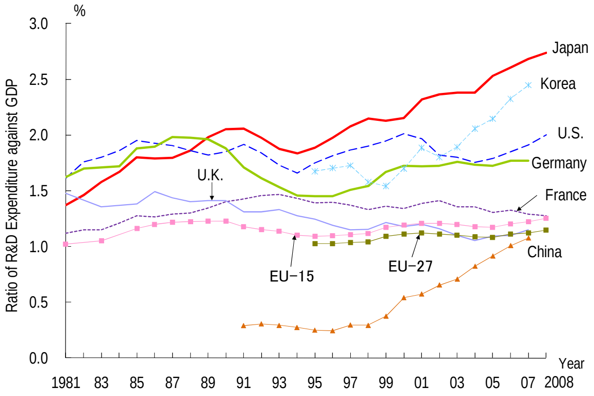
Note: 1) Refer to Chart 1-1-4 for the definition of the business enterprise sector in each country.
2) Includes expenditure in the field of social sciences and humanities (until 2006, only natural sciences in Korea)
3) Purchasing power parity equivalent is the same as Reference Statistics E.
4) Real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

Source: <Japan>Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”; OECD, “Main Science and Technology Indicators 2009/2”
<U.S.>NSF, “Science and technology Indicators 2010”
<Germany>Bundesministerium für Bildung und Forschung, “Bundesbericht Forschung 2004, 2006”, “Bundesbericht Forschung und Innovation 2008”; OECD, “Main Science and Technology Indicators 2009/2” since 2007
<U.K.>National Statistics website: www.statistics.gov.uk
<China > OECD, “Main Science and Technology Indicators 2009/2”; since 2004, S&T Statistics Data Book (website)
<France, Korea and EU> OECD, “Main Science and Technology Indicators 2009/2”

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 against GDP in the business enterprise sector, the latest available ratio for Japan was 2.74%. Japan has kept the top spot since 1990. Korea has stayed in second position since 2002, and its ratio in recent years has been drawing near to that of Japan. U.S. has been on an upward trend in recent years, while 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

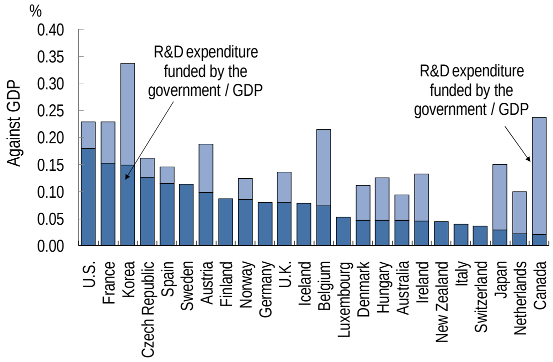


Note: 1) GDP is the same as Reference Statistics C.
2) Same as in Chart 1-3-3.
Source: Same as in Chart 1-3-3.

Next, the amount of R&D expenditure in the business enterprise sector which was funded by the government (direct funded distribution) against GDP, and the amount of corporation tax deduction by R&D tax incentives against GDP are examined (Chart 1-3-5).

The results show that the amount of direct aid by the government to the business enterprise sector accounts for a large proportion in U.S., France, Korea, etc, while the amount of indirect aid accounts for a large proportion in Canada, Korea, Belgium, Japan, etc. Both direct and indirect support are large in Korea.

Chart 1-3-5: Direct fund distribution and R&D tax incentives by the government for R&D in the business enterprise sector (2007)

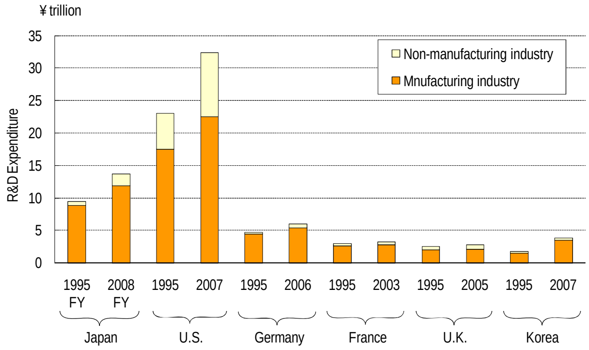


Note: Values estimated by each country (in accordance with the survey for R&D tax incentives by NESTI). Preliminary budget values are also included. Values for U.S., France, Korea, Norway, U.K., Iceland, Denmark, Switzerland and Canada are from 2008; those for Australia are from 2006.
Source: OECD, “STI Outlook 2008”

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

The ratio of R&D expenditure in the manufacturing industry against the total accounts for 80 to 90% in almost all the countries. However, this ratio in U.S. was only 70%, and means that the proportion of R&D expenditure in the non-manufacturing industry is relatively large in U.S. compared to that in other countries. Also the ratio of R&D expenditure in non-manufacturing industry in the latest year was higher compared to that for 1995 in every country (Chart 1-3-6).

Chart 1-3-6: Comparison between R&D expenditure in the manufacturing industry and in all industries in selected countries (OECD purchasing power parity equivalent)



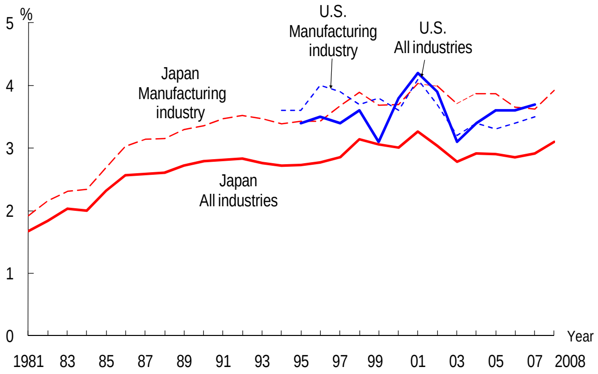
Note: 1) Refer to Chart 1-1-4 for the definition of the business enterprise sector in each country.
2) Purchasing power parity is the same as in Reference statistics E.
<Japan> 1) The industrial classification was made in accordance with the classification in the survey of research and development based on the Japan standard industry classification. The data of FY 1995 was based on the "Japan standard industry classification" revised in 1993 (the 10th edition), and the data of FY 2007 was based on that revised in 2007 (the 12th edition). Beginning in 2002, the scope of the non-manufacturing sector in the survey of research and development was expanded by adding the categories "academic research institution" and "financial industry."
2) Fiscal year was used as a year scale.
<U.S.> For the data of 1995, FFRDCs were not included, and SIC was adopted as an industrial classification. But for the data of 2006, NAICS was adopted as an industrial classification.
<Germany> For the data for 1995 and for the data of 2005, German industrial classification, "Classification of Economic Activities", revised in 1993 and in 2003 was used respectively.
<France> For the classification of the data of 1995 and 2005, France activity classification table, "Nomenclature d'activités française (NAF), revised in 1993, and revised in 2003 was used respectively.
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.>NSF, "R&D in Industry" for each year; S&E Indicators 2010
<Germany> BMBF, "Bundesministerium für Bildung und Forschung, "Bundesbericht Forschung 2004, 2006"; "Bundesbericht Forschung und Innovation 2008"
<France>OECD, "STAN Database"
<U.K.>OST, "SET Statistics"
<Korea> Korean Science and Technology Statistics Service (website)

(2) 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 U.S. The ratios are shown for both all industries together and for the manufacturing industry.

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

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



Note: Refer to Chart 1-1-4 for the definition of the business enterprise sector of each country.
<Japan>1) The contents and timing of the survey in "Report on the Survey of Research and Development" by the Ministry of Internal Affairs and Communications were revised since the time of survey in 2002 (FY 2001 was the target) .
2) R&D expenditure in all the industries per sales amount represents such values in "all the industries other than finance and insurance industries" since FY 2001.
3) The industrial classification was made in accordance with the classification in the survey of research and development based on the Japan standard industry classification.
4) Following the revision in industrial classification, the classification in the survey of research and development was changed in the edition of 1996, 2002 and 2008.
<U.S.>1) As an industrial classification, SIC and NAICS were used until 1998 and since 1999 respectively.
2) FFRDCs have been excluded since 2001.
Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "R&D Industry"; "Science and Engineering Indicators 2010" beginning in 2003.

1.3.3 R&D expenditure in the university and college sector

Key points

○The R&D expenditure in the university and college sector was 3445.0 billion yen (FY 2008), which is the equivalent of 2,236.1 billion (FY 2007) yen if the labor cost is multiplied by FTE factor.

○With regard to the annual average growth rate of R&D expenditure by real value (2000 base, national currency), Japan, U.S. and France showed a lower rise in the 1990s than in the 2000s. However, U.S. was still relatively high at 3.9%.

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

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

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

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

The scope of higher education institutions depends on the country, but in every country the main institutions are universities. The institutions under survey also depend on the country. The summary of targeted institutions is as follows: For Japan, universities (including graduate schools), junior colleges, technical colleges, university research institutes and other institutions were targeted(5) (6). For U.S., universities & colleges (institutions which perform R&D which is the equivalent of 150,000 dollars or more; FFRDCs are excluded) were targeted. For Germany, universities, comprehensive universities, and colleges of theology, etc. were targeted. For France, CNRS (including their facilities), 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 U.S., S&E(7) fields were covered, while in Korea, only the field of natural sciences and engineering was included until 2006 (Chart 1-1-4 on Page 17).

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)”.

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

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(5) According to “Report on School Basic Survey (FY 2008)” by MEXT in FY 2008, 765 universities (86 national, 92 public and 595 private universities), 406 junior colleges (2 national, 26 public and 378 private junior colleges) and 64 technical colleges are covered.

(6) In “Report on the Survey of Research and Development” compiled by the Ministry of Internal Affairs and Communications, which was used as the materials for the statistics of Japan’s universities and colleges sector in this chapter, universities are surveyed by faculty (by course in the case of graduate schools), and the total number is 2.271 as of March 31, 2008. “Other institutions” include Inter University Research Institutes Corporation, the National Institution for Academic Degrees and University Evaluation, the Center for National University Finance and Management, National Institute of Multimedia Education, and the museum, center and facility at universities.

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

all teachers are exclusively limited to research. Therefore, it is natural to consider that the situation in which the labor cost of all the teachers is measured as R&D expenditure is an over-estimation with regard to R&D expenditure.

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

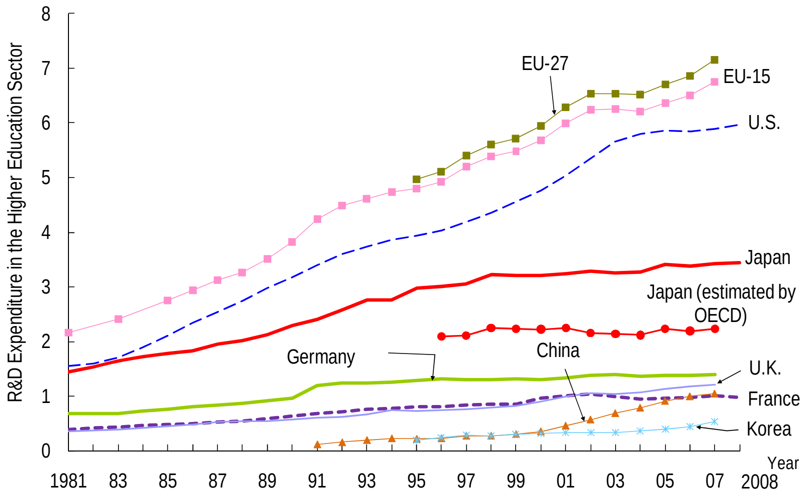
Chart 1-3-8(A) shows the nominal values of R&D expenditure in the university and college sector. The values of R&D expenditure in the university and college sector for "Japan" and "Japan (estimated by OECD)" were 3,445.0 billion yen (FY 2008) and 2,236.1 billion yen (FY 2007), respectively. Japan's values have been slightly increasing since 1996. With regard to other countries, the rise in U.S. and the EU is remarkable. Out of the EU countries, in Germany, France and U.K., where R&D expenditure is large, the amount is gradually increasing in the long term although the size of the change is not significant. In China, R&D expenditure is steadily increasing and recently the level has reached the same as that of France. Next the annual average growth rate (of the nominal values) of R&D expenditure by country with each country's national currency shows that the growth rate was lower in the 2000s (2000 to the latest valuable year in each country) compared to that in the 1990s (1991 to 2000) in Japan, Germany and France (Chart 1-3-8(B)).

When the growth rates are compared with the real values which are adjusted considering the influence of price, it is found that the growth rate was lower in the 2000s compared to that in the 1990s in Japan, U.S. and France. However, U.S. figure was relatively high at 3.9%. The countries with higher growth rates during the 2000s are China, Korea and U.K. China's rate was particularly remarkable (Chart 1-3-8(C)).

Chart 1-3-8: Trend of R&D expenditure in the university and college sector for selected countries

(A) Nominal values (OECD purchasing power equivalent)

Attention to international comparison



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

National currency	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	2.41	3.21	3.44 (2008)	3.24%	0.89%
Japan (estimated by OECD) (¥ trillions)	2.09 (1996)	2.22	2.24 (2007)	1.26% ('96→'00)	0.08%
U.S. ($ billions)	18.2	30.7	51.2 (2008)	5.98%	6.59%
Germany (€ billions)	6.15	8.15	9.91 (2007)	3.18%	2.84%
France (€ billions)	3.75	5.80	7.78 (2008)	4.97%	3.73%
U.K. (£ billions)	2.02	3.69	6.52 (2007)	6.93%	8.46%
China (¥ billions)	1.37	7.67	31.5 (2007)	21.1%	22.3%
Korea (₩ trillions)	0.77 (1995)	1.56	3.33 (2007)	8.16% ('95→'00)	11.4%

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

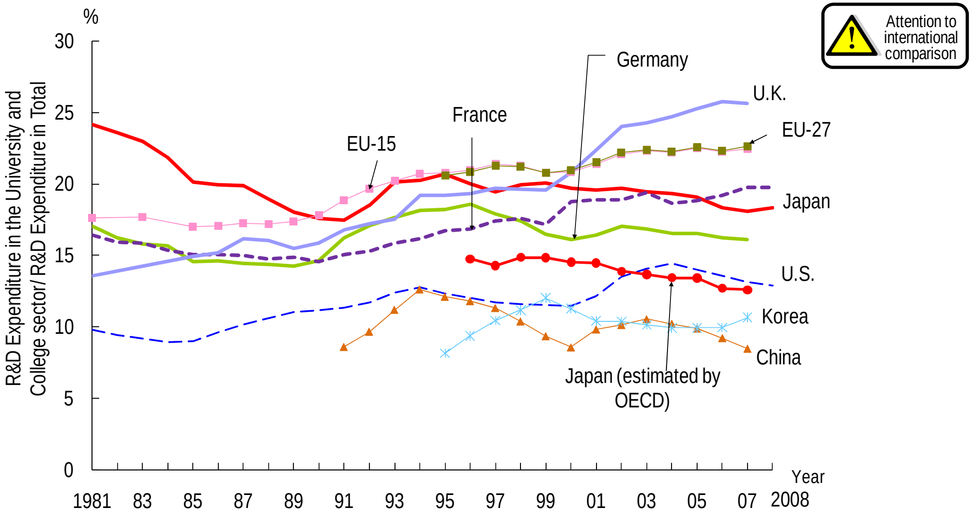
National currency	1991	2000	Latest year with available data	Annual average growth rate	
				'91→'00	'00→Latest year
Japan (¥ trillions)	2.38	3.21	3.78 (2008)	3.38%	2.07%
Japan (estimated by OECD) (¥ trillions)	2.04 (1996)	2.22	2.43 (2007)	1.75% ('96'→'00)	1.28%
U.S. ($ billions)	21.6	30.7	41.8 (2008)	4.01%	3.93%
Germany (€ billions)	7.05	8.15	9.16 (2007)	1.62%	1.70%
France (€ billions)	4.20	5.80	6.56 (2008)	3.67%	1.54%
U.K. (£ billions)	2.53	3.69	5.43 (2007)	4.29%	5.67%
China (¥ billions)	2.43	7.67	24.6 (2007)	13.6%	18.1%
Korea (₩ trillions)	1.20 (1995)	1.56	2.84 (2007)	3.00% ('95→'00)	8.92%

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

The trend of the ratio of R&D expenditure in the university and college sector against the total R&D expenditure for each country is shown in Chart 1-3-9.

In Japan, the ratio has tended to decrease recently. On the other hand, in U.K., the ratio has tended to increase, and the growth has been especially remarkable since 2000. The increase is considered to be influenced by the rise in R&D expenditure in the university and college sector and the fall in that in the business enterprise sector. In U.S. and Germany, the ratio has repeated ups and downs in the long term, and has recently remained flat.

Chart 1-3-9: Trend of the ratio of R&D expenditure in the university and college sector against the total 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 1-3-10 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 share of costs for intramural R&D expenditures borne by different sectors, more than 80% is covered by government sector in Germany and France, while about 70% is covered in U.S., U.K. and, in recent years, Korea. In Japan, the figure is about 50%. Countries where business enterprises bear a relatively large share of the costs are Germany and Korea at 12–15%. Countries where business enterprises bear a relatively low share are Japan and France at about 2–3%. In U.S. and U.K., the share is 5–6%. As for the share borne by foreign countries, U.K. is high relative to the other countries at 8%.

In 2006–2008, the share of costs borne by the Japanese government was 48.9%, while that borne by business enterprises was 2.9%. Compared with 2000–2002, the government share decreased by 2.2 percentage points, while the business enterprise share increased by 0.2 percentage points.

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

In Germany, government and non-profit institution bear large percentages of the costs. In 2004–2006, they accounted for 82.5% of the whole. The business enterprise sector also accounts for a large share relative to the other countries at 13.8%. Compared with 2000–2002, the share borne by government and non-profit institution fell by 3.3 percentage points, while that of business enterprises rose by 2.0 percentage points.

The government's share in France is also large. During 2006–2008, it accounted for 89.3%, the largest share of any of the selected countries. On the other hand, the business enterprise sector's share was only 1.67%, the smallest of any of the selected countries. The government share decreased by 1.7 percentage points, and the business enterprise share decreased by 1.2 percentage points compared with 2000–2002.

In U.K., government's percentage of costs is large as well, at 69.3% in 2005–2007. The business enterprise share is 4.6%. Compared with 2000–2002, the government share of costs rose 3.0 percentage points, while the business enterprise share fell 1.5 percentage points.

In Korea, the government share of costs increased by 11.5 percentage points in 2005–2007 (76.0%) compared with 2000–2002 (64.4%). This was the largest increase in any of the selected countries.

Next, the percentage of R&D expenditure by the government and business enterprise sectors that goes to universities and colleges is examined.

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

Comparing 2000–2002 to the latest available year, the largest increase in the share of government R&D expenditure that went to universities and colleges was in U.K. The largest increase in the business enterprise sector's share was in Germany.

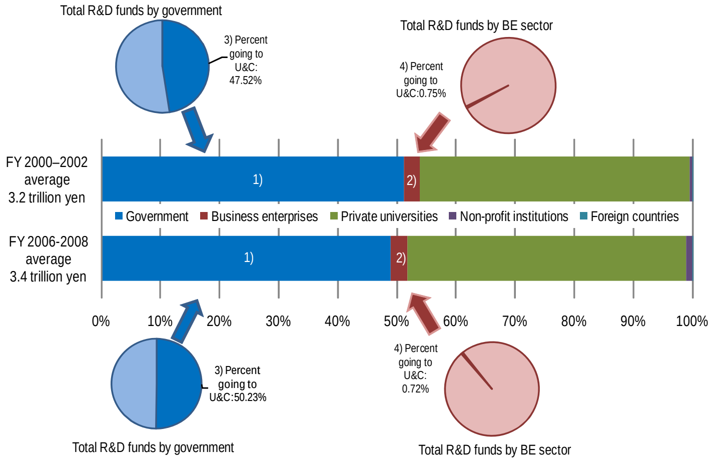
Chart 1-3-10: Changes in the cost-sharing structure for universities and colleges R&D expenditure in selected countries

(A) Table

⚠ Attention to international comparison

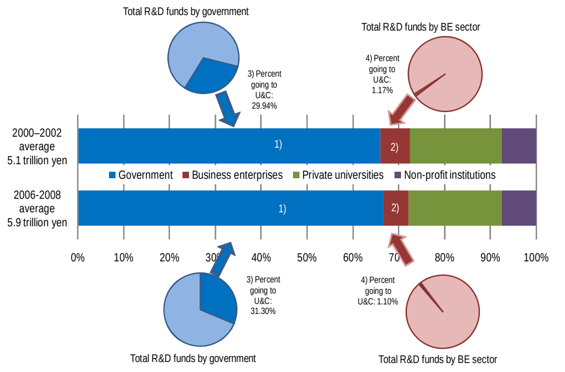
Country Most recent year (3-year moving average)	Total university research expenditures (OECD purchasing power parity basis)	Break down of university research expenditures				3) Percentage of total government R&D expenditures going to universities	Change from 2000–2002	4) Percentage of total business sector R&D expenditures going to universities	Change from 2000–2002
		1) Percentage received from government	Change from 2000–2002	2) Percentage received from business sector	Change from 2000–2002				
Japan '06-08	¥3.4 trillion	48.94%	△2.23%	2.86%	0.24%	50.23%	2.71%	0.72%	△0.03%
Japan (OECD) '05-07	¥2.2 trillion	51.31%	1.28%	2.93%	△2.10%	40.87%	3.21%	0.49%	△0.01%
U.S. '06-08	¥5.8 trillion	66.62%	0.61%	5.55%	△0.87%	31.30%	1.36%	1.10%	△0.07%
Germany '04-06	¥1.4 trillion	82.45%	△3.28%	13.85%	1.96%	47.00%	2.00%	3.38%	0.39%
France 06-08	¥1.0 trillion	89.34%	△1.67%	1.67%	△1.21%	45.10%	△0.07%	0.63%	△0.40%
U.K. '05-07	¥1.2 trillion	69.32%	2.95%	4.65%	△1.50%	56.70%	5.90%	2.61%	△0.40%
Korea '05-07	¥0.5 trillion	76.00%	11.55%	14.31%	△0.32%	32.73%	5.07%	1.96%	△0.20%

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

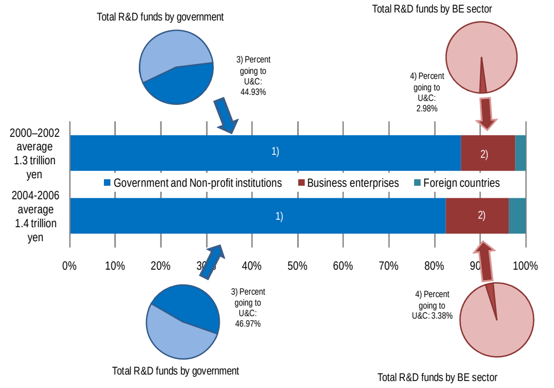


⚠ For the Japanese statistics, of R&D expenditures used at universities and colleges, the share of costs borne by universities and colleges refers to funding by private universities and colleges. Most of that is R&D expenditures self-funded by the private universities and colleges.

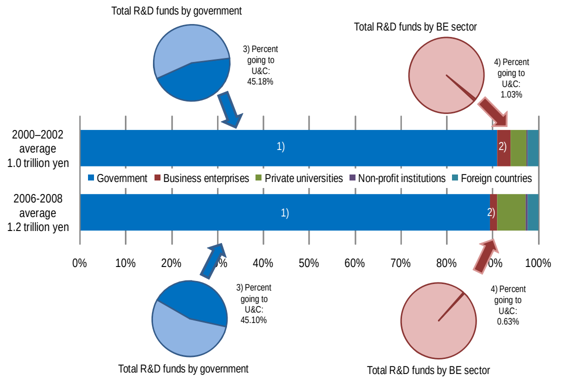
(C) Cost-sharing structure for universities and colleges R&D expenditures in U.S.



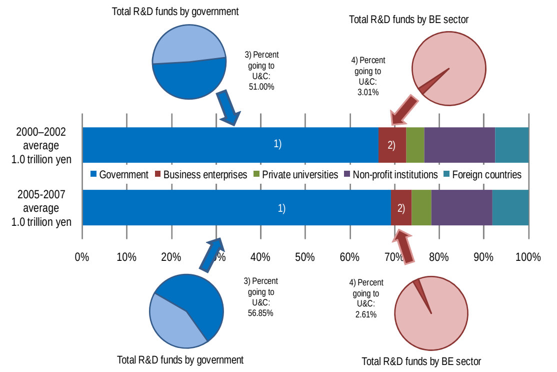
(D) Cost-sharing structure for universities and colleges R&D expenditures in Germany



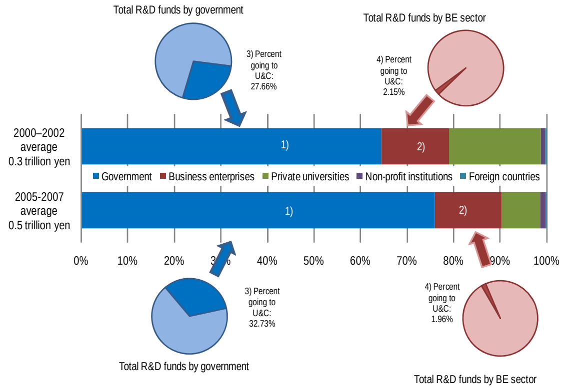
(E) Cost-sharing structure for universities and colleges R&D expenditures in France



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



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



Notes: 1) Three-year averages are used. For example, 2006–2008 refers to the average value for the years 2006 through 2008.
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 2006–2008 in Japan, of costs borne by government, 50.23% 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 U.S.

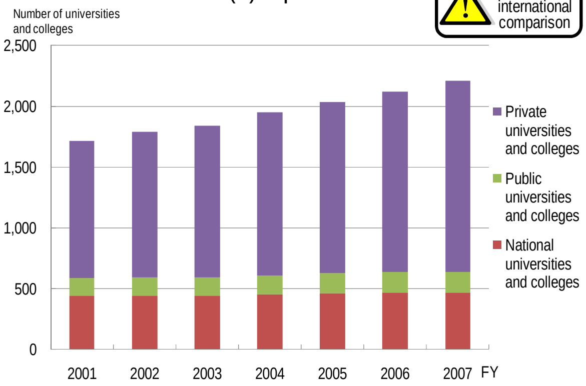
Chart 1-3-11 shows changes in the number of universities and colleges in Japan and U.S. covered by R&D statistics. U.S. (NSF) does not cover all universities and colleges. It covers only universities and colleges that use annual R&D budgets of at least 150,000 dollars. While Japan's Survey of Research and Development, in contrast, includes junior colleges, for the sake of comparison between Japan and U.S., only four-year universities and colleges will be discussed here.

In Japan in recent years, the ratio of national, public and private universities and colleges is 2:1:7. In U.S., the ratio of public universities and colleges to private universities and colleges is 6: 4.

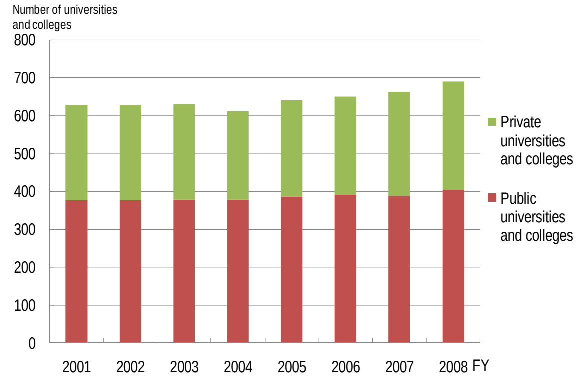
Chart 1-3-11: Number of universities and colleges

(A) Japan

Attention to international comparison



(B) U.S.



Note: There are differences in what is included in "universities and colleges" in Japan and U.S., so care is required when making international comparisons. In Japan's case, they include four-year universities; they do not include junior colleges or Inter-University Research Institute Corporation, etc. In the case of U.S., they include institutions implementing annual R&D 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 U.S. and changes therein will be examined.

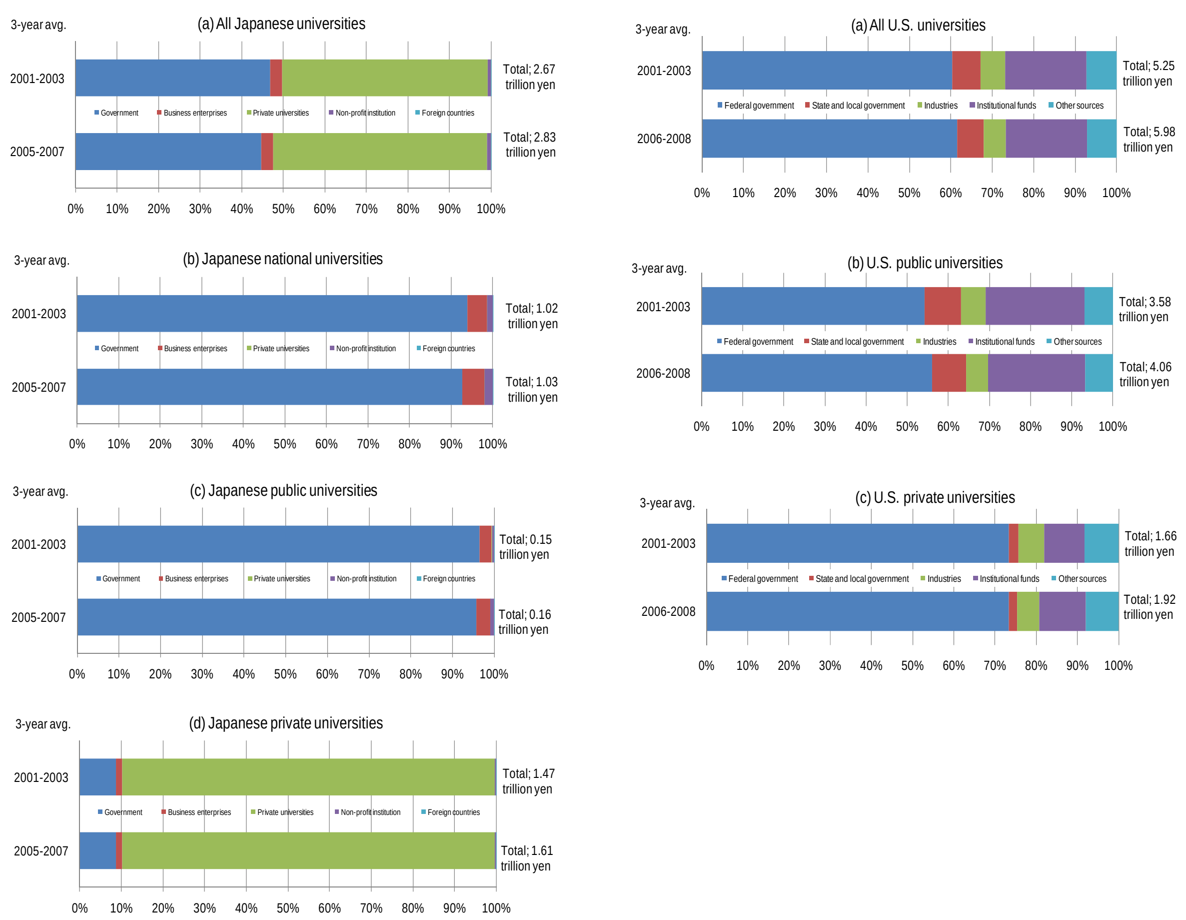
Chart 1-3-12(A) shows the funding structures for Japanese universities (four-year universities) according to type, i.e., national, public and private universities. At national and public universities, more than 90 % of funding comes from government. Little funding comes from business enterprises or other sectors. Looking at the share for national universities in 2005–2007, government funding accounted for 92.7% of funding. This was a decrease of 1.1 percentage points from 2001–2003.

As for private universities in 2005–2007, 89.4% of funding for R&D expenditures came from private universities, indicating that their R&D is mostly self-funded. Funds from government accounted for 8.6% during 2005–2007, an increase of 0.7 percentage points from 2001–2003. There was very little funding from the business enterprise sector, which accounted for only 1.6%.

Chart 1-3-12(B) shows the R&D expenditure funding structure of U.S. universities and colleges divided into public and private universities and colleges. In U.S. during 2006–2008, shares of funding from federal, state and local governments were large, 64.4% at public universities and colleges and 75.4% 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 (23.5%) than at private universities and colleges (11.3%).

Chart 1-3-12: Funding structure for R&D expenditures of universities and colleges in Japan and U.S.

Attention to international comparison



(A) Japan

(B) U.S.

Notes: See Chart 1-3-11 for caution on international comparison.

<U.S.> 1) Institutional funds are funds of unspecified purpose that come from business enterprises, foundations, and other outside funding sources. This includes indirect costs of projects.

2) Other funding refers to other unclassified sources. It includes, for example, funds donated by individuals for research use.

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

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

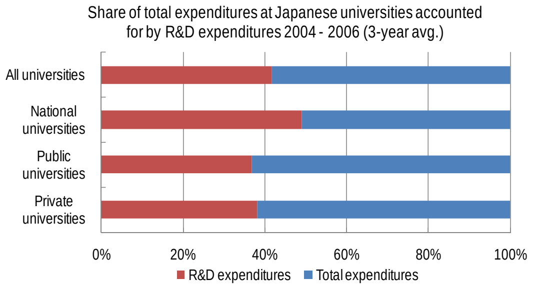
(4) Comparison of share of R&D expenditures in total operating costs at Japanese and U.S. universities and colleges

The shares of total operating costs (total expenditures) at Japanese and U.S. universities and colleges accounted for by R&D expenditures were compared. Four-year averages from 2004 through 2006 at degree-granting four-year universities and colleges in Japan and 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 1-3-13, R&D expenditures accounted for 40.9% of total expenditures at all universities. By type of university, the highest share was at national universities with 48.9%, while public universities are at 36.8% and private universities at 38.1%.

Chart 1-3-13: Share of total expenditures at Japanese universities accounted for by R&D expenditures

(A) Percentage



(B) Amount

2004-2006 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥6.7 trillion	¥2.8 trillion	40.9%
National universities	¥2.1 trillion	¥1.0 trillion	48.9%
Public universities	¥0.4 trillion	¥0.2 trillion	36.8%
Private universities	¥4.2 trillion	¥1.6 trillion	38.1%

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"

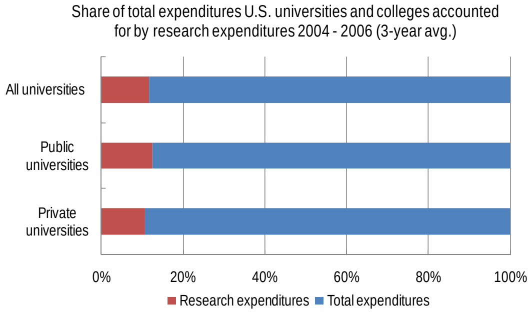
In the case of U.S., the NSF does not keep statistics on total operating costs (total expenditures) at universities and colleges, so National Center for Education Statistics (NCES) IPEDS data was used. IPEDS is a database on postsecondary education (including higher education) in U.S. It has data on 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. 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 1-3-14, the share of all expenditures accounted for by research at all universities and colleges was 11.7%. At public universities and colleges, it was 12.4%, and at private universities and colleges, it was 10.7%.

Comparing Japan and 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 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 1-3-14: Share of total expenditures at U.S. universities and colleges accounted for by research expenditures (IPEDS data)

(A) Percentage



(B) Amount

2004-2006 (3-year avg.)	(1) Total expenditures	(2) Research expenditures	(2)/(1)
All universities	¥39.2 trillion	¥4.6 trillion	11.7%
Public universities	¥23.2 trillion	¥2.9 trillion	12.4%
Private universities	¥16.0 trillion	¥1.7 trillion	10.7%

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 and colleges' R&D expenditures according to the NSF and research expenditures according to IPEDS are compared.

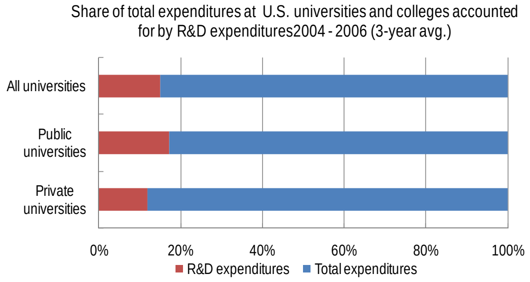
The NSF's R&D statistics cover universities and colleges with annual R&D expenditures of at least 150,000 dollars. There are a little under 700 such universities and colleges in U.S. The NSF total is still about 1 trillion yen higher than for IPEDS' research expenditures, which cover about 2,600 universities and colleges (including about 650 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 1-3-15 in this case, the share of total expenditures at all universities and colleges accounted for by R&D expenditures is 15.0%. By type of institution, the share is 17.2% at public universities and colleges and 11.9% 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 1-3-15: Share of total expenditures at U.S. universities and colleges accounted for by R&D expenditures (NSF data)

(A) Percentage



(B) Amount

2004-2006 (3-year avg.)	(1) Total expenditures	(2) R&D expenditures	(2)/(1)
All universities	¥39.2 trillion	¥5.9 trillion	15.0%
Public universities	¥23.2 trillion	¥4.0 trillion	17.2%
Private universities	¥16.0 trillion	¥1.9 trillion	11.9%

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 1-3-16).

Chart 1-3-16: Comparison of statistics on R&D expenditures at Japanese and U.S. universities and colleges

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

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

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

Chart 1-3-17 uses IPEDS data to show the revenue and expenditures of U.S. universities and colleges. Looking at revenue by source, revenue from tuition accounts for 23.2% of overall revenue for all universities and colleges. The next largest sources are state and local governments (16.5%) and investment income (or loss; 13.7%).

Breaking down universities and colleges by type, 28.9% of the revenue of public universities and colleges come from state and local governments, more than is received from tuition. At 31.3%, tuition is the largest source of revenue for private universities and colleges. Investment income (or loss) also accounts for a large share at 24.2%.

Looking at expenditures by purpose, at 28.3%, expenditures on instruction account for the largest overall share for all universities and colleges. This is followed by research expenditures at 11.7%. At 9.9%, hospitals also account for a relatively large share.

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

Chart 1-3-17: Financial status of U.S. universities and colleges

(A) Shares of revenue by source of fund

(Unit: %)

2004–2006 (3-year moving average)	Total revenue	Tuition	Federal government	State/local government	Investment income (loss)	Hospitals	Subsidiary enterprises	Other
All universities	100.0	23.2	13.2	16.5	13.7	9.0	7.7	16.5
Public universities	100.0	16.7	14.1	28.9	5.3	10.8	8.3	16.0
Private universities	100.0	31.3	12.1	1.2	24.2	6.9	7.0	17.1

(B) Shares of expenditure by purpose

(Unit: %)

2004-2006 (3-year moving average)	Total expenditures	Instructional expenditures	Research expenditures	Related support expenses	Subsidiary enterprises	Hospitals	Grants and scholarships	Other
All universities	100.0	28.3	11.7	8.8	8.8	9.9	2.1	30.4
Public universities	100.0	25.5	12.4	5.8	8.2	11.2	3.1	33.8
Private universities	100.0	32.3	10.7	13.3	9.6	7.9	0.7	25.5

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

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

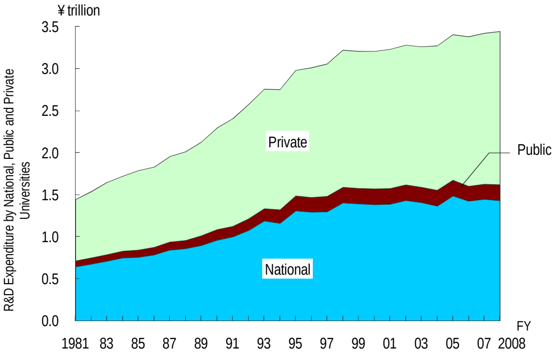
As stated above, it is necessary to be careful about the fact that the labor cost, which comprises a part of the R&D expenditure in the university and college sector in Japan, includes the cost for duties other than research. However, in this section, the R&D expenditure in the university and college sector by type, national, public or private, is examined in accordance with the data associated with R&D expenditure in universities and colleges. Published in the “Report on the Survey of Research and Development” (Chart 1-3-18).

R&D expenditure for the entire university and college sector in Japan in FY 2008 was approximately 3,445 billion yen, which was composed of approximately 2,177.8 billion yen for the field of natural sciences and engineering and approximately 1.2672 trillion yen for the field of social sciences and humanities, respectively. The proportion of R&D expenditure by type of universities against that total was, 41.6% for national, 5.5% for public or 52. 9% for private universities. The proportion of R&D expenditure by type of universities against the total expenditure only in the field of natural sciences and engineering was 53.8% for national, 6.1% for public and 40.1% for private universities. In the case of the field of social sciences and humanities, the proportion for each was 20.7% in national, 4.3% in public and 74.9% in private universities.

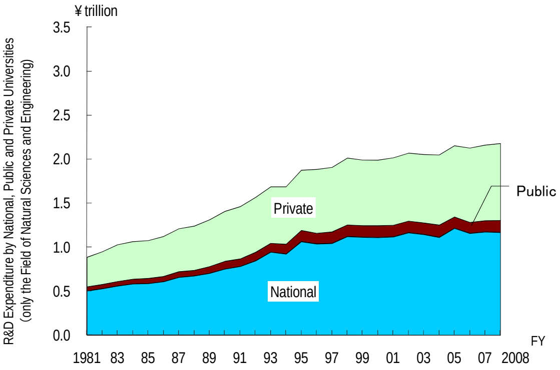
In summary, it was found that national universities accounted for large proportion of R&D expenditure in the field of natural sciences and engineering (natural sciences, engineering, agricultural sciences, medical sciences etc). On the other hand, private universities accounted for large proportion of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

Chart 1-3-18: R&D expenditure by national, public and private universities

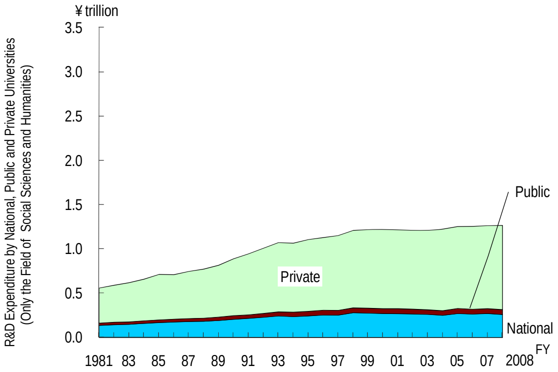
(A) All fields



(B) Field of natural sciences and engineering



(C) Field of social sciences and humanities

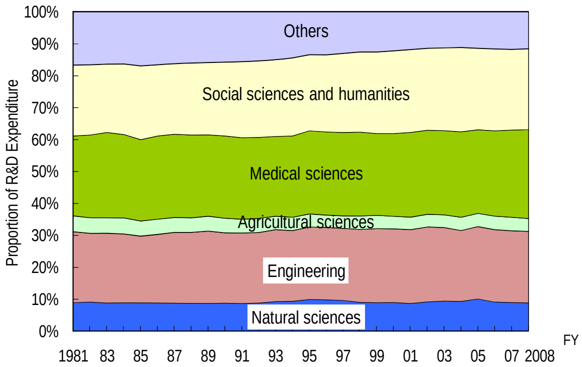


Note: “Social sciences and humanities” includes “Other.”
Source: Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”

Subsequently, the trend in the proportion of R&D expenditure in each field of study in the university and college sector is examined. The field of study represents the activities of education and 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 to be central is used to represent the field of study of research.

Chart 1-3-19 shows that R&D expenditure of each field changes only slightly. It is difficult to understand actually what kinds of R&D are performed from this chart because the fields of study shown are classified only in accordance with the kinds of faculties, as mentioned above.

Chart 1-3-19: Trend of the proportion of R&D expenditure by field of study in universities and colleges



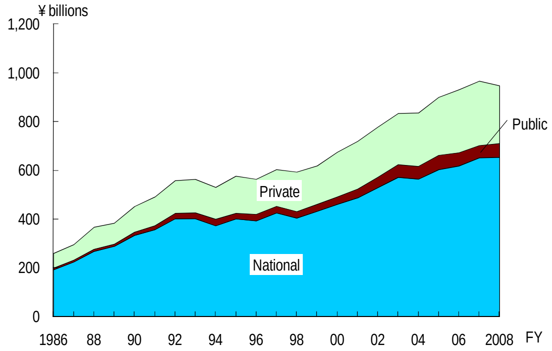
Note: Classification into the field of study represents a classification into the element of the organization, such as the faculty.
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

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 1-3-20). The trend of R&D expenditure which universities and colleges receive from the business enterprise sector has shown an extreme rise since FY 1999. But the amount of that in FY 2008 (94.8 billion yen) was only 2.8% of the total intramural R&D expenditure of universities in the same fiscal year (approximately 3,445 billion yen).

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

Chart 1-3-20: 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

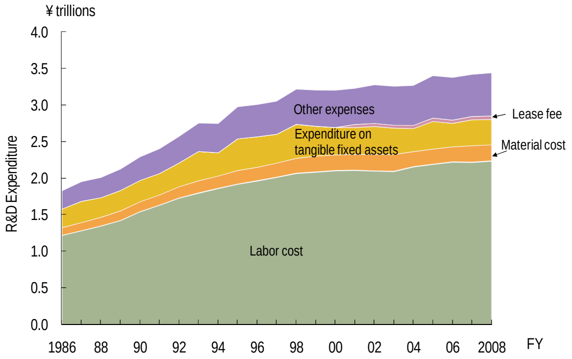
With regard to the breakdown of intramural R&D expenditure in universities and colleges by item of expense, the proportion of “labor cost” is large. The “labor cost” in FY 2007 was approximately 2,235.9 billion yen at 64.9% of the total (Chart 1-3-21).

According to the comparison between the case of national universities and the case of private universities, in national universities, the proportion of “labor cost” against the total was almost 60%, and that of “other expenses” was on the rise.

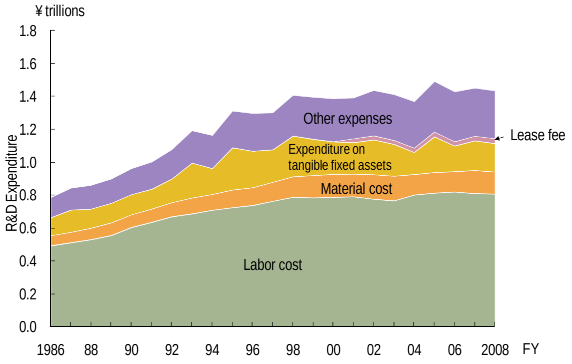
The “labor cost” in private universities was large at about 70%. But in private universities the field of social sciences and humanities comprises the main part. If only the field of natural sciences and engineering is focused upon, the total R&D expenditure is reduced to a half, and the “labor cost” against the reduced total expenditure is approximately 60%. On the other hand, the “labor cost” of the field of natural science and engineering alone in national universities was approximately 60% of the whole, but decreased to around 50%.

Chart 1-3-21: R&D expenditure by item of expense in universities and colleges

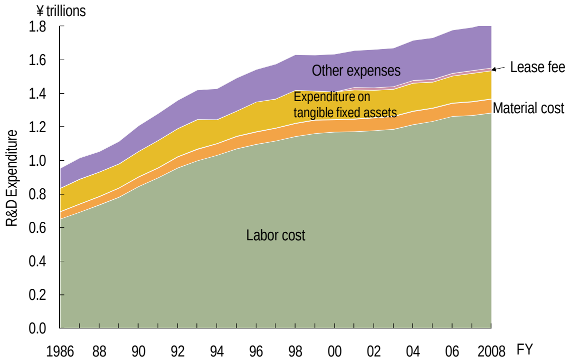
(A) Total



(B) National universities



(C) Private universities



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

1.4 R&D expenditure by type of R&D

Key points

○The expression R&D expenditure by type of R&D is a classification of R&D expenditure into that for basic research, applied research, and development. In Japan, however, this classification has been made only for the field of natural sciences and engineering (for Korea, only natural sciences until 2006).

○Out of R&D expenditure in FY 2007 for Japan, the proportion of that for basic research was 13.7%, and a large proportion, or 48.9%, 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 25.1%. In contrast, the proportion of R&D expenditure for the basic research was smallest in China at 4.7%. In Japan and U.S., the values were 13.7% and 17.4%, respectively.

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 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, 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.

In Japan (and in Korea until 2006; all fields have been covered since 2007), only the field of natural science and engineering is covered by the measurement of total national R&D expenditure by type of R&D(8). Therefore the nominal total of national R&D expenditure by type of R&D is different from the actual total.

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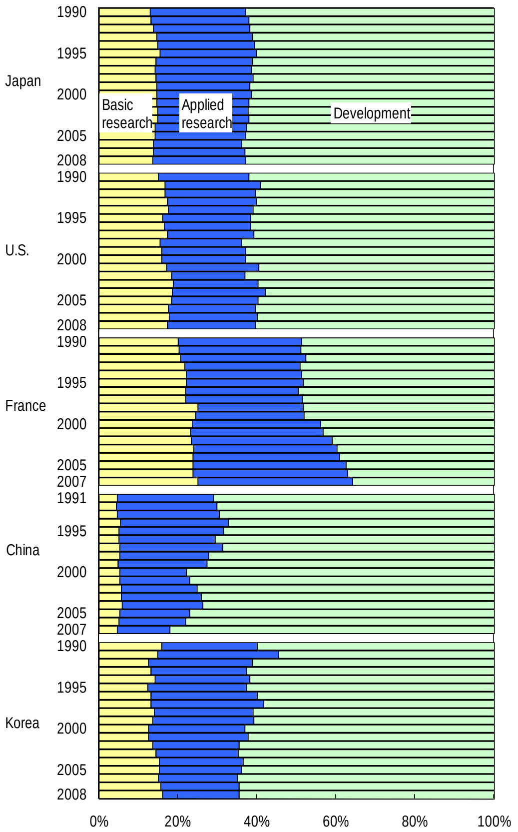
(8) The definition of R&D expenditure by type of R&D in Japan’s survey of R&D expenditure, the “Survey of Research and Development” is as follows, and only the field of science and engineering is covered.
Basic research: theoretical or experimental research in order to create hypotheses and theories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

Chart 1-4-1 shows the proportion of development by type of R&D. In Japan, although no significant change was observed in the long term, R&D expenditure for development is gradually tending to increase.

The proportion of basic research was largest in France and smallest in China. In France, that for applied research also accounts for a large proportion and is increasing. The proportion for development is large in every country, but the size was especially remarkable in China. China, together with Korea, is on the rise in R&D expenditure for development in the long term.

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

Attention to international comparison



Note: 1) In Japan (and Korea until 2006), R&D expenditure covers only the field of natural 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.
2) Figures for Germany are for basic research only.
3) Purchasing power parity equivalent is the same as that for Reference statistics E.
<Japan> Fiscal year is used as a year scale.
<U.S.> Values in 2007 is of preliminary.
Source: <Japan>The Ministry of Internal affairs and communications, "Report on the Survey of Research and Development".
<U.S.>NSF, “National Patterns of R&D Resources 2008 Data Update”
<France, China>OECD, “Research & Development Statistics 2009”
<Korea>Korea National Statistical Office, Statistical DB (web site)

(1) Basic research in each country

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

According to the trend of the proportion of basic research expenditure by performing sector (Chart 1-4-2), the university and college sector accounts for a large proportion in almost all the selected countries. Especially in France, approximately 70% of the total is used by the university and college sector.

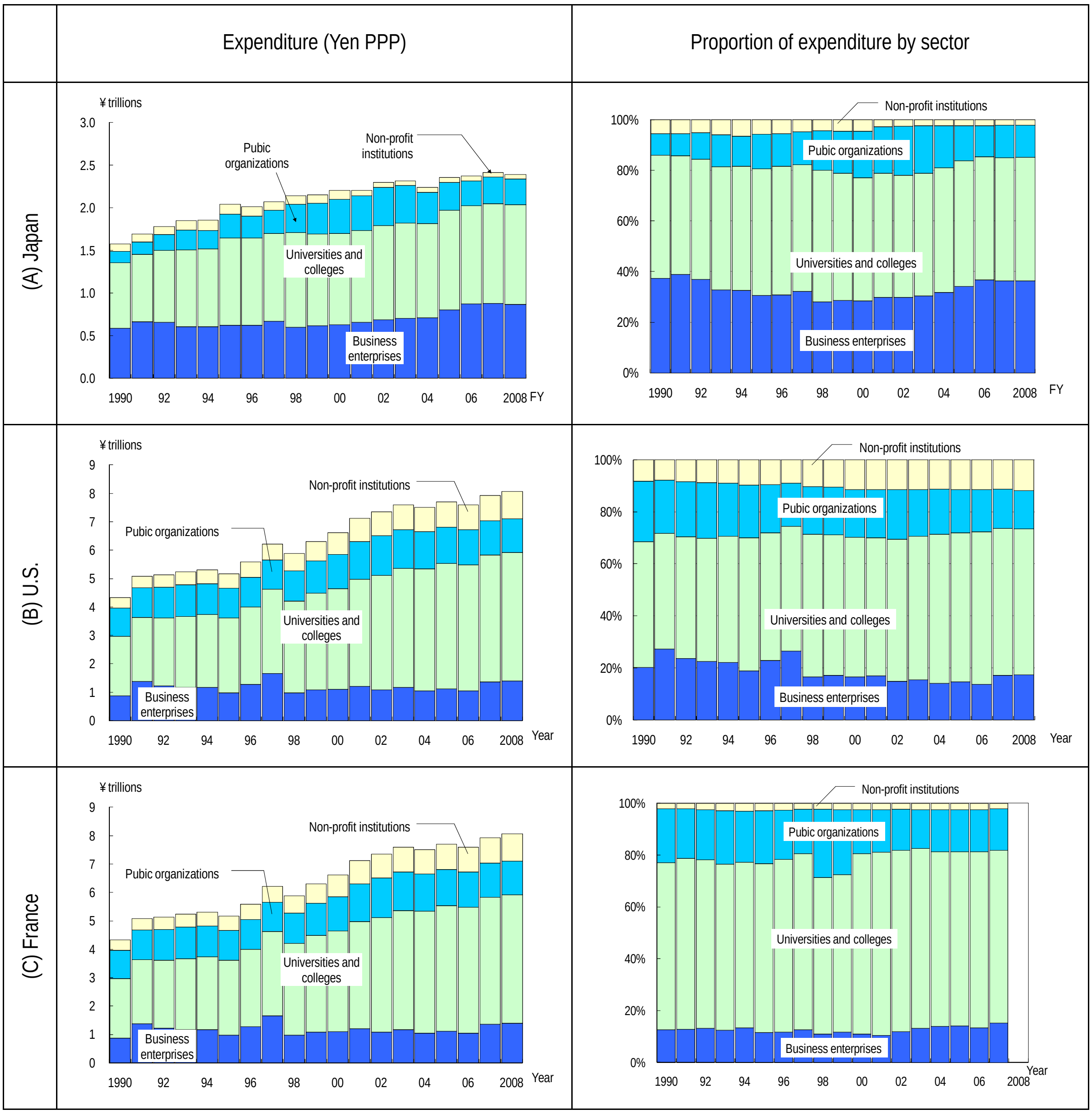
In Japan, the business enterprise sector accounts for a relatively large proportion of basic research expenditure. This proportion is even higher in Korea, where the business enterprise sector has rapidly grown to become the center of basic research since 2000.

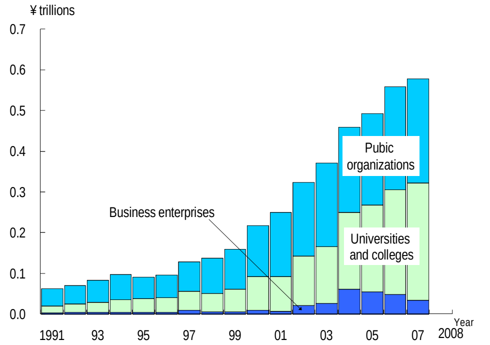
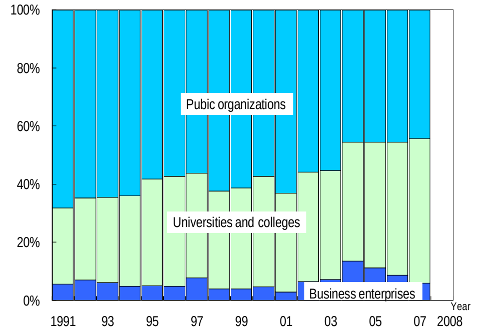
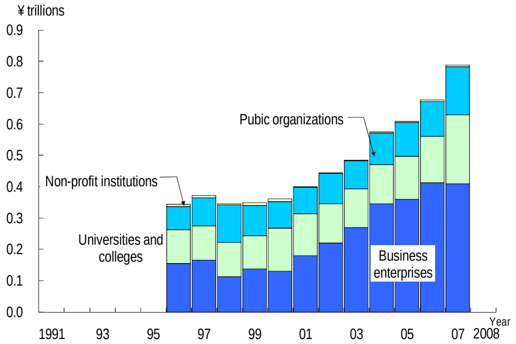
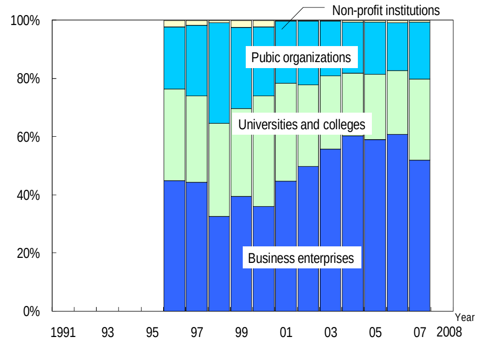
The country in which the public organization sector accounts for the largest proportion of basic research expenditure is China. This proportion in France and Korea is also large compared to other countries. With regard to France, discrepancies were found in the data of the public organization sector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

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

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

Attention to international comparison



	Expenditure (Yen PPP)	Proportion of expenditure by sector
(D) China		
(E) Korea		

Note: 1) In Japan (and Korea until 2006), R&D expenditure covers only the field of natural sciences and engineering. But R&D expenditure in other countries is the total of the field of natural sciences and engineering and of social sciences and humanities. Therefore it is necessary to be careful when international comparisons are made.
2) Purchasing power parity equivalent is the same as for Reference statistics E.
<U.S.> Values in 2007 are preliminary .
Source: <Japan> The Ministry of Internal Affairs and Communications. "Report on the Survey of Research and Development"
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<France, China and Korea>OECD, "Research & Development Statistics 2009"

1.4.2 R&D expenditure by type of R&D in each sector for each country

Key points

- ○With regard to R&D expenditure by type of R&D in the public organization sector, the R&D expenditure for development and for applied research account for big proportion in Japan, U.S. and China, and in France and U.K., respectively.
- ○With regard to R&D expenditure by type of R&D in the business enterprise sector, the expenditure for development accounts for 70% or more in Japan, U.S., China and Korea. Expenditure for applied research for approximately 40% in France and U.K.

(1) R&D expenditure by type of R&D in the public organization sector

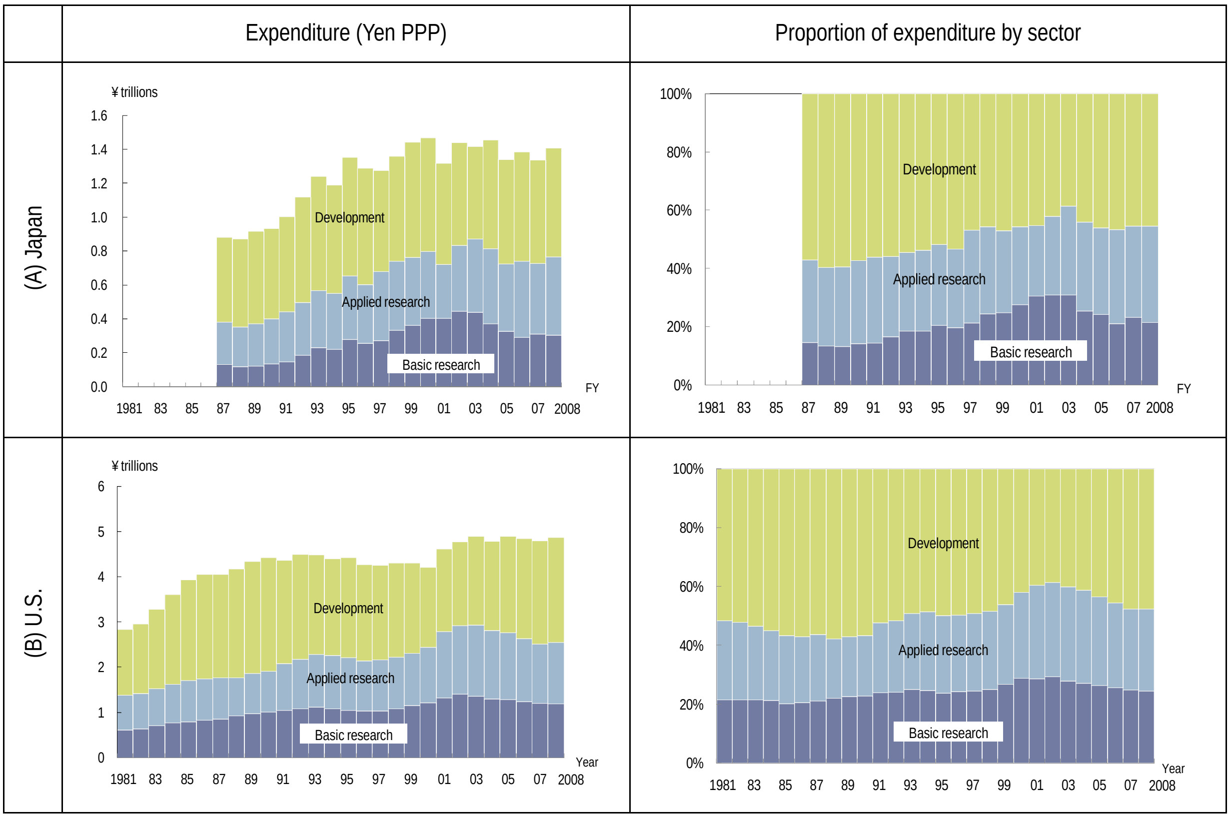
Among R&D expenditure by type of R&D in the public organization sector (Chart 1-4-3), the proportion of R&D expenditure for basic research has been on the rise in every country, but in recent years, the trend has become flat or begun to decline.

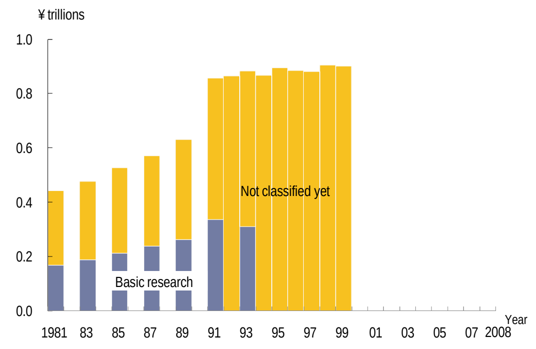
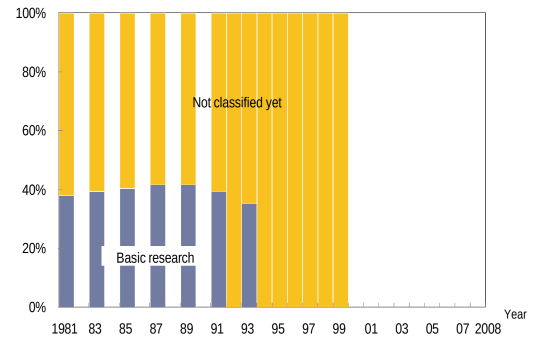
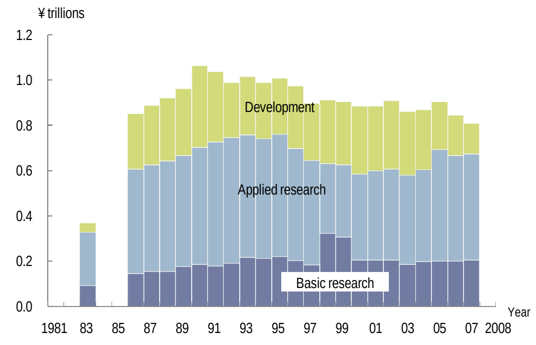
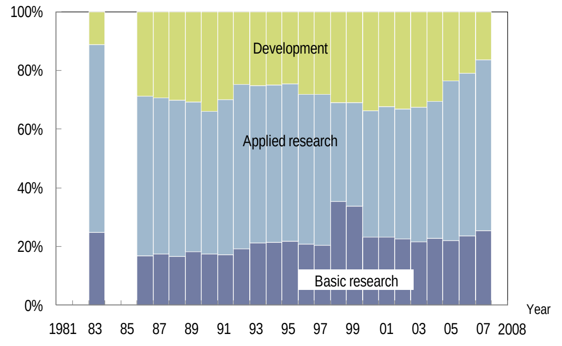
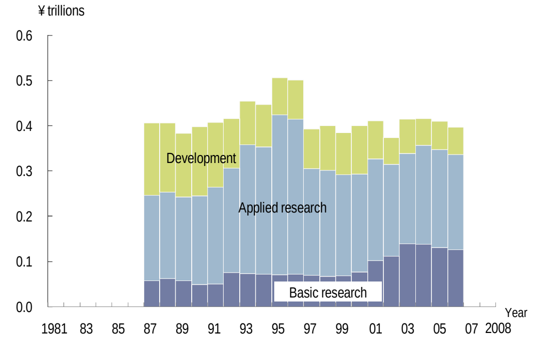
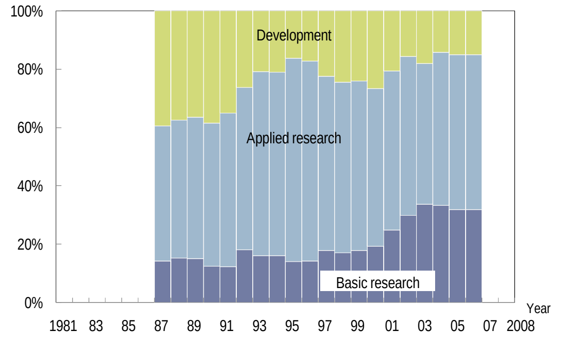
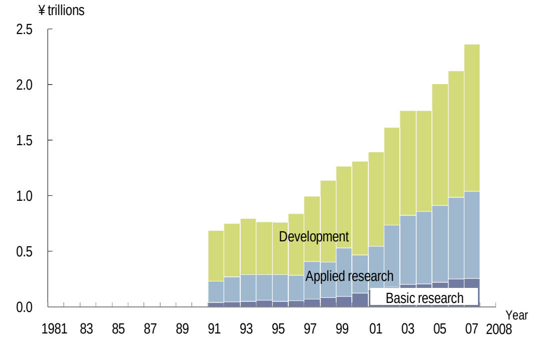
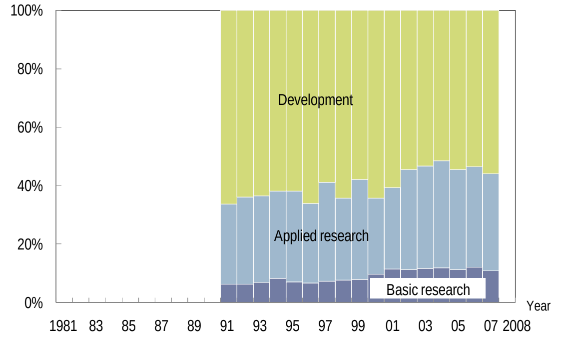
The proportion of R&D expenditure for development is large in Japan, U.S. and China compared to other countries.

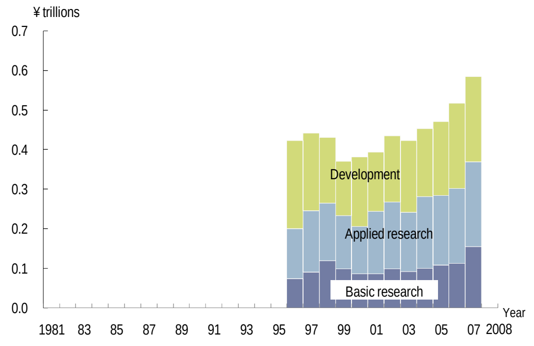
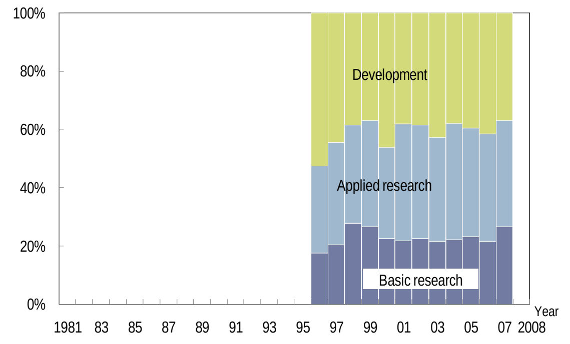
In France and U.K., R&D expenditure for applied research accounts for a large proportion of the total. Germany seems not to have surveyed R&D expenditure by type of R&D on its own. Because Germany has not published data on R&D expenditure by type of R&D, the OECD statistics were used in this section, although the values are limited to those until 1999.

Chart 1-4-3: R&D expenditure by type of R&D in the public organization sector for selected countries

⚠ Attention to international comparison



	Expenditure (Yen PPP)	Proportion of expenditure by sector
(C) Germany		
(D) France		
(E) U.K.		
(F) China		

	Expenditure (Yen PPP)	Proportion of expenditure by sector
(G) 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 that for the field of natural sciences and engineering and of social sciences and humanities. Therefore it is necessary to be careful when international comparisons are being made.
2) With regard to R&D expenditure, refer to Chart 1-1-4.
3) Purchasing power parity equivalent is the same as of Reference statistics E.
<U.S.>Values in 2008 are of preliminary budget amounts.
<Germany>1) West Germany until 1990 and unified Germany since 1991 respectively
2) Germany's data have not been included in materials published by the OECD since 2000.
<France>1) Change in the classification of the target for survey was made in 1991 （France Télécom and GIAT Industries were moved from the public organization sector to the business enterprise sector).
2) Method of statistics was changed in 1998 (method to estimate R&D expenditure in the field of defense).

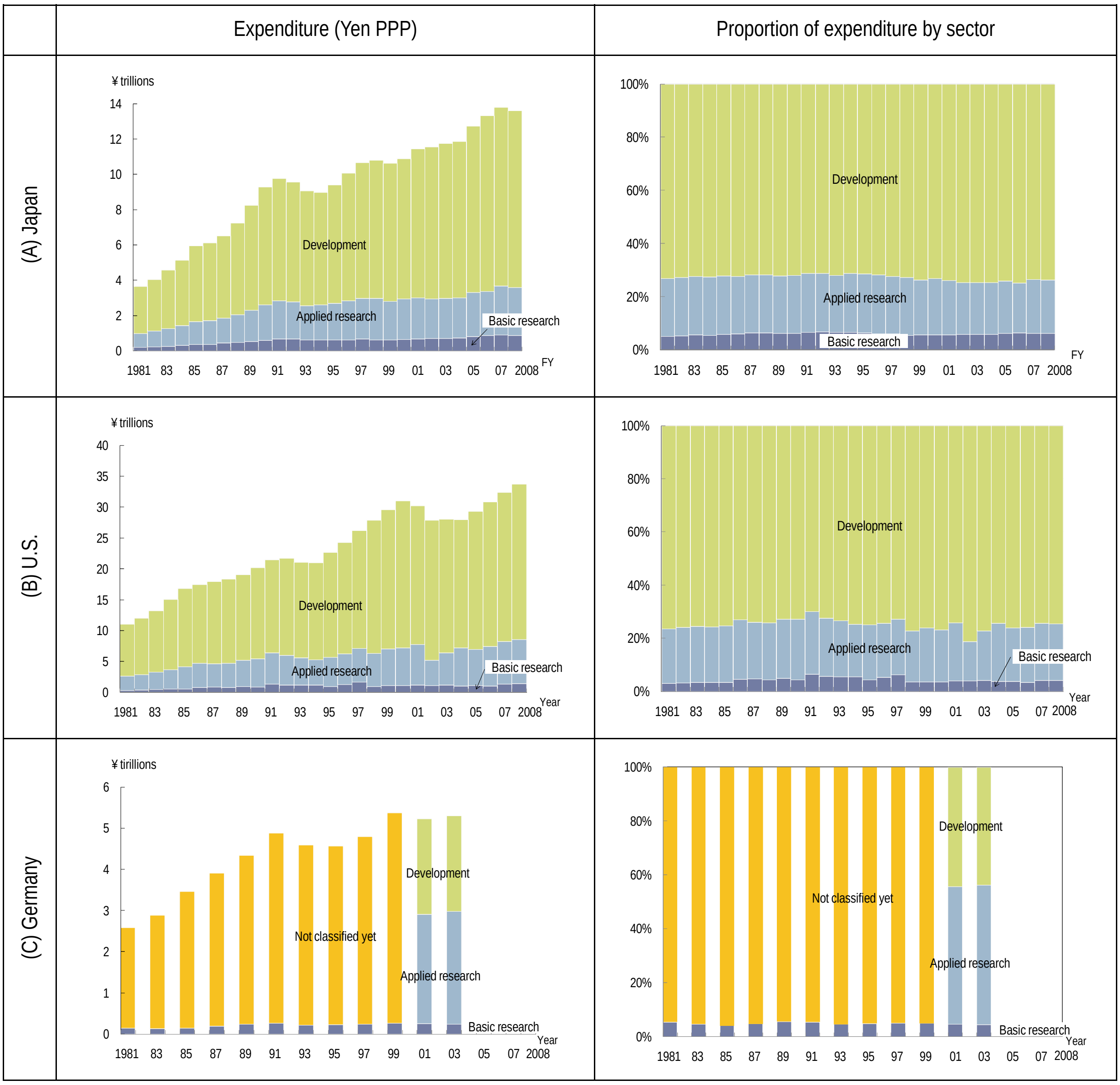
Source: <Japan>The Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development".
<U.S.>NSF, “National Patterns of R&D Resources 2008 Data Update”
<Germany, France, U.K., China and Korea>OECD, “Research & Development Statistics 2009”

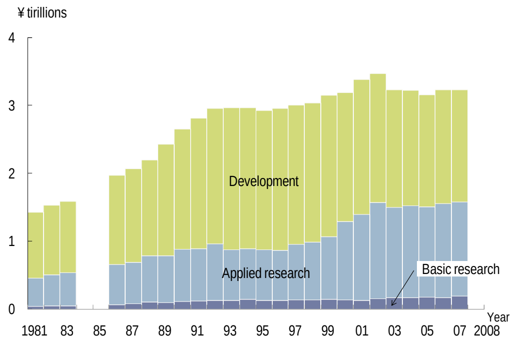
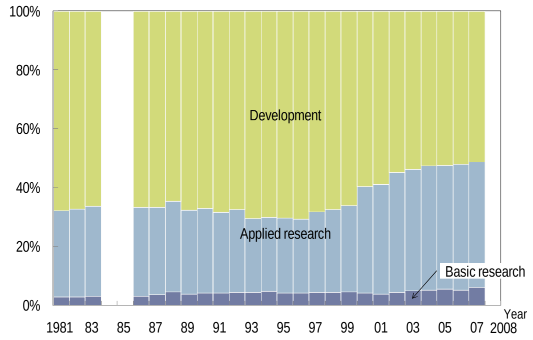
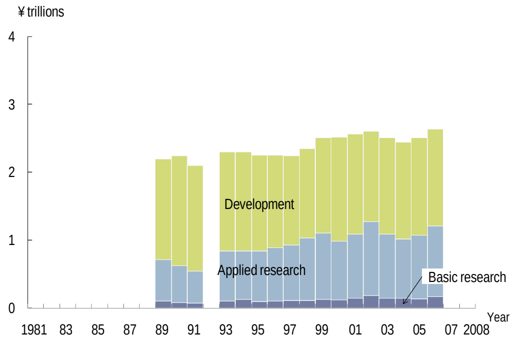
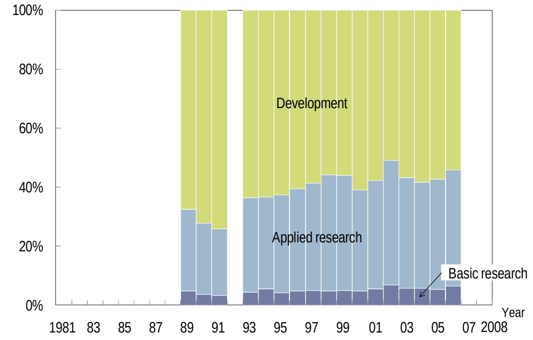
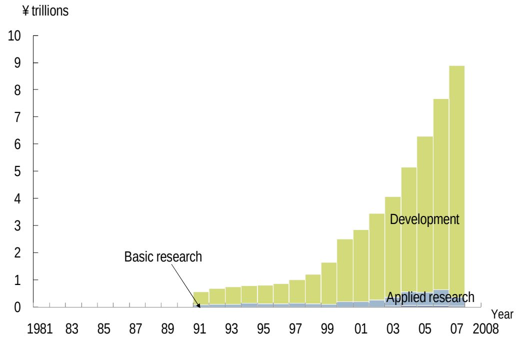
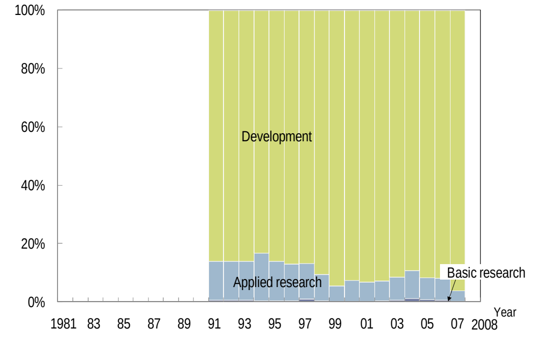
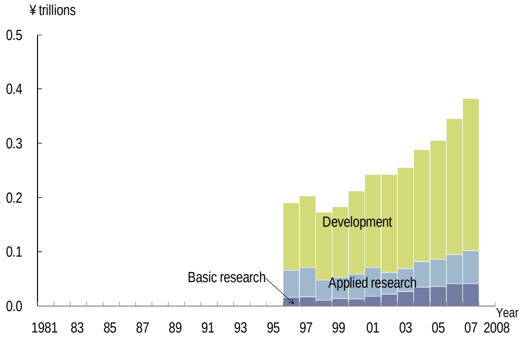
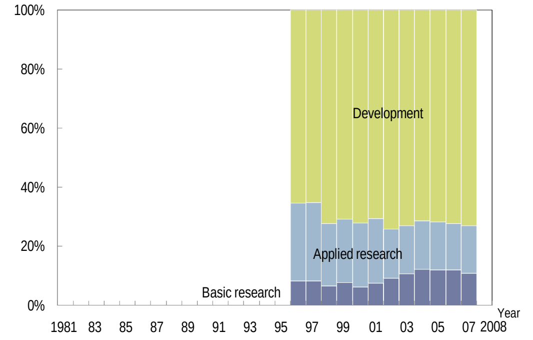
(2) R&D expenditure by type of R&D in the business enterprise sector

With regard to R&D expenditure by type of R&D in the business enterprise sector for each country (Chart 1-4-4), the proportion for development was large in almost all the selected countries. Among all, the proportion for development was the highest in China at approximately 90%, followed by Japan, U.S. and Korea at 70%. These proportions have not shown significant change in the long term.

The proportion for applied research has continued to increase in France and U.K. in recent years. And in all countries, the R&D expenditure for basic research accounts for an extremely small proportion of the total.

Chart 1-4-4: R&D expenditure by type of R&D in the business enterprise sector for selected countries (for all industries)



	Expenditure (Yen PPP)	Proportion of expenditure by sector
(D) France		
(E) U.K.		
(F) China		
(G) Korea		

Note: Purchasing power parity equivalent is the same as for Reference statistics E.
<U.S.>Values in 2008 is of preliminary.
<Germany>West Germany until 1990 and unified Germany since 1991, respectively.
<France>1) Change in the classification of the target for survey was made in 1991（France Télécom and GIAT Industries was moved from the public organization sector to the business enterprise sector).
2) Method of statistics was changed in 1998 (method to estimate R&D expenditure, method to evaluate the field of defense, method to evaluate R&D activities in large companies).

Source: <Japan >The Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.>NSF, “National Patterns of R&D Resources 2008 Data Update”
<Germany, France, U.K., China and Korea>OECD, “Research & Development Statistics 2009”

(3) R&D expenditure by type of R&D in the university and college sector

With regard to R&D expenditure by type of R&D in the university and college sector, basic research accounts for a large proportion of the total (Chart 1-4-5).

In Japan, no difference in trend was shown in the proportion of R&D expenditure for basic research, applied research and development. In other words, Japan’s university and college sector is consistent in the direction of its research.

In U.S., both the amount and the proportion of R&D expenditure for basic research is on the rise, while that for applied research and development is gradually reducing

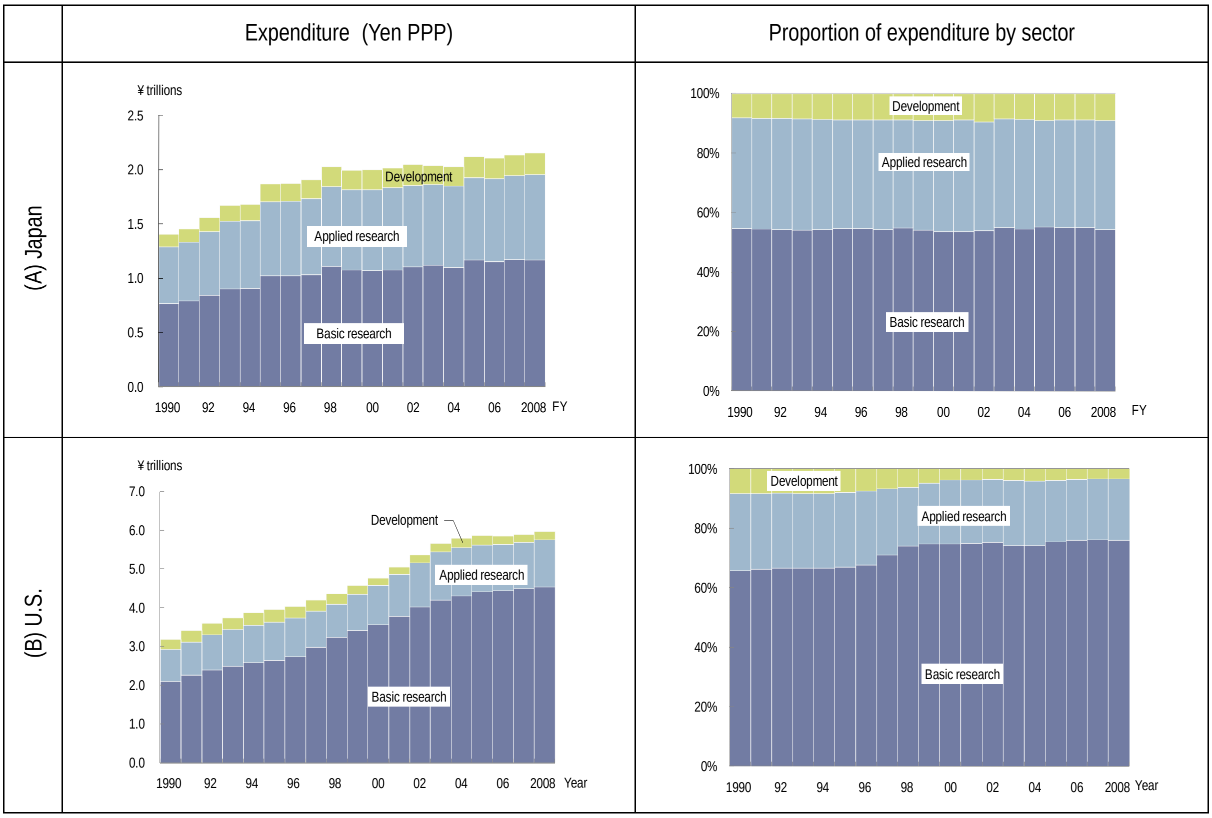
In France, R&D expenditure for basic research accounts for an overwhelmingly large proportion of the total, while that for development accounts for a very small proportion of the total, respectively.

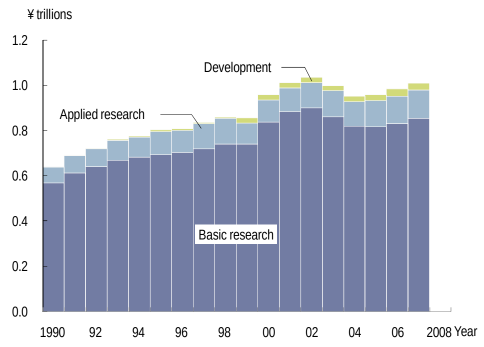
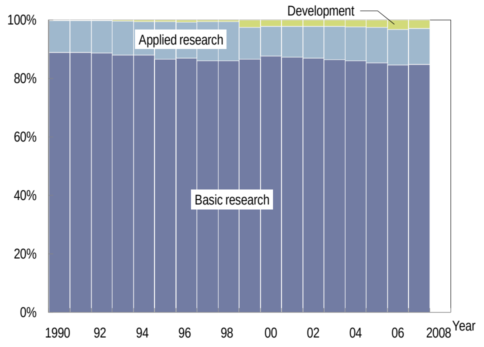
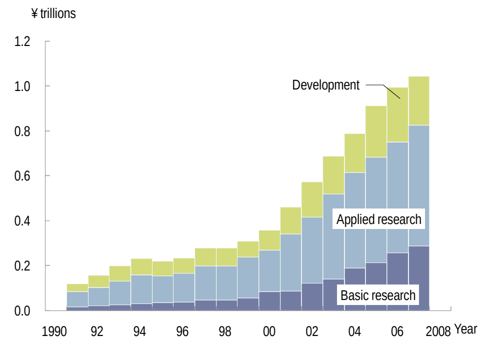
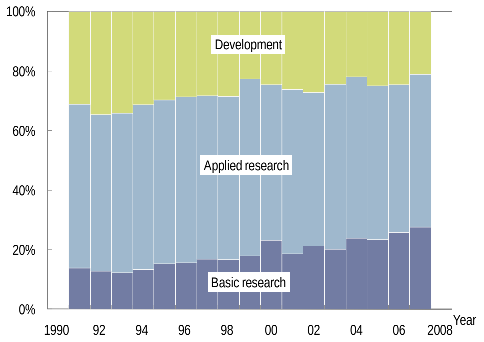
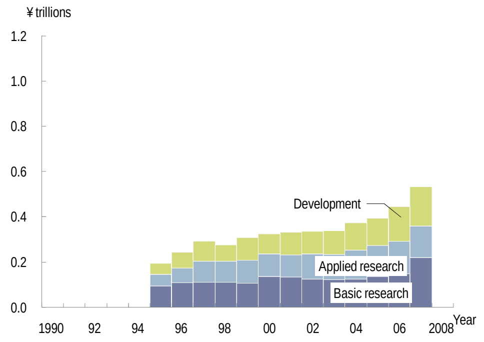
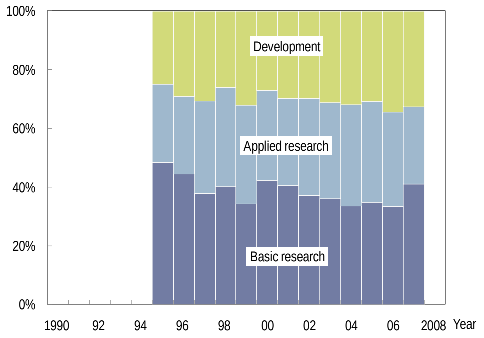
In China, the proportion of R&D expenditure for basic research is small, while that for applied research is large; however, the former is on the rise in the long-term.

In Korea, recently the proportion of each of the three types of research work are approximately the same each other. The proportion of R&D expenditure for basic research has been reducing.

Chart 1-4-5: R&D expenditure by type of R&D in the university and college sector in selected countries

Attention to international comparison



	Expenditure (Yen PPP)	Proportion of expenditure by sector
(C) France		
(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 that for the field of natural sciences and engineering and of social sciences and humanities. Therefore it is necessary to be careful when international comparison is being made.
2) Refer to Chart 1-1-4 for R&D expenditure.
3) Purchasing power parity equivalent is the same as for Reference Statistics E.
<U.S.> Values in 2007 is of preliminary.

Source: <Japan>The Ministry of Internal affairs and Communications, "Report on the survey of Research and Development".
<U.S.>NSF, "National Patterns of R&D Resources 2008 Data Update"
<France, China and Korea>OECD, "Research & Development Statistics 2009"

Chapter 2 ： R&D personnel

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

2.1 International comparison of the number of researchers in each country

Key points

○The definition and measurement of researchers in each country are conducted in line with the Frascati Manual. However, the actual methods used for the investigations are often different in each country. In particular, the university and college sector are excluded from the coverage of R&D statistical surveys in some countries. Also some countries set special conditions regarding the scope of the range of the surveys. Also there are countries which apply the full-time equivalent (FTE) method in surveying the number of researchers. And there are other countries which apply actual head counting (HC) for this purpose. Therefore, it could be said that there are many contributing factors which reduce the performance of the international comparability. In addition, in U.S., the number of researchers belonging to some sectors is not reported to the OECD. This forces the OECD to utilize estimated figures as a substitute. For the reasons given above, it is necessary to be careful in making international comparisons and trend comparisons of the number of researchers.

○In 2009, the number of researchers in Japan was a total of about 660,000, if the number of researchers working at universities and colleges is calculated by using the FTE method. The number is about 890,000 in the head count method. In recent years, the number of researchers in China has greatly increased. But the number of researchers per capita still lags behind compared to the other selected countries.

○If comparing the number of researchers by sector, in every country, the business enterprise sector has the largest proportion. On the other hand, when studying the number of female researchers by sector, the percentage hired by the business enterprise sector is small in every country.

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.

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(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.

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

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 clearly seen according to the country regarding the measurements of researchers working in the university and college sector.

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(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”.

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

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

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

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

Chart 2-1-2(A) shows the measurement method used until 2001, which was neither FTE nor HC, but a method of measuring the people 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 measuring 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.

As mentioned above, more than one method of measuring researchers is used in Japan. Therefore, figures found by these 3 types of methods will be given as the number of researchers. Since 2008,the FTE coefficient obtained through new FTE surveys is used (Chart 2-1-2 (C)).

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

(A) Until 2001

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

(B) 2002–2007

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

(C) After 2008

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

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

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

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

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

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

2.1.2 Trends in the numbers of researchers in each country

The number of Japan’s researchers in 2009 was 660,000 (people) and its HC value was 890,000 (people) respectively. In 2008, Japan converted to using FTE to calculate the number of researchers. Data continuity between 2007 and 2008 is therefore impaired.

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

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

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

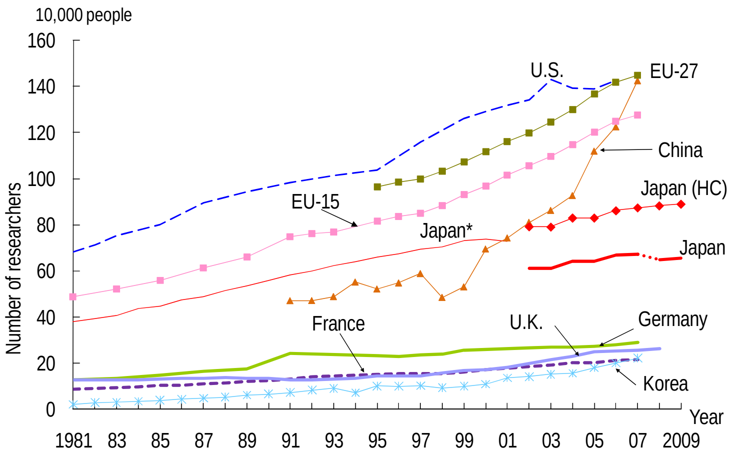
In U.K., because no statistical survey for R&D is conducted in the university and college sector, the total number of researchers since 1999 was calculated using the estimates by the OECD. Recently, however, U.K. has begun publishing the number of researchers. Figures have been available since 2005.

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

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

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

⚠ Attention to international comparison



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

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

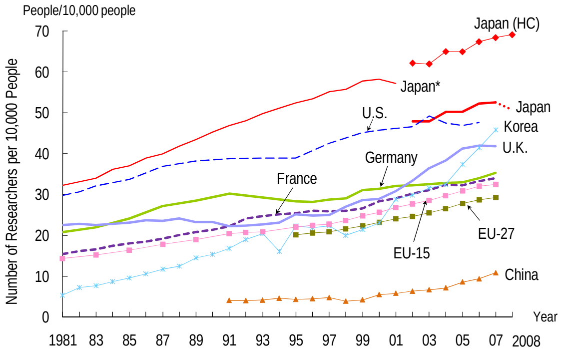
Next, an international comparison is conducted in which the influence of the size of each country is reduced by using the relative value of the number of researchers, in other words, the number of researchers per capita (Chart 2-1-4). As far as the period since 2002 is concerned, Japan's values have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

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

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

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

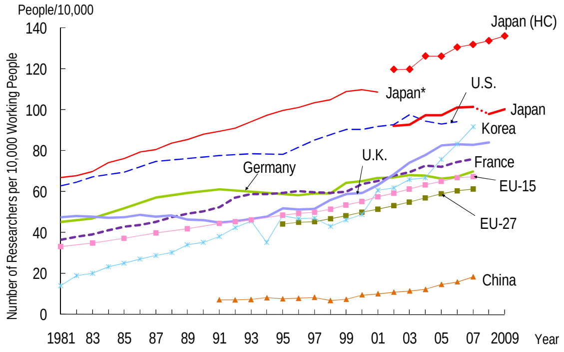
Attention to international comparison



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

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

Attention to international comparison



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

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

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

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

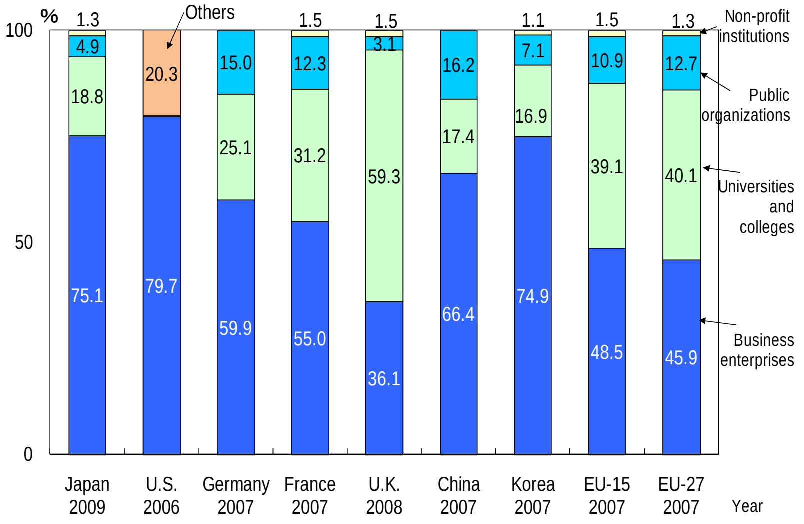
In each country except U.K., the number of researchers in the business enterprise sector accounts for the largest proportion of the total, followed by that in the university and college sector, the public organization sector and the non-profit institution sector.

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

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

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

Attention to international comparison



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

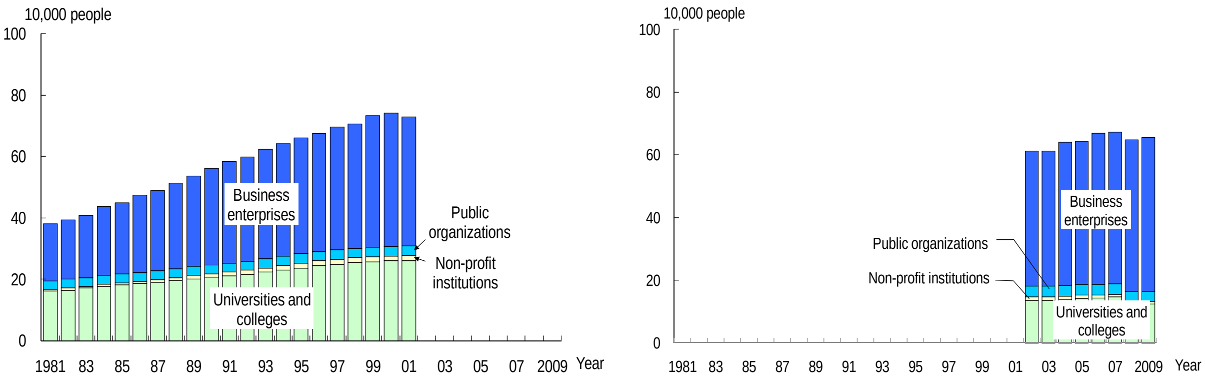
Source: <Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development”; MEXT, “Survey on the data for full-time equivalents in universities and colleges” (2002 and 2008)
<U.S., Germany, France, U.K., China, Korea and EU> OECD, “Main Science and Technology Indicators 2009/2”

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

Attention to international comparison

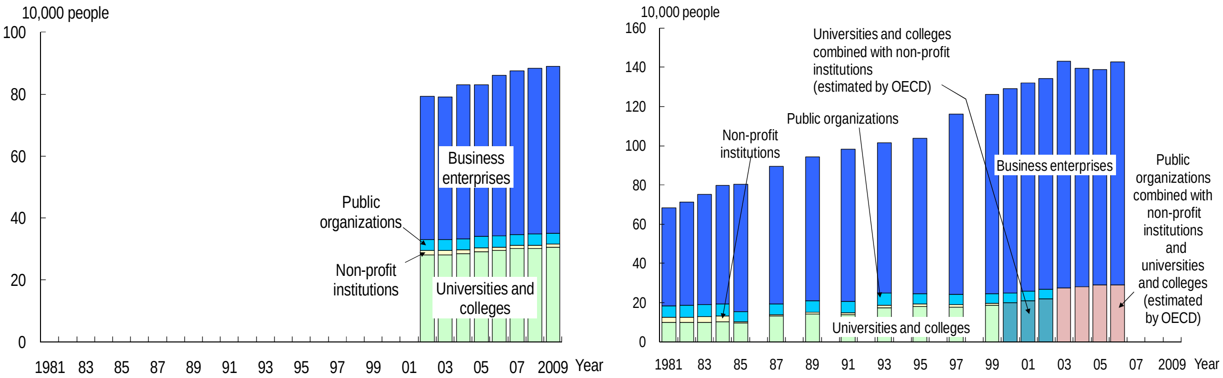
(A) Japan *

(B) Japan



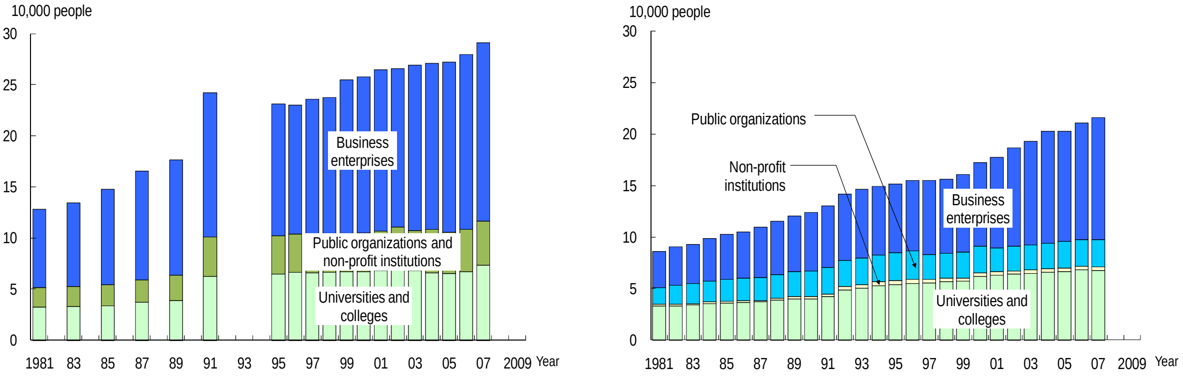
(C) Japan (HC)

(D) U.S.

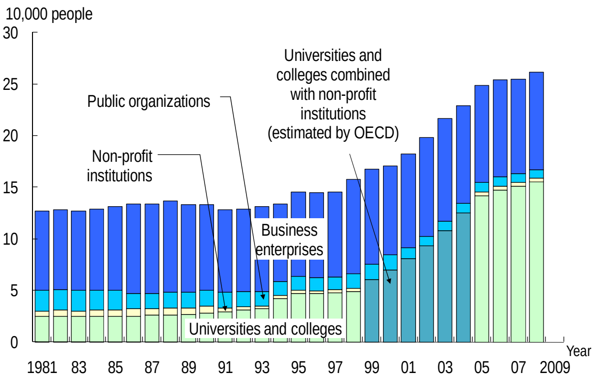


(E) Germany

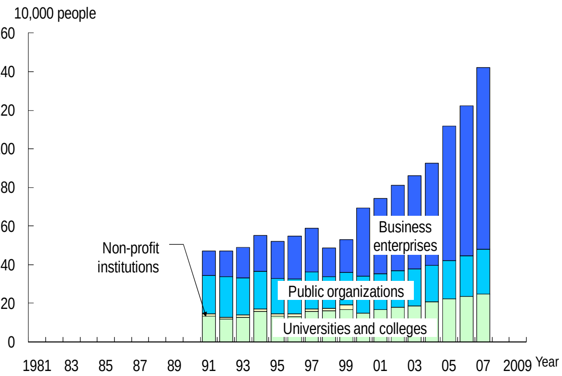
(F) France



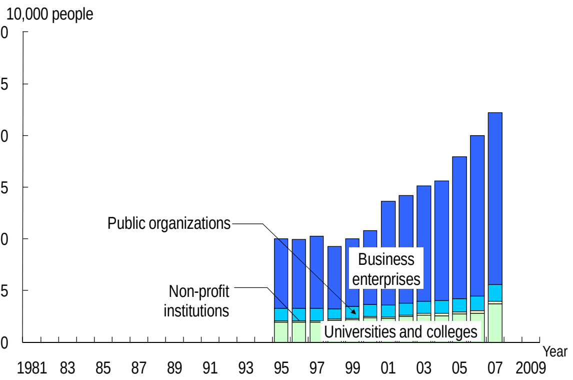
(G) U.K.



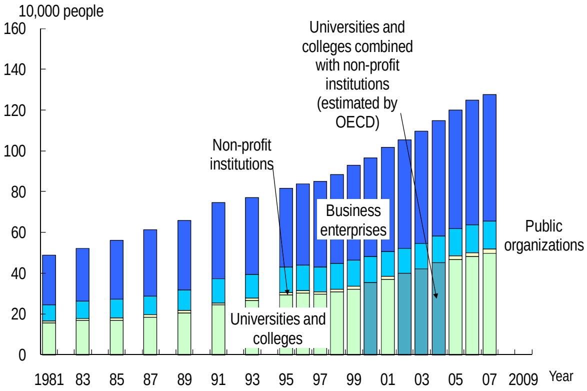
(H) China



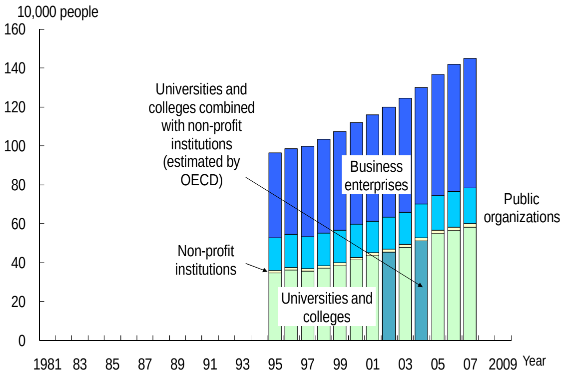
(I) Korea



(J) EU-15



(K) EU-27



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

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

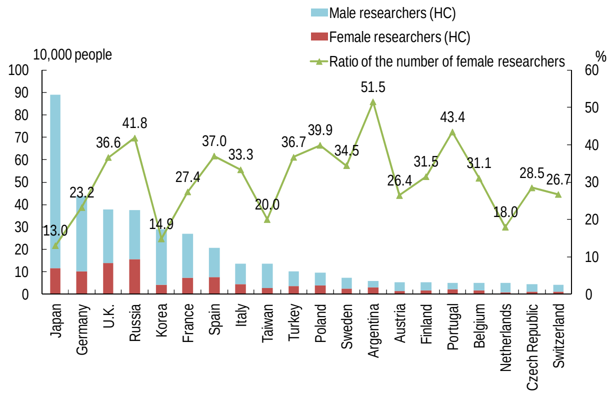
2.1.4 Female researchers in each country

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

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 U.S. and China. Figures for U.K. are estimates by that country.

The ratio of the number of female researchers against the total in Japan was 13.0% in 2009. This ratio was the smallest among the surveyed countries, but the number place Japan third behind Russia and U.K. (Chart 2-1-8).

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



Notes: 1) Data are for 2009 in Japan; for 2008 in Russia and the Czech Republic, for 2006 in France and Italy, for 2005 in the Netherlands, for 2004 in Switzerland and for 2007 for other countries and regions.
2) Values are on a head count basis.
3) Data for U.S. were not included in materials below
4) Value for U.K. is estimated.
5) Value for Russia is underestimated or based on underestimated data.
6) Value for the Netherlands is provisional.

Source: <Japan> Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<Others>OECD, "Main Science and Technology Indicators 2009/2"

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

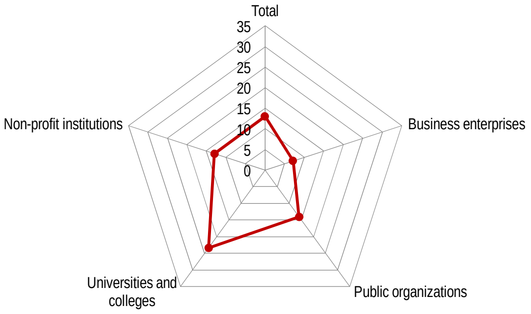
The data for U.K. in the university and college sector is estimated. In Germany, the data of the public organization sector and that of the non-profit institution sector were combined.

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

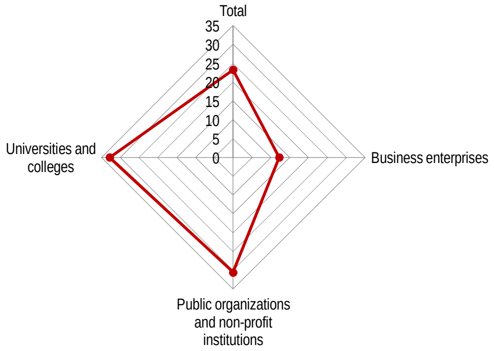
In Japan, the number of female researchers in the university and college sector accounted for 23.3% of the total in 2009. This value was larger than that of Korea. The number of female researchers in the business enterprise sector was lowest, accounting for 7.1% of the total. In this connection, positive activities by female researchers in the business enterprise sector are required in the future.

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

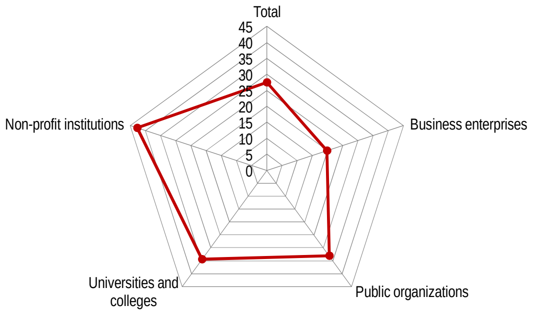
(A) Japan (2009)



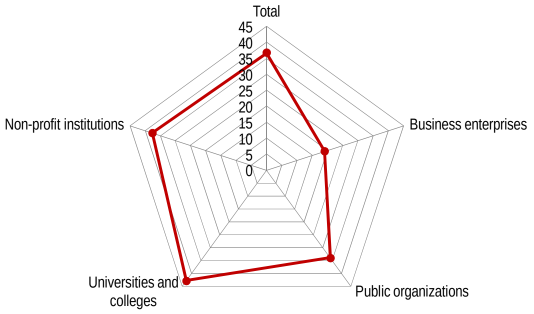
(B) Germany (2007)



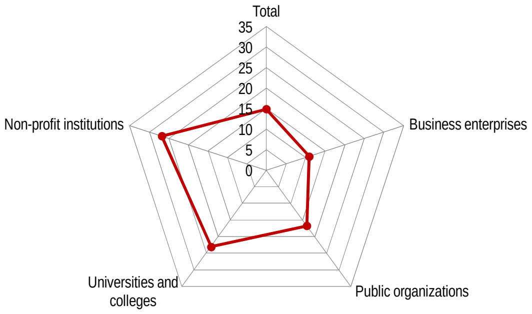
(C) France (2006)



(D) U.K. (2007)



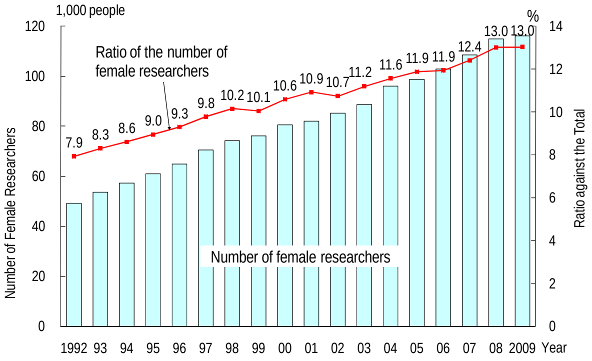
(E) Korea (2007)



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

Next, the number of female researchers in Japan and their ratio against the total was examined and the result in 2009 was 116,106 people and 13.0% respectively (Chart 2-1-10). Past trend shows the tendency of the number and the ratio of female researchers to rise. It is true that the number is not high compared to other countries; however, it can be predicted that the role of female researchers in Japan will advance with the development of knowledge-based society.

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



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

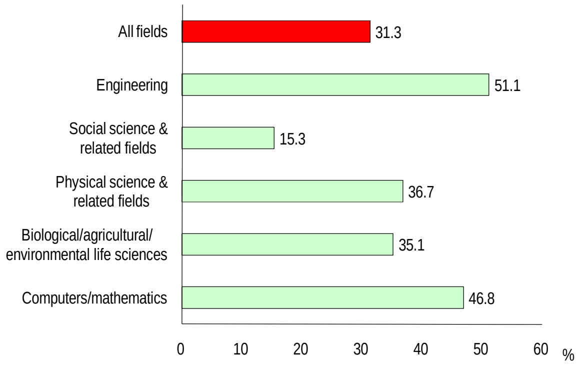
2.1.5 Doctoral degree holders

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

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

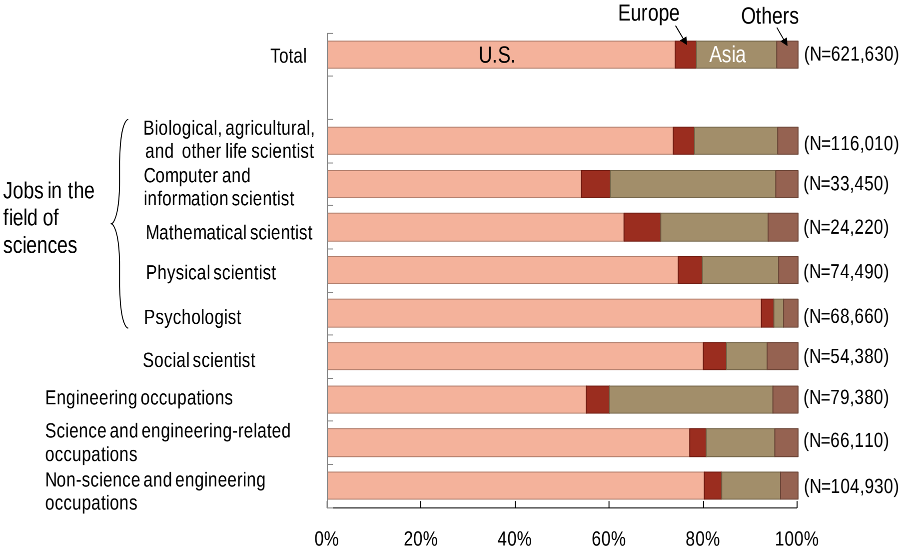
Next, which country and region doctoral degree holders came from and which specialized occupational fields they were employed in is examined. Understandably, U.S. born researchers account for more than half the proportion of each total in almost every specialized occupational field, and account for 74.0%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

Chart 2-1-11: Ratio of the doctoral degree holders from foreign countries against the total by specialized field of study in U.S. (2006)



Source: NSF, "SESTAT PUBLIC 2006" website

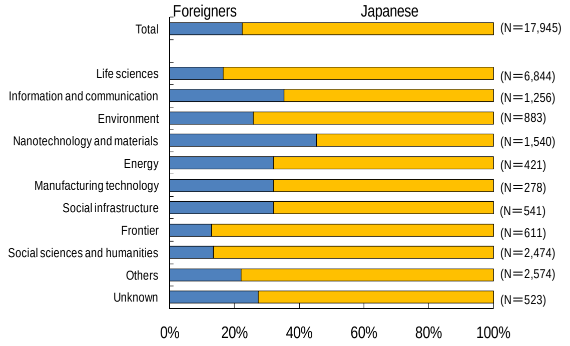
Chart 2-1-12: Status of employment for doctoral degree holders by country or region of origin in each occupational field (2006)



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

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

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



Notes: Positions for post doctoral fellows are for the employees under a fixed term contract, and composed of (1) employees engaged in research at university institutes, but not at the position of professor , associate/assistant professor, nor assistant, and (2)employees regularly engaged in research at research institutes run by independent administrative corporations etc, but not at the position of the leader of a research group nor senior research fellow, etc. (including those who obtained the required number of credits and then conditionally withdrew from school, i.e., so-called ABDs).
Source: NISTEP "Survey on Postdoctoral Fellows and Research Assistants (FY2007 and FY2008 Data)"

2.1.6 Mobility of researchers

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

The status of new graduate employment(4) and transfer, both to(5) and from the latest work place, of the researchers in Japan was examined (Chart 2-1-14). The number of researchers employed within the borders in 2009 was 73,829 people. Of these, the number of new graduates employed was 35,432 and the number of mid career recruits was 38,397, respectively. The former was 1.3 times and the latter was 1.4 times the figures for 2002.

According to a comparison by sector, in the business enterprise sector, the numbers for new graduate employment have been higher than those for mid career recruits. The former increased by 50% during the period from 2002 to the latest available year.

In the university and college sector, the number of mid career recruits has been higher than that of new graduates employed. The number of mid-career recruits increased by 50% in the same period.

In the non-profit institution sector combined with the public organization sector, the number of mid career recruits has been higher than that of new graduates employed. However, the number of mid-career recruits fell by 10% compared with 2002. In the business enterprise sector and the university and college sector, the number of new graduates employed and mid career recruits was higher than the number transferring to other sectors. On the other hand, in the non-profit institution/public organization sector, the number of new graduates employed and the number of mid-career recruits gradually declined.

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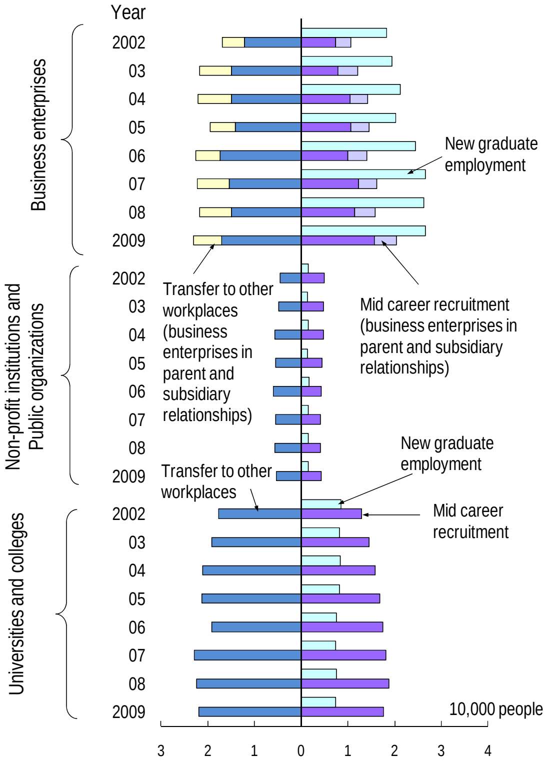
(4) The new graduate employment represents so called new university graduates. Casual and part time workers as well as temporary workers at universities or research institutes are included.
(5) People transferred from the latest workplace include retired people.

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



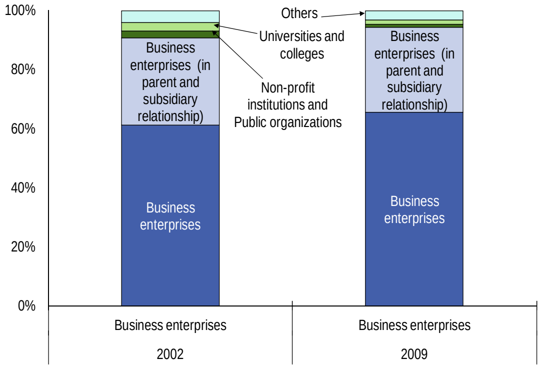
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

In this connection, the sectors of the people who were employed as mid career recruits are examined by former affiliated sector by comparing the data from 2002 and that for the latest year for each sector where they were affiliated in 2009 (Chart 2-1-15).

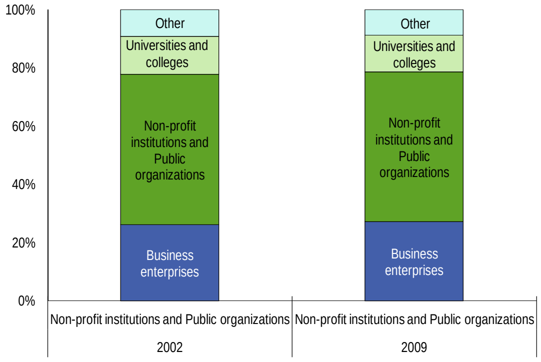
In 2009, the number of researchers transferred from the business enterprise sector accounted for a significantly large proportion, 94.3%, of the total number of researchers transferred to the same sector. Also in the non-profit organization sector combined with the public organization sector, the number of transferred researchers from the same sector accounted for the largest proportion, 57.5%, of the total number of the transferred researchers. In the university and college sector, the proportion was 41.6%. In each sector, the ratio of the number of transferred researchers from the same sector in 2009 accounted for a large proportion, and it has increased since 2002. With regard to transfers from other sectors, the proportion of the number of researchers from the non-profit institution sector and from the public organization sector accounted for the largest in the university and college sector. And those from the business enterprise sector were the largest in the non-profit institution and public organization sector.

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

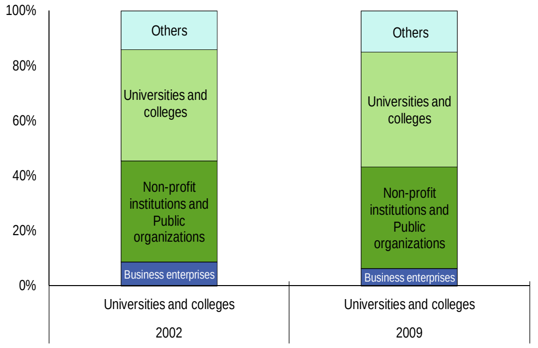
(A) Business enterprises



(B) Non-profit institutions and Public organizations



(C) Universities and colleges



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

2.2 Researchers by sector

Key points

○The number of researchers in the public organization sector can significantly change due to the privatization of public organizations and depending on changes to the scope of the statistics for R&D.

○The number of researchers in the public organization sector per 10,000-person population in the latest available year was 5.3 in Germany, which was the highest value, followed by 4.2 in France. Japan's value was 2.6. 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 U.S., whose data did not include the number of researchers in local governments, was 1.7.

○Looking at the numbers of researchers in the business enterprise sector, Japan and U.S. show a rising trend over the long term, while China in recent years has shown a sharp upward trend. In Germany and U.K., numbers have been flat. 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 U.S. was approximately 60% to 40%. The trends of both countries are different in this way.

○The number of researchers in the university and college sector in Japan in accordance with the statistics by the OECD was extremely large compared to other countries (180,000 people (2006) in Japan, while 190,000 people (1999) in U.S.). But if the number of researchers in the university and college sector is measured using the statistics for education, the value is not necessarily extremely large (250,000 people in Japan compared to 740,000 people in U.S. (both in 2006)).

2.2.1 Researchers in the public organization sector

(1) Researchers in public organizations in each country

Below is a summary of what "public organizations" in this section represent. Bearing in mind the differences for each country, the number of researchers in public organizations by country is examined.

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 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 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.

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

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

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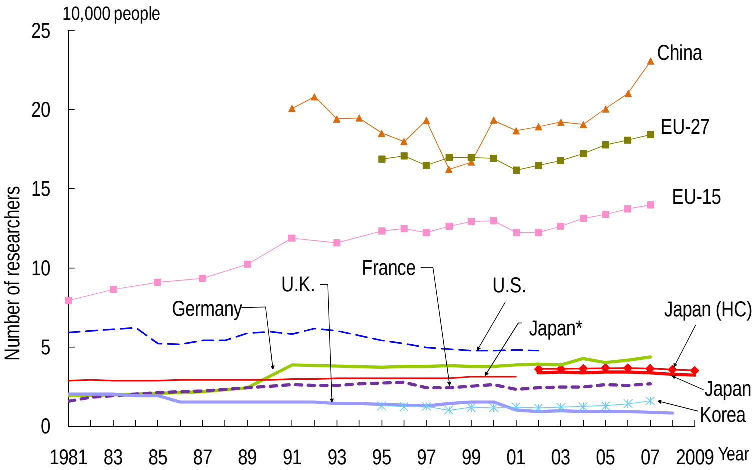
(6) The Defense Evaluation and Research Agency (DERA).

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

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

Attention to international comparison



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

(Unit: people)

Country (Year)	
Japan (2008)	2.56
U.S. (2002)	1.66
Germany (2007)	5.30
France (2007)	4.16
U.K. (2008)	1.33
China (2007)	1.75
Korea (2007)	3.27

Notes: 1) The definition and measurement method of researchers in the public organization sector is different depending on country. Therefore it is necessary to be careful when international comparisons are being made. Refer to Chart 2-1-1 for the definition of researchers in each country.
2) FTE values were used.
3) Values include the number of researchers in social sciences and humanities (only in natural sciences and engineering in Korea through 2006).
<Japan>1) National and public research institutes, special corporations and independent administrative corporations.
2) Refer to Chart 2-1-3 for researchers.
<U.S. >1) The federal government only.
2) Out of "federal scientists and engineers", only researchers who are mainly in charge of "research" and "development" as their work have been measured since1998.
3) A part of the Department of Defense has been excluded since 2003.
<Germany>1) The federal government, non-profit institutions (organizations which receives 160,000 Euros or more as public funds), legally independent university research institutes and research institutes run by local governments (Equivalent of local governments).
2) Former West Germany and unified Germany until 1990 and since 1991 respectively.
<France>Scientific and technical research establishment "Etablissement public a caractere scientifique et technologique" (other than CNRS), commercial and industrial research public establishment "Etablissement public a caractere industriel et commercial", administrative research public establishment "Etablissement public a caractere administratif" (other than higher education institutions) and departments and agencies belonging to ministries.
<U.K. >The central government (U.K), decentralized governments (Scotland etc.) and research councils.
<China>Research institutes run by the government.
<Korea>National and public research institutes, government supported research institutes and national and public hospitals.

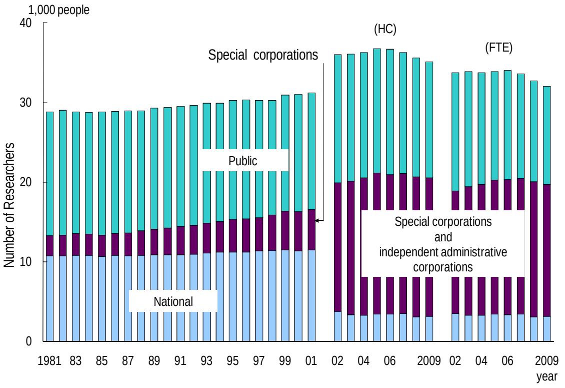
Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"; MEXT, "Survey on the data for full-time equivalents in universities and colleges" (2002 and 2008)
<U.S.>NSF, "National Patterns of R&D Resources 1995, 1998, 2002 Data Update"; from 2000,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

(2) Researchers in the public organization sector in Japan

It should be noted that in Japan's public organization sector, part of the "national" research institutes turned into independent administrative corporations in 2001 (furthermore, part of the "special" corporations also turned into independent administrative corporations in 2003). As a result, data since 2002 has had no continuity with the previous data. Given this background, the number of Japan's researchers in the public organization sector was 32,050 people in total in 2009. When examined by type of organization, the number of researchers in "special and independent administrative corporations" accounts for half of the total or 16,606 people, while that in "public" research institutes accounts for approximately 40% of the total or 12,335 people, and that in "national" research institutes accounts for slightly less than 10% of the total or 3,109 people (Chart 2-2-2).

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

Attention to trend



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

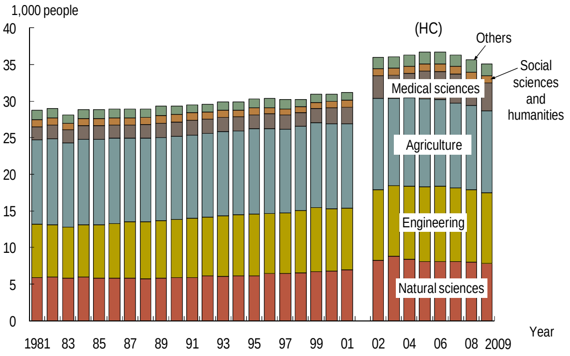
Source: Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"

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

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

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

(A) Trend in the number of researchers



(B) Affiliations of researchers by specialty (2009)

(Unit: People)

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

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

2.2.2 Researchers in the business enterprise sector

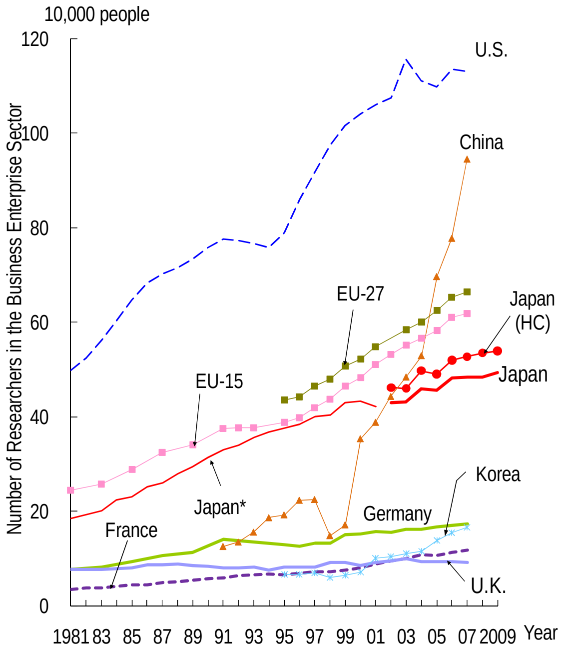
(1) Researchers in the business enterprise sector in each country

The number of researchers in the business enterprise sector is measured by statistical survey on R&D in every selected country. Therefore, the data for this sector is considered to be 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.

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

In France and U.K., part of public organizations were privatized and transferred into the business enterprise sector. Accordingly, the number of researchers in the previous affiliations was added to that in the business enterprise sector although this change is not that noticeable due to the fact that the initial number of researchers in the business enterprise sector already accounts for large proportion (Chart 2-2-4).

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



Notes: FTE values were used.

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

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

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

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

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

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.> NSF, "National Patterns of R&D Resources 1995, 1998, 2002 Data Update"; OECD, "Main Science and Technology Indicators 2009/2"
<Germany>Bundesministerium für Forschung und Technologie, "Bundesbericht Forschung" 1996, 2000, 2004, "Bundesbericht Forschung und Innovation 2007, 2008"; OECD, "Main Science and Technology Indicators 2009/2" for the data since 2007
<France, U.K., China, Korea and EU> OECD, "Main Science and Technology Indicators 2009/2"

(2) Researchers by industry in each country

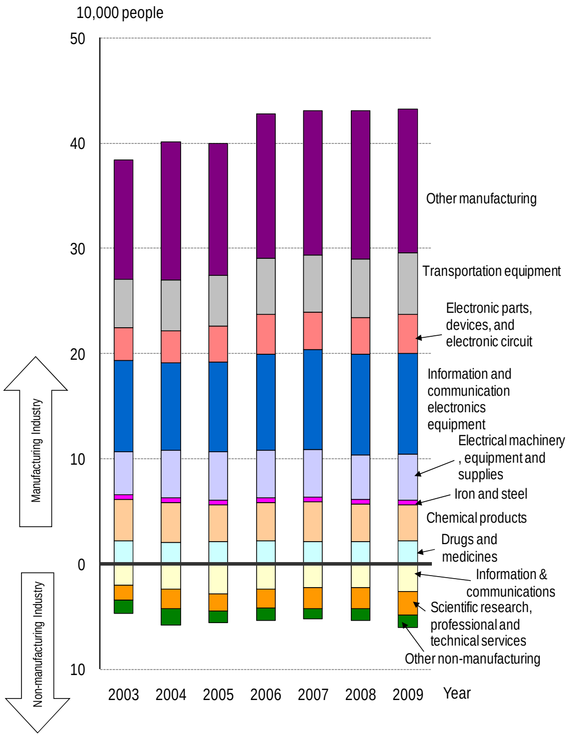
Chart 2-2-5 shows the number of researchers by industry in various countries. Industrial classification in this section represents what each country established for the statistical survey of R&D in the business enterprise sector referring to standard industrial classifications. Standard industrial classifications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

Given the background mentioned above, by examining the number of researchers by industry in Japan, 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 greatly influenced by the manufacturing industry. In the non-manufacturing industry, no significant change was shown. In U.S., the number of researchers in non-manufacturing industry is remarkably large compared to that in Japan and Germany. In Germany, values are growing both in the manufacturing and non-manufacturing industries.

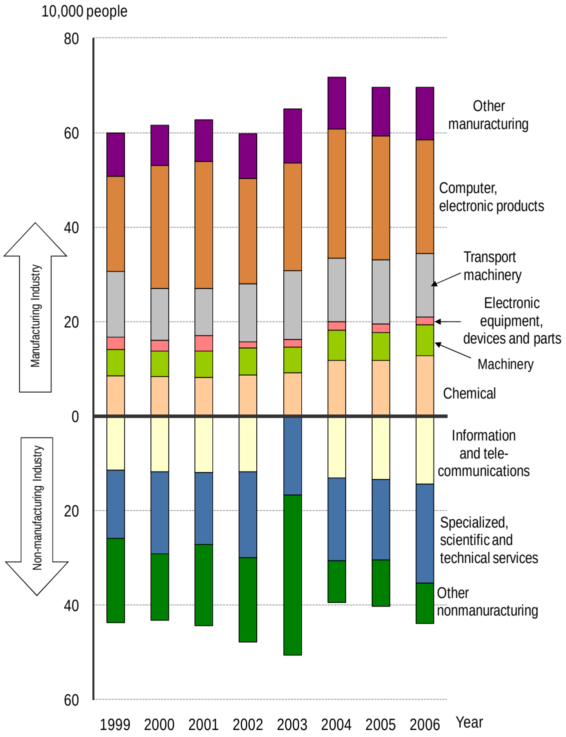
It should be noted that in Germany, the “software industry” and “R&D”, etc. are classified into “real estate, lease and business activities”. Variations in standard industrial classifications like this example should be taken in to account.

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

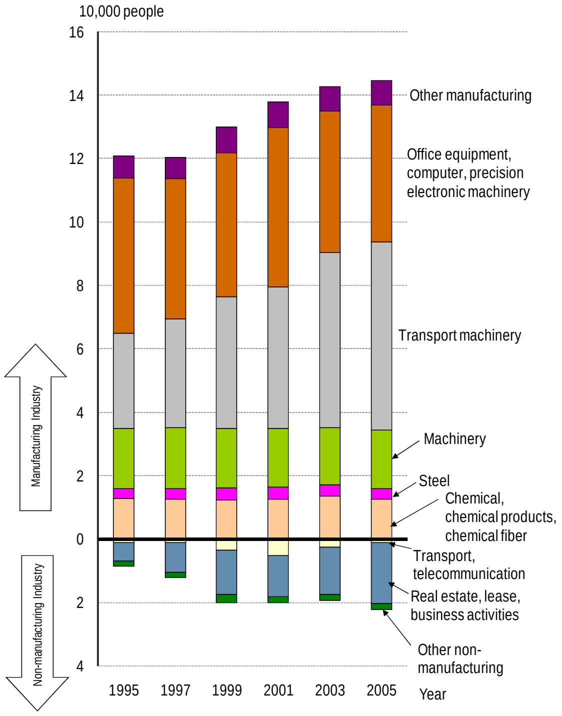
(A) Japan



(B) U.S.



(C) Germany



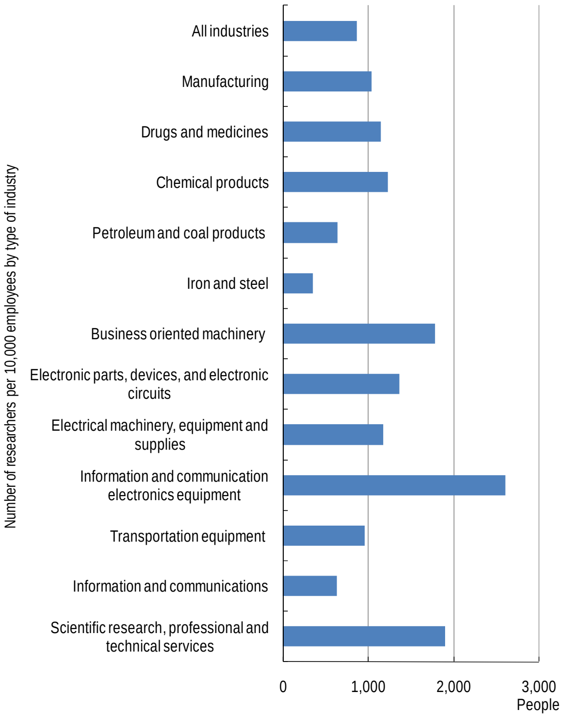
Notes: Same as for Chart 2-2-4.
Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development"
<U.S.>NSF, "Industrial R&D for each year"
<Germany>BMBF, "Research and Innovation in Germany 2007", "Bundesbericht Forschung und Innovation 2008"

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

The number of researchers per 10,000 employees (whether or not researchers) was examined in some types of industries picked up in order to understand which types of industries and enterprises employ researchers in Japan. The top position was for the industry of "information and telecommunication machinery and equipment" which has 2,603 researchers followed by the industry of "academic research, specialized and technical service" which has 1,893 researchers (Chart 2-2-6).

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

Chart 2-2-6: Number of researchers per 10,000 employees by type of industry in Japan (2009)



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

2.2.3 Researchers in the university and college sector

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

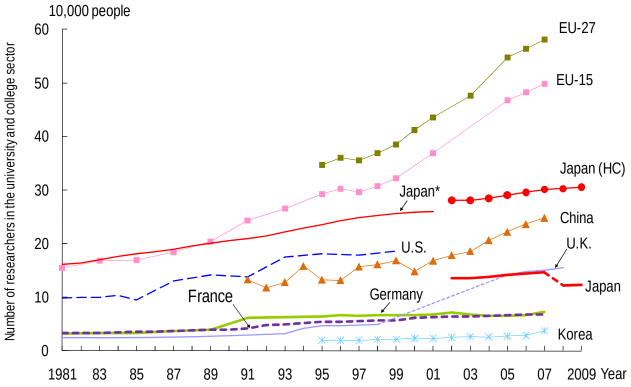
With regard to researchers in the university and college sector, international comparison is difficult. The details were described in 2.1.1., and the main points which should be noted are restated below.

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

Given the above, next the trend over time by country is examined. In Japan, the number of researchers in the university and college sector was approximately 123,000 people in 2009. In Germany, the data since 1991 is influenced by the 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). In France, the number of researchers has been consistently on the rise. In China, the number of researchers has rapidly increased since 2000. The influence of the policy on science and technology (985 programs) is considered to be substantial to this increase. In Korea, the number of researchers is on the rise although the values themselves are small (Chart 2-2-7).

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

Attention to international comparison



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

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

(2) International comparison of the number of researchers in the university and college sector

It is true that an international comparison of researchers in the university and college sector is difficult as mentioned above, and inconsistency exists among the figures announced by each country.

The National Institute of Science and Technology Policy examined ways of improving international comparisons in "Comparative Analysis of R&D Inputs and Outputs between Japan and major countries", one of its projects for "Follow-up Studies for Third Science and Technology Basic Plan" in 2008. From this material, part of the data on researchers in the university and college sector is shown below.

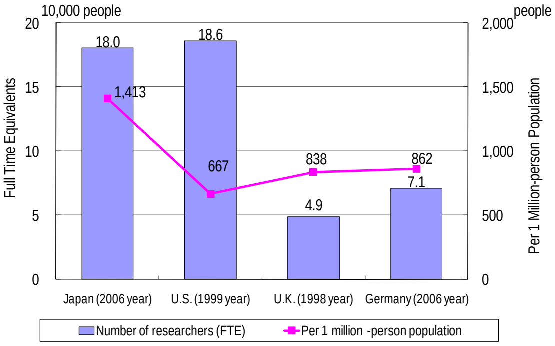
Chart 2-2-8 (A) shows the number of researchers in the university and college sector (FTE) (left axis) and that per 1 million-person population (right axis) publicly announced by the OECD. According to the data, although some inconsistencies among the year of survey exist, the number of researchers in Japan was extremely large and the ratio to population was almost twice larger than the ratio in U.S.

Next, Chart 2-2-8(B) shows the number of researchers in the university and college sector estimated in accordance with each country's statistics on education. The values in this figure are the result of estimates in accordance with Japan's measurement method of the number of researchers in the university and college sector; in other words, the values were obtained after extracting the data for the breakdown of "regular researchers" which appeared in the "Survey of Research and Development" ("teachers", "doctor course students", and "medical staff and others") from the statistics on education for each country$^{(7)}$

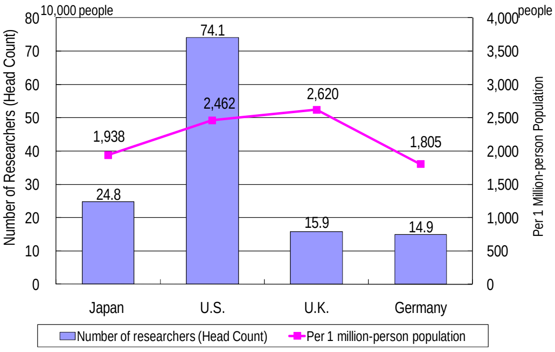
The latter Chart shows that the number of researchers in Japan is approximately one third of that in U.S. Also, the number of researchers per 1 million-person population is approximately 2,000 to 2,500 people in each country. It is apparent that Japan does not have an especially large number of researchers compared to other countries.

Chart 2-2-8: Number of researchers in the university and college sector

(A) The number of researchers based on the data by OECD (FTE)



(B) The results of the estimate of the number of researchers in accordance with the statistics on education (2006)



Source: NISTEP, "Comparative analysis of R&D inputs and outputs

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(7)The following materials were used as statistics on education for each country.
Japan: MEXT, "Report on School Basic Survey"
U.S.: The Integrated Postsecondary Education Data System (IPEDS),
U.K.: The Higher Education Statistics Agency (HESA)
Germany: The Federal Statistical Office (Personal an Hochschulen)

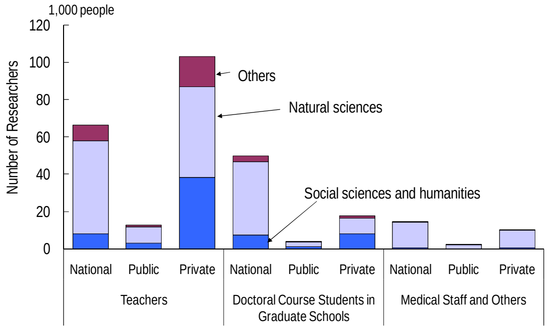
(3) Researchers in the university and college sector in Japan

Chart 2-2-9 shows the number of researchers in the university and college sector in Japan by type of researcher, by type of organization, and by academic field of study in Japan. The number of researchers in the university and college sector in this section represents the number of "regular researchers" as stated in the "Report on the Survey of Research and Development", which does not cover external non-regular researchers.

The value of the total was 279,766 people on March 31, 2009, and 65.1% of those or 182,067 people are teachers. The number of researchers in the university and college sector includes "doctoral course students in graduate schools (71,529 people)" and "medical staff and others (26,170 people)". In these statistics, almost all the teachers in universities are measured as researchers(8).

The number of researchers in "private universities" accounts for a large proportion of those categorized as "teachers" and the number of researchers in "national universities" accounts for a large proportion of those categorized as "doctoral course students in graduate schools". More detailed examination shows that the number of researchers of the field of "natural sciences" accounts for the great majority of those in "national universities" and also of "doctoral course students in graduate schools". On the other hand, compared with national and public universities, the number of researchers in the field of "social sciences and humanities" accounts for great proportion of that in the "private universities", and the huge number of researchers in "private universities" was due to the large number of researchers in these fields.

Chart 2-2-9: Breakdown of the number of researchers in the university and college sector in Japan (2009)



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

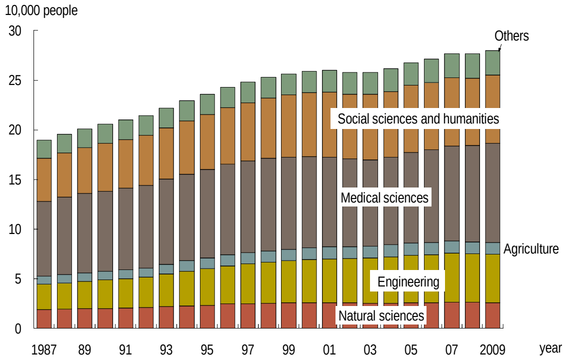
Next, the trend in the number of researchers by specialized field of study was shown (Chart 2-2-10(A)).

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 2-2-10: Researchers in the university and college sector in Japan

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



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(8) According to the statistics on universities and colleges (MEXT, "Report on School Basic Survey" 2009 version), as of May 1, 2009, the number of regular teachers in faculties of universities combined with graduate schools was 172,039 and in junior colleges was 10,128, respectively.

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

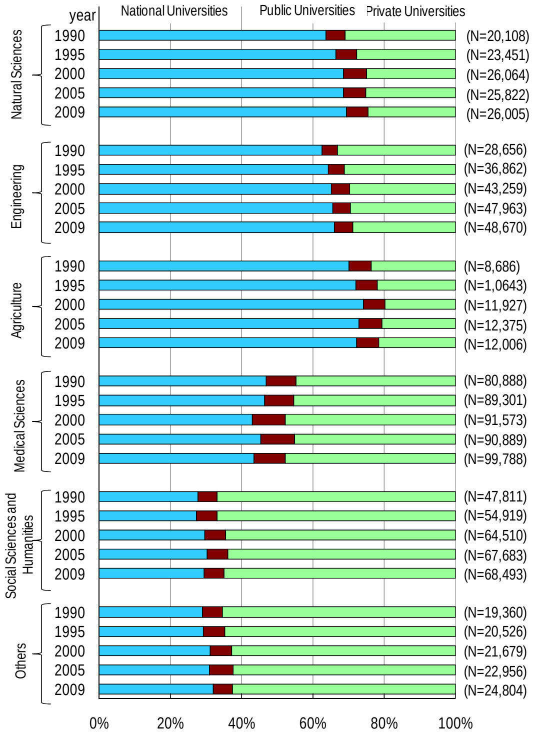
Chart 2-2-10(B) shows the proportion of the number of researchers by type of university, in other words, national, public and private universities, after classifying them by the field of their personal specialized knowledge.

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. On the other hand, the number of researchers in "private universities" accounts for a large proportion of the number of researchers with knowledge in the field of "medical sciences", "social sciences and humanities" and "others".

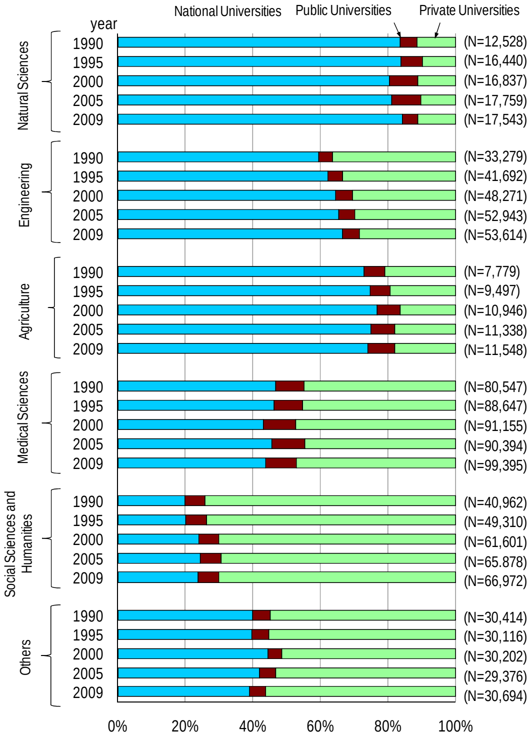
Next, the proportion of researchers by type of university in each field of affiliation (academic field) is examined (Chart 2-2-10(C)). This proportion is almost the same as in the case for each specialized field of study (Chart 2-2-10(B)). But the number of researchers in "national universities" accounts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

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

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



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



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

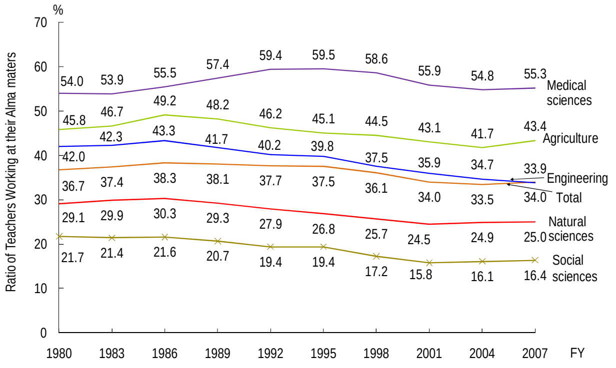
(4) Greater diversity in alma maters of university teachers

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 2007 was 34.0% against the total, but is decreasing in the long term. Examined by field of study, the number of teachers working at their alma mater accounts for a large proportion or approximately 50% in the field of "medical sciences", and the trend is flat. The proportion has recently decreased in the field of "engineering", and remains flat or increasing in other fields (Chart 2-2-11(A)).

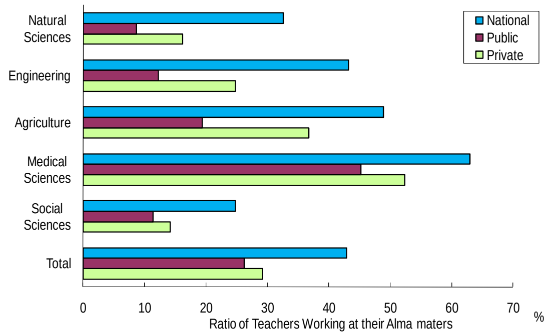
Chart 2-2-11: Ratio of university teachers working at their alma maters

(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. But in "natural sciences" the number of teachers working at their alma maters was approximately a half in private universities and a quarter in public universities, respectively (Chart 2-2-11(B)).

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



Resource: MEXT, "Statistical Survey on School Teachers"

2.3 Research assistants

Key Points

○With regard to the number of research assistants per researcher by sector, the value is large in the public organization sector and small in the university and college sector in almost all the countries. Especially in Japan, the number of research assistants is so small that the value is approximately a half of that in Germany and France.

○Out of the number of research assistants in the university and college sector in Japan, the number of “assistant research workers” has been flat while that of “clerical and other supporting human resources” is increasing in number.

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

2.3.1 Status of research assistants in each country

Research assistants tend to be recognized as being peripheral despite the fact that they are important participants in R&D. But both researchers and research assistants are important actors in modern R&D which is being complicated and large-scale and the differences between them should be recognized as a classification simply based on the characteristics of duties.

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(9)” and “Other supporting staff(10)” 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 U.K. and China, the terms in documents compiled by the OECD were used. There was no data for research assistants in U.S.

Chart 2-3-2 shows the number of research assistants per researcher by sector. In each country, the value is declining in the business enterprise sector. In the public organization sector and the non-profit institution sector, year-on-year fluctuation is significant. Almost no change is shown in the university and college sector. There are no data for universities in U.K. from 1994 through 2004. U.K. began publishing estimated figures in 2005. The continuity of data from before 1994 and after 2005 is therefore impaired.

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(9) 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.

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

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

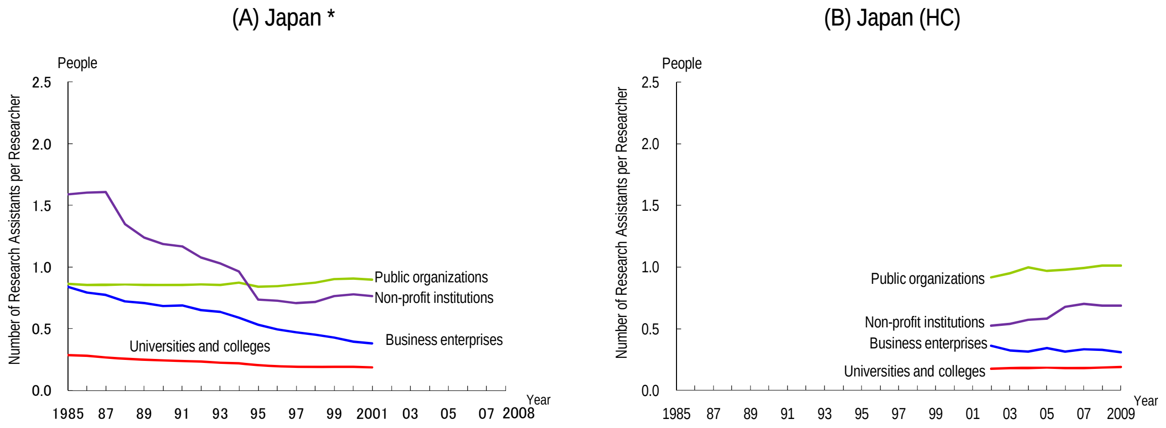
Country	Business Enterprises	Universities and Colleges	Public Organizations	Non-profit Institutions
Japan	(1) Assistant research workers (2) Technicians (3) Clerical and other supporting personnel	(1) Assistant research workers (HC) (2) Technicians (HC) (3) Clerical and other supporting personnel (HC)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

Notes: 1) For U.S., Germany and France, terms in their national languages are shown (this version is in Japanese). For U.K. and China, terms used in OECD materials are shown.
2) FTE values were used although values mentioned as (HC) are actual numbers without conversion.
3) Nothing on U.S.

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

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

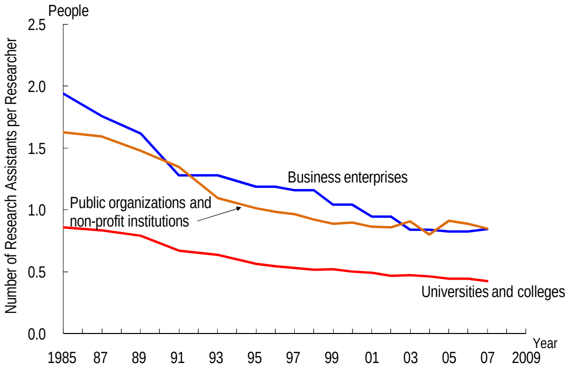
Attention to international comparison



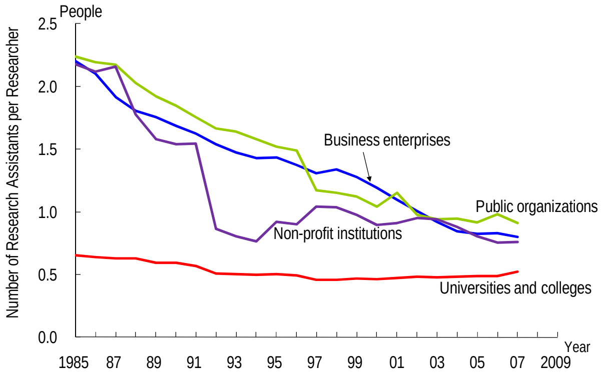
(A) Japan *

(B) Japan (HC)

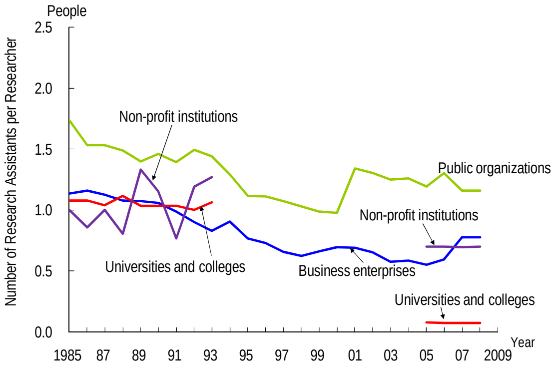
(C) Germany



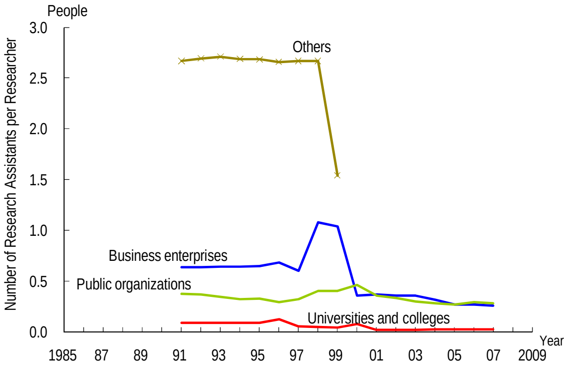
(D) France



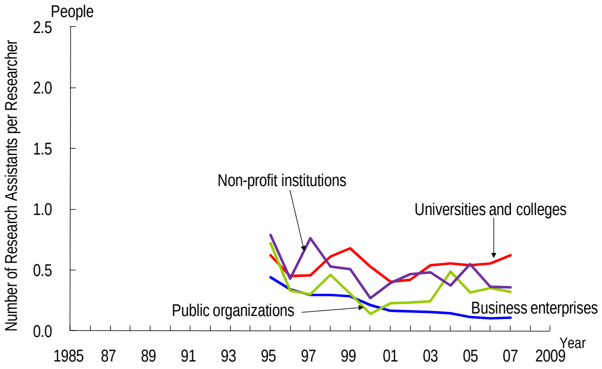
(E) U.K.



(F) China



(G) Korea



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

Source: <Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development",
<Germany>Bundesministerium für Forschung und Technologie, "Bundesbericht Forschung" 1996, 2000, 2004, "Bundesbericht Forschung und Innovation 2007, 2008";
since 2007, OECD, "Main Science and Technology Indicators 2009/2"
<Other countries>OECD "Main Science and Technology Indicators 2009/2"

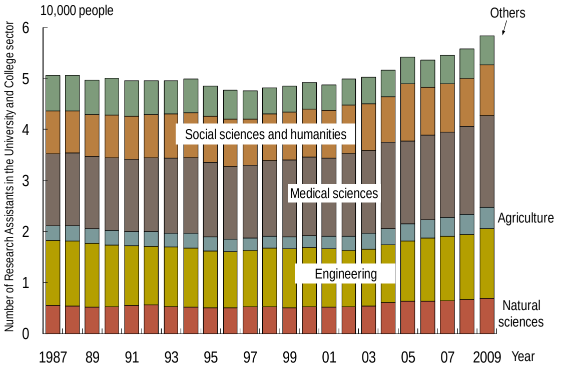
2.3.2 Status of research assistants in the university and college sector in Japan

(1) Breakdown of research assistants

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

Chart 2-3-3 shows the number of research assistants by the academic field of their affiliation. Their numbers have tended to be on the rise mainly in the field of natural sciences and the field of agriculture since around 2000, and the total for all fields was 58,000 people in 2009.

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



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

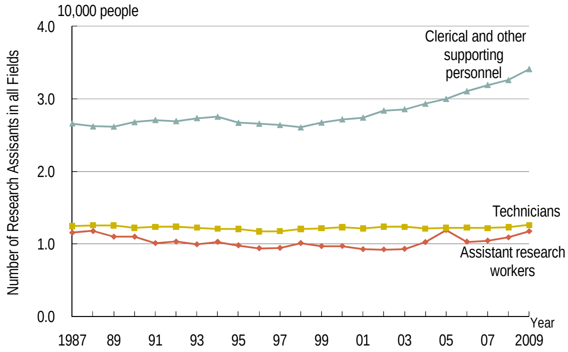
Next, looking at the breakdown of the number of research assistants, the number of “clerical and other supporting personnel”, which account for the largest proportion of the total, has been increasing since 2000. It was and 34,000 people in 2009 (Chart 2-3-4(A)).

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

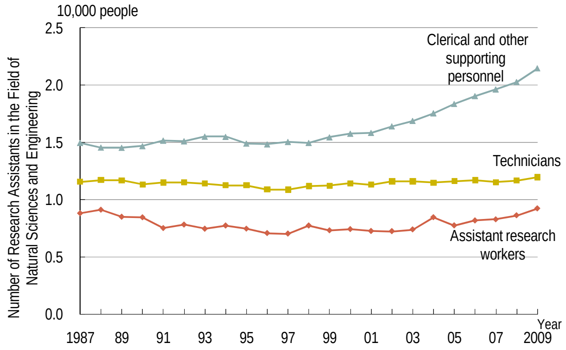
The breakdown of the number of research assistants by the academic field of their affiliation shows that the number of “clerical and other supporting personnel” is highest both in the field of “natural sciences” and the field of “social sciences and humanities” as it was in the breakdown of the total.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

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

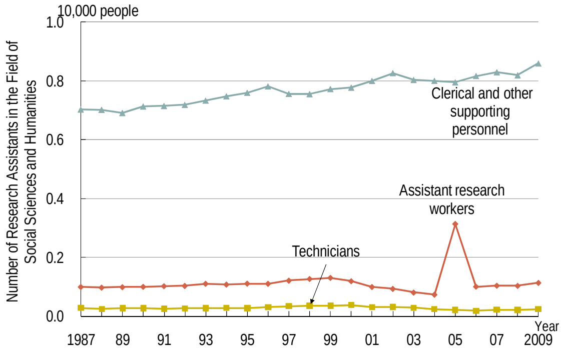
(A) Breakdown of the total



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



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



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

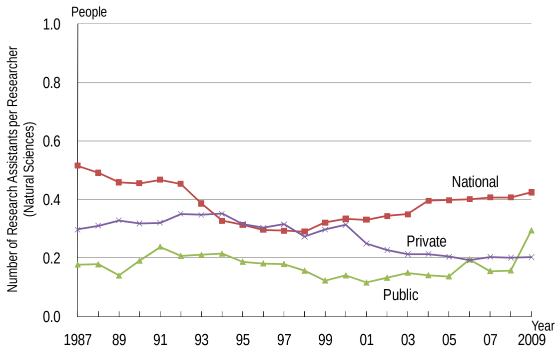
(2) Research assistants per researcher

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).

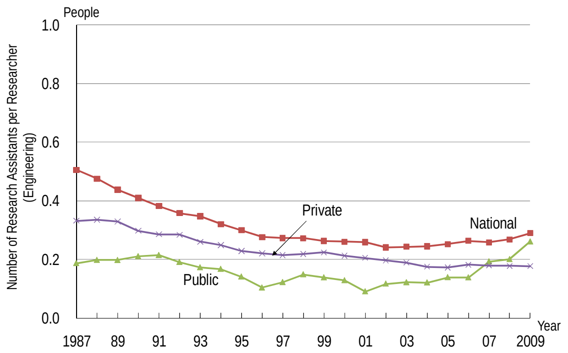
The number of research assistants per researcher is large in national universities in every field. In the field of “engineering”, although the number had been decreasing in the long term in both national and private universities, a rising trend has been apparent in recent years. In the field of “medical sciences”, the research assistants per researcher is small, and the difference with the research assistants per teacher in Chart 2-3-6 is significant. This difference, however, is due to the huge number of “medical staff and others” in this field compared to the other fields. In other words, the large number of researchers or the large denominator, rather than the small number of research assistants, influenced the result (Chart 2-3-5).

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

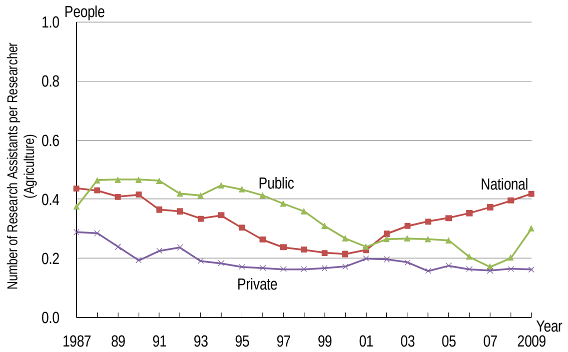
(A) Natural sciences



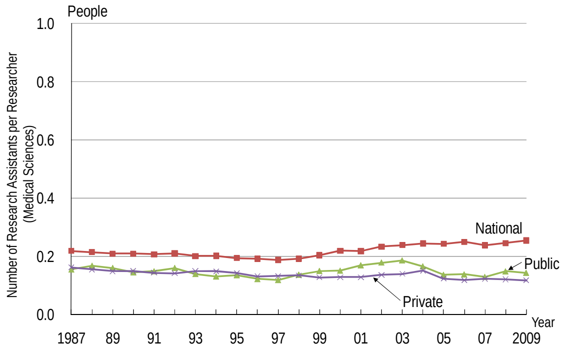
(B) Engineering



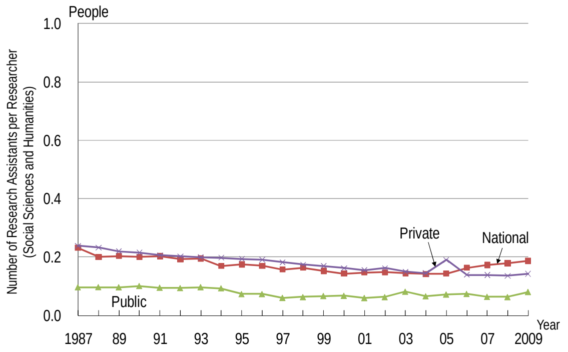
(C) Agriculture



(D) Medical sciences



(E) Social sciences and humanities



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

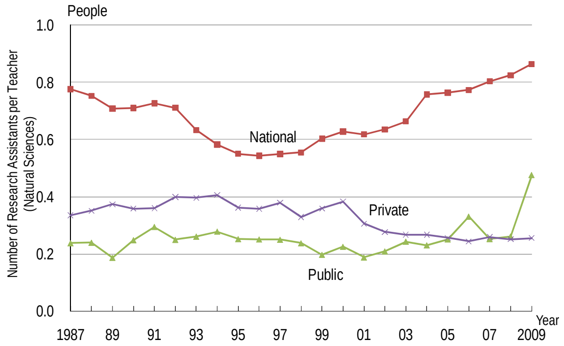
(3) Research assistants per teacher

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

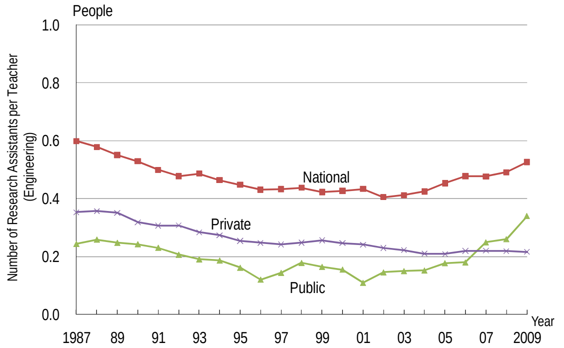
In every field, the number of research assistants is large in "national universities". In addition, the number of research assistants per teacher in the field of "natural sciences" and "agriculture" of "national universities" have a similar tendency of a decreasing trend until the 1990s which begins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

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

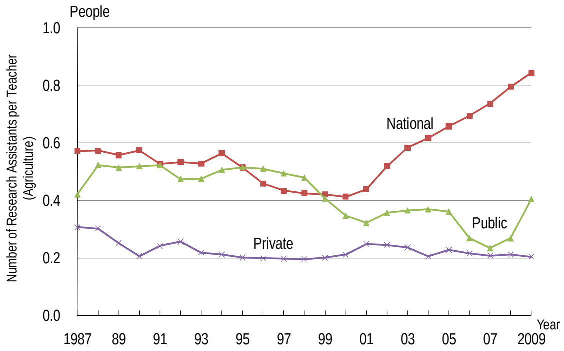
(A) Natural sciences



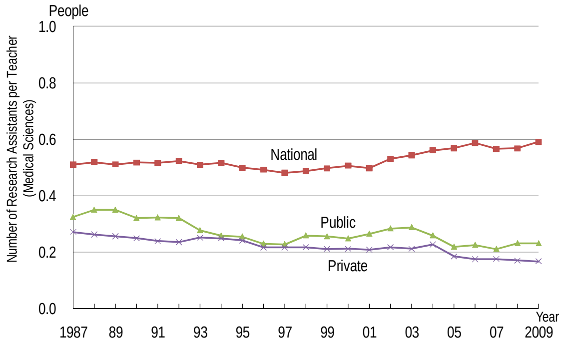
(B) Engineering



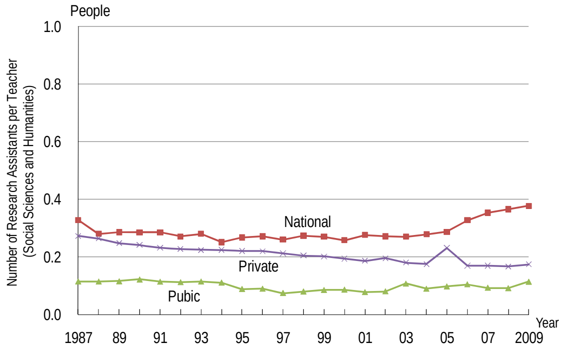
(C) Agriculture



(D) Medical sciences



(E) Social sciences and humanities



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

Chapter 3 : Higher Education

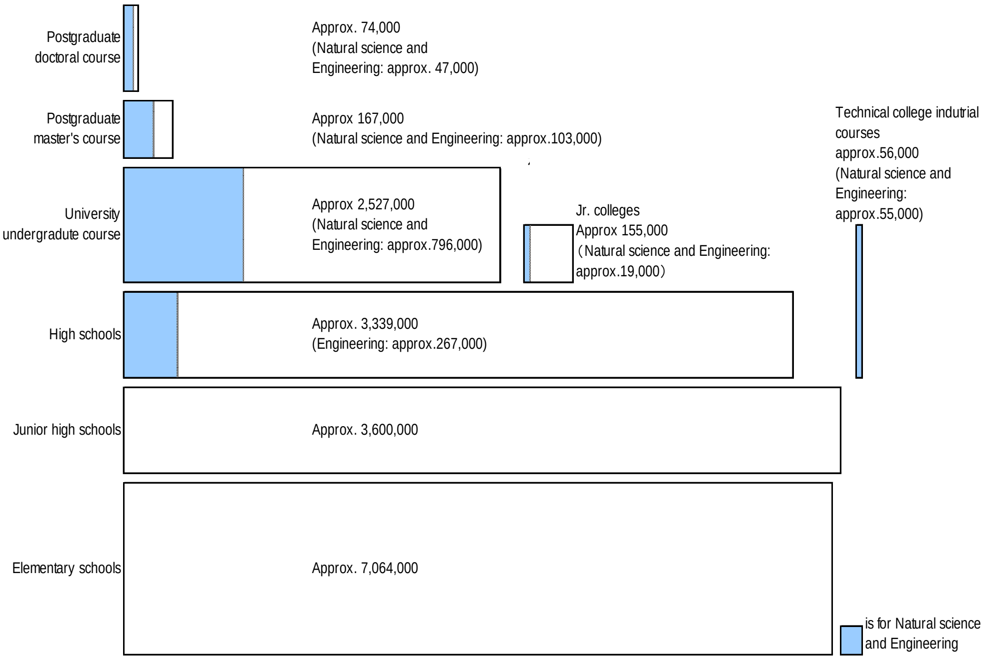
The cultivation of human resources relevant to science and technology is one of the most important basic infrastructures for promoting science and technology. This chapter describes the cultivation of human resources for science and technology in school education, mainly looking at conditions in universities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

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

Chart 3-1 shows the total numbers of students and pupils in school education for the FY 2009, 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 7,064,000, that of pupils in junior high schools are about 3,600,000, and that of high school students are about 3,339,000 (including only the regular courses). The number of undergraduate students is about 2,527,000 (including approx 796,000 in the field of "Natural science and engineering"), and that of college students is about 155,000 (including approx 19,000 in the field of "Natural science and engineering"). The number of master's program students in graduate schools is about 167,000 (including approx 103,000 in the field of "Natural science and engineering") and that of doctoral program students is about 74,000 (including approx 47,000 in the field of "Natural science and engineering").

Chart 3-1: The present status of the number of students and pupils in school education (for the FY 2009)



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 has been roughly unchanged since about 2000, and that for the FY 2009 is about 609,000. The numbers newly enrolled in private universities and colleges is high, and constitutes about 80% of the total. When classified by field, the students who major in “Natural science and engineering” are about 30% of the total. Of these, the students who study in national universities and colleges are about 30%, and those in private universities and colleges are about 60%.

○The numbers newly enrolled in master’s programs has been roughly unchanged since about 2005 and that for the FY 2009 is about 78,000. The numbers newly enrolled in national universities and colleges constitutes about 60% of the total. When classified by field, the students who major in “Natural science and engineering” are about 60% of the total. Of these, the students who study in national universities and colleges are about 60%, and those in private universities and colleges are about 30%.

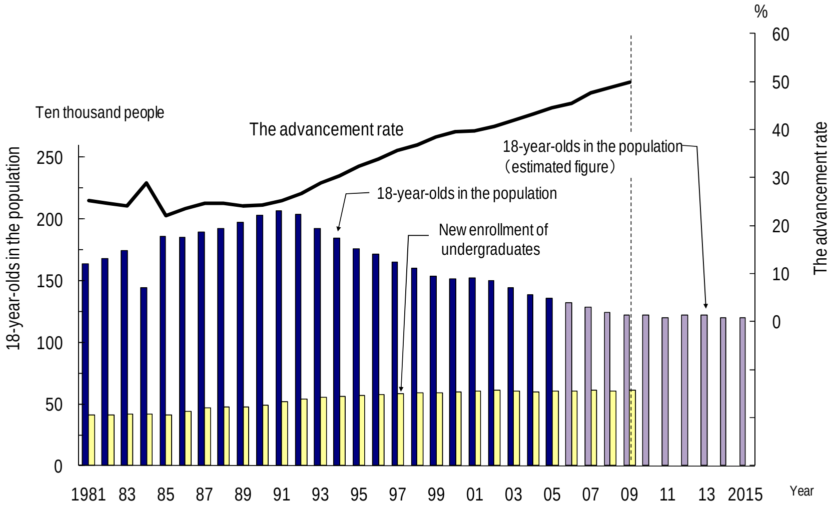
○The number newly enrolled in doctoral programs has been decreasing since peaking in 2003 and was about 16,000 for the FY 2009. The numbers newly enrolled in national universities and colleges is high and constitutes about 70% of the total. When classified by field, the students who major in “Natural science and engineering” are about 70% of the total. Of these, about 70% of the students study in national universities and colleges, and the students who study in private universities and colleges are about 20%.

3.2.1 New enrollment of undergraduates

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

Under circumstances of young people increasingly wanting to proceed to higher education and an increase in the number of student places, the numbers newly enrolled for undergraduate studies has increased from about 413,000 for the FY 1981 to about 609,000 for the FY 2009, which represents a growth of 1.5 times. As a result, the advancement rate for the FY 2009 (the ratio of the number newly enrolled to the total of 18-year-olds) is 50%, which is the highest rate ever.

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



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

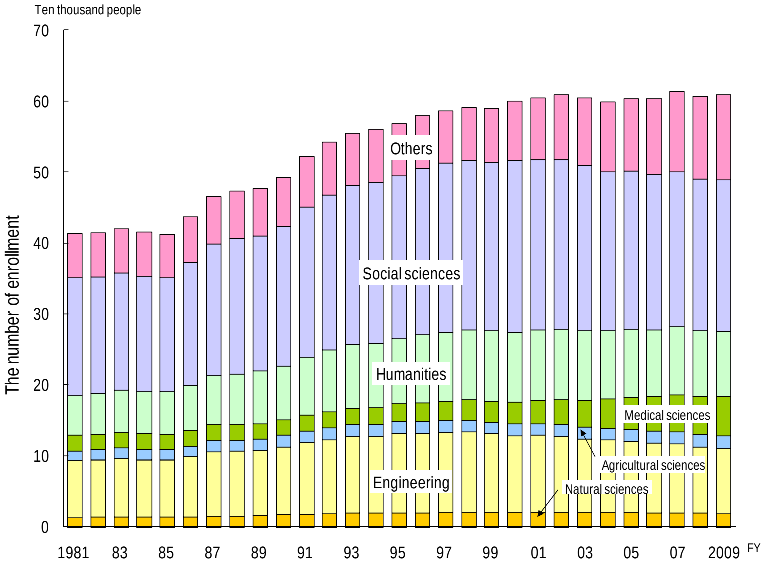
Source: 1) 18-year-olds in the population: <until 2007>Ministry of International Affairs and Communications, Statistics Bureau, “Population Estimates” (as of October in every year).
<After 2008>National Institute of Population and Social Security research, “Population Projections for Japan: 2006-2055, December 2006”
2) The numbers newly enrolled for undergraduate studies: MEXT, “Report on School Basic Survey”

Chart 3-2-2 (A) shows changes in new enrollment of undergraduates by major fields. The new enrollment of undergraduates in Japan has been largely unchanged since the FY 2000 and it was about 609,000 in 2009. The breakdown of the new enrollment was followed closely by the field of “Social sciences” (approx 213,000); the field of “Humanities” (approx 92,000); the field of “Engineering” (approx 94,000); the field of “Medical sciences” (approx 55,000), the field of “Natural sciences” (approx 19,000); Others (Home economics, Education, Art, others; approx 120,000) and especially the number newly enrolled in The field of “Medical sciences” is 2.5 times compared with that for the FY 1981 and also that of “Others” became 1.9 times by comparison.

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. And the large number of the new enrollment in private universities and colleges is 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
2009	Total	608,731	91,793	213,233	18,872	91,611	17,743	55,183	-	17,165	41,670	17,765	43,696
	National	101,847	6,666	15,501	7,158	30,488	7,096	10,710	-	287	16,235	839	6,867
	Public	28,414	4,755	8,022	631	3,396	1,024	5,713	-	698	374	959	2,842
	Private	478,470	80,372	189,710	11,083	57,727	9,623	38,760	-	16,180	25,061	15,967	33,987

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

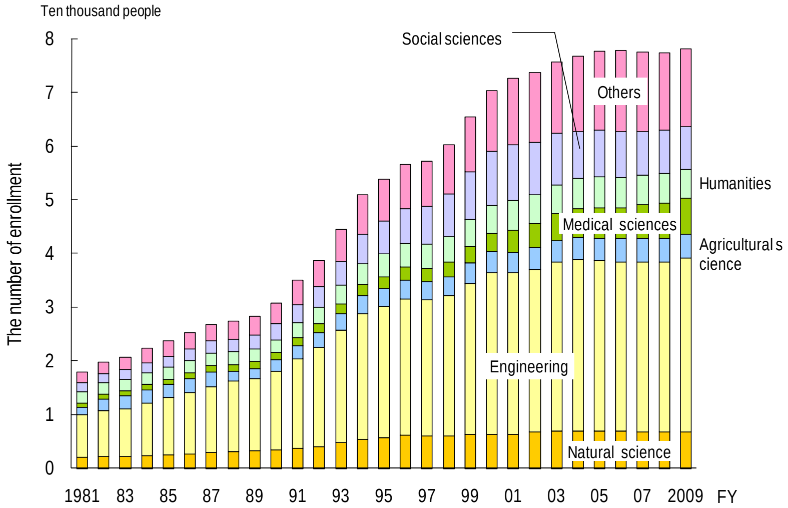
The number of new enrollments in graduate school master's program for the FY 2009 was about 78,000 in all. The breakdown of the major subjects was followed closely by "Engineering" (approx 32,000 (41.6%)); "Social sciences" (approx 8,000 (10.2%)); "Medical sciences" (approx 7,000 (8.6%)); and "Natural sciences" (approx 7,000 (8.5%)).

Since there has been greater of focus on graduate schools since the FY 1990, the number of new enrollments in master's programs in graduate schools greatly increased between the FY 1990 and the FY 2000. The rate of the increase was 2.3 times. Looking at this by major subject, the growth of the "Social sciences" was 3.4 times and that of "Medical sciences" was 2.5 times. During the 2000s, the overall rate of increase stagnated. New enrollments in "Medical sciences," however, approximately doubled. "Others" also increased (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 subjects, there is a large number of "Natural science and engineering" in national, public and private Universities and Colleges. Private universities and colleges have relatively more "social sciences and "Humanities". However, regarding "Medical sciences", the composition of national universities and colleges was about a half of the total, and that of private universities and colleges was also about 40% of the total (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
2009	Total	78,119	5,296	7,977	6,610	32,479	4,463	6,699	19	489	4,698	2,020	7,369
	National	44,683	1,603	2,164	4,516	20,987	3,648	3,047	19	74	3,910	518	4,197
	Public	4,971	196	559	593	1,593	149	912	-	139	26	307	497
	Private	28,465	3,497	5,254	1,501	9,899	666	2,740	-	276	762	1,195	2,675

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

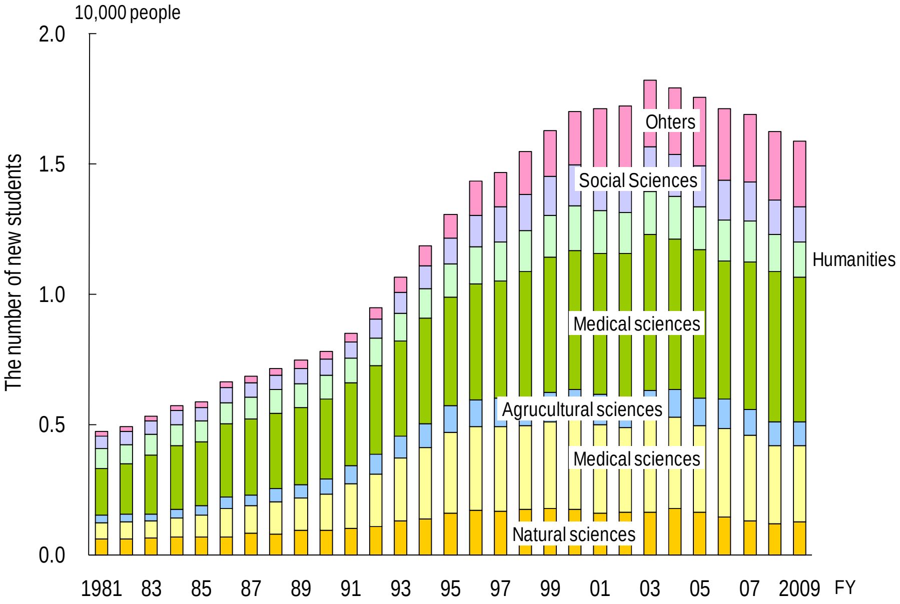
Looking at the number of new enrollments in graduate school doctoral programs, this was 16,000 in all for the FY 2009. When compared with 18,000 for the FY 2003 which was the highest ever, there has been a 12.8% decrease. The breakdown of the major subjects was followed closely by “Medical sciences” (approx 6,000 (34.8%)); “Engineering” (approx 3,000 (18.6%)); “Natural sciences” (approx 1,000 (7.9%)); “Humanities” (approx 1,000 (8.6%)); “Social sciences” (approx 1,000 (8.5%)).

The number of new enrollments in graduate school doctoral programs has largely increased since the beginning of the 1990s. This resembles the increase in the number of new enrollments in graduate school master’s programs. The number of new enrollments in master’s programs remains unchanged since mid-2000s; however, that for doctoral programs has been decreasing since its peak in 2003 (Chart 3-2-4 (A)).

Looking at major fields by national, public and private universities and colleges, it is national universities and colleges that account for 80% - 90% in “Natural sciences”, “Engineering” and “Agricultural sciences”, and for 60% in “Medical sciences”. It can be said that the ratio of the students who major in “Natural science and engineering” is high in national universities and colleges (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
2009	Total	15,901	1,371	1,346	1,259	2,954	900	5,538	-	62	487	183	1,801
	National	10,533	594	578	1,034	2,385	775	3,445	-	7	354	83	1,278
	Public	1,026	53	95	93	113	30	485	-	15	0	36	106
	Private	4,342	724	673	132	456	95	1,608	-	40	133	64	417

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

3.2.4 The ratio of female students

New enrollment of female students for undergraduate studies in the FY 2009 was 262,000, which accounted for 43.1% of the total and a percentage increase of 19.9 point than that for the FY 1981, which was only 23.2% (Chart 3-2-5).

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

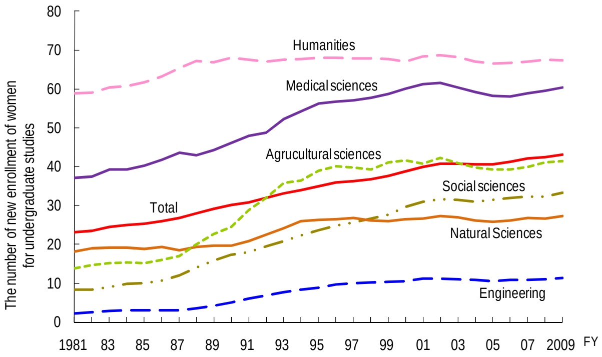
Next, when looking at the percentage of new enrollment by women in master’s programs, many take “Humanities” which is the same as in the case of new enrollments for undergraduates. However, the percentage of female students in “Medical sciences” is also high. Although the percentage for the FY 1990 was 22.9%, it became 52.3% in FY 2009, which was more than the percentage of men.

The percentage of new enrollment of female students in doctoral programs for the FY 2009 was 32.1%, which was 3.0 points higher than the percentage of new enrollment of female students in master’s programs in the same year.

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

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

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



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

(Unit:%)

	FY	Total	Humanities	Social sciences	Natural sciences	Engineering	Agricultural sciences	Medical sciences	Others
Undrgraduate students	1990	30.2	67.9	17.3	19.7	5.1	24.5	46.0	59.1
	2000	38.8	67.1	29.6	26.5	10.5	41.5	60.1	62.6
	2009	43.1	67.3	33.2	27.2	11.4	41.5	60.4	61.0
Master's grprograms	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
	2009	29.1	60.4	38.4	20.6	10.2	34.2	52.3	46.3
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
	2009	32.1	52.7	36.3	20.7	13.7	31.6	33.9	42.0

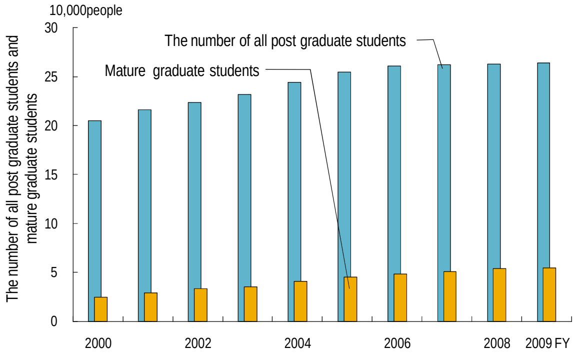
Source: MEXT, “Report on School Basic Survey”

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 2009, the number of working people was 54,642, which accounts for 20.7%. Compared with 12.1% in the FY 2000 when statistical data on mature students was first gathered, this is about double (Chart 3-2-6).

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



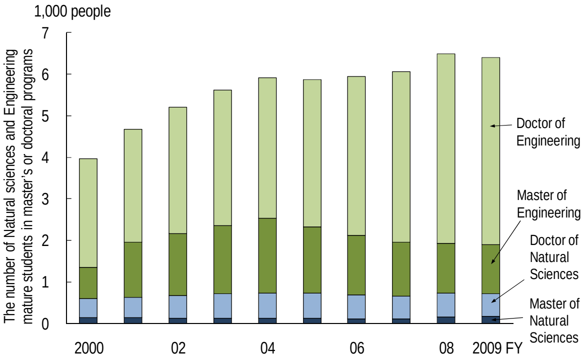
Note: 1) “Mature” is the persons who enter into employment for taking current income such as pay or wage as of May 1st in each year, and include retired employees and house wives.
2) Postgraduate students here are persons who are registered in a master’s program and the preliminary term of a doctoral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

Source: MEXT, “Report on School Basic Survey”

Looking at the number of “Natural sciences” and “Engineering” mature graduate students by degree, those who enrolled in doctoral programs in “Engineering” were 4,505 in the FY 2009 , which is a 1.7 times increase on those in the FY 2000. The number of mature graduate students in master’s programs in “Engineering” has been tending to decrease since FY 2004, and it was 1,185 in 2009, which is one-fourth compared with the number of mature students in doctoral programs.

Mature students who take doctor’s courses in “Natural sciences” were 541 and those who take master’s courses in “Natural sciences” were 174 in FY 2009. This number was lower than that for “Engineering.” It was only 1.1 to 1.3 times the number during the FY 2000 (Chart 3-2-7).

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



Source: MEXT, “Report on School Basic Survey”

3.3 Career options for students in Natural sciences and Engineering

Key Points

○Looking at career options for undergraduate students in "Natural sciences and engineering" after graduation, students who enter employment are about 60% and those who proceed to higher education are about 40%. When it comes to master's students, those who enter employment are about 90% and those who go on to the next stage of education are about 10%. The percentage of students who head into the workforce has increased during recent years.

○Looking at those who enter employment among the graduates of "Natural sciences and engineering" by industrial classification, in case of undergraduates, the "Manufacturing industry", "Service type industries" and "Others" comprise one-third each. And in the case of master's students, the percentage of students who enter employment in the "Manufacturing industry" is about 60%, and the percentage of students who find employment in "Service type industries" is about 20%.

○Looking at students in undergraduate, master's, and doctoral courses in "Natural sciences and engineering" who enter employment by industrial classification, those, who become "professional and technical workers", account for over 80%. The breakdown shows that many undergraduate students and masters course students become "Engineers". In the case of doctoral students, more enter the academic profession, so that "Scientific researchers" are about 30%, "Engineers" are about 40% and "teachers" are about 20%.

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

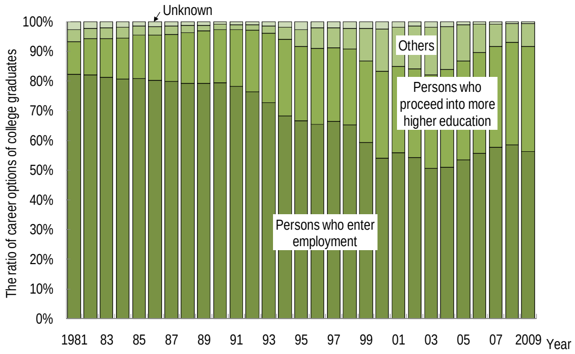
This section describes career options particularly for students of "Natural sciences" and "Engineering". "Persons who enter employment" as used herein represents those who get jobs with routine income. Persons who get temporary or part time jobs are included in "Others". This data was based on a survey 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 2009, the percentage of "persons who entered employment" was 56.2%, which is the biggest share, and that of "persons who proceeded with more higher education" was 35.5% 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, though, it has been increasing.

Partly due to the influence of upgrading and expanding graduate schools since the late 1990s, the percentage of "persons who proceed to higher education" has been consistently increasing. (Chart 3-3-1)

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



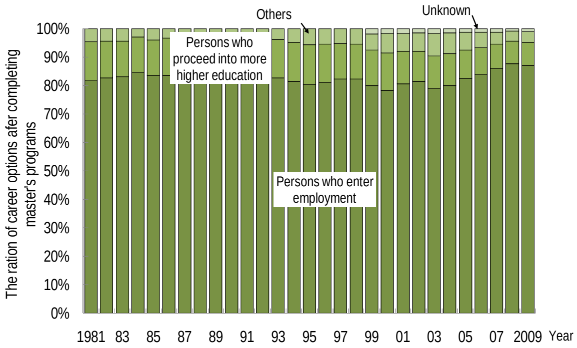
Note: 1) The number of persons graduating each March is indicated.
2) This chart includes both "persons who entered employment" and "persons who proceeded with more higher education" in the "number of persons who entered employment".
3) Persons who entered employment are persons who work for current 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. At the beginning of the 2000s, the percentage increased more and it accounted for 87.0% in 2009. The percentage of "Person who proceed to higher education" has been declining in the 2000s and it was 8.2% in 2009 (Chart 3-3-2).

Chart 3-3-2: Career options of persons who complete master's programs in "Natural sciences and Engineering"



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

Column: Postdoctoral career options in Natural sciences and Engineering

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

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

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

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

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

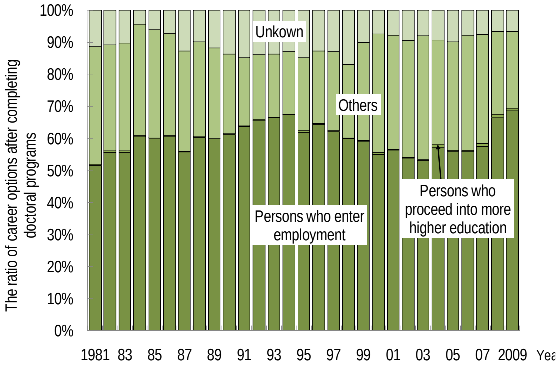
Different from college graduates and persons who complete master’s degree programs, there are many doctoral graduates who aim at academic careers. As for getting into a company, the recruiting time is more or less set. However, academic recruitment occurs throughout the year. Therefore, there are many people, who seek academic careers, who have not still set their career in concrete as of May 1st of the year following graduation, which is scope of target for School Basic Survey. Regarding career options for these people who are not employed or proceed to higher education, they are sorted into “other persons who were not applicable in these categories”. Actually, the percentage of “other persons who were not applicable in these categories” in “not otherwise classified” (1,251 persons) for the FY 2009 was about 80%, which was the largest.

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

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

Last year, the percentage of doctoral graduates in Natural sciences and Engineering who entered employment climbed to about 70%.

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



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

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

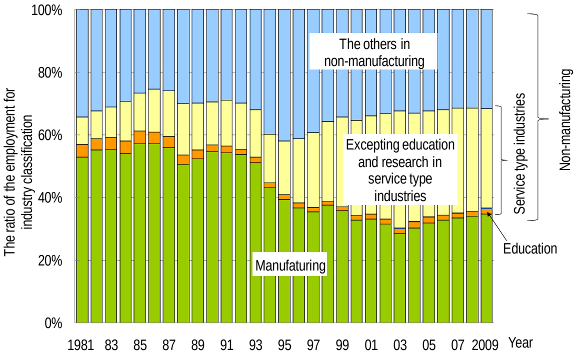
This section shows the place of employment by industry classification of the students described in section 3.3.1, “The status of employment and continuing education among students of Natural sciences and Engineering.” The industry classification used herein is the “Japan Standard Industry Classification: JSIC” which determines an industry by the main services of its business enterprises (The revision of JSIC was conducted in 1993, 2002 and 2007 and all were applied from the next year). “Education” as used herein is “school education” and includes elementary schools, junior high schools, high schools and 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 at the change in the percentage of college graduates who enter employment by industry classification, the percentage of employment in “Manufacturing” was at the 50% level in the 1980s. However, it has declined to a 30% level in recent years. On the other hand, the percentage of employment in “Service-type industry” of “Non-manufacturing” has increased from a 10% level to a 30% level. And the percentage of employment in “education” in “Service-type industry” has decreased from a 4% level to a 1% level in recent years.

The places of employment of the latest college graduates in Natural sciences and Engineering by industry classification show about the same percentage for “Service-type industry”, “Manufacturing” and “others in Manufacturing” (Chart 3-3-4).

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



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

2) 1981 - 2001

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

Education: “Education” within “service industry” in the same Classification

Research: No applicable classification

2002 – 2006

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

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

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

2007 -

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

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

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

Source: MEXT, “Report on School Basic Survey”

(2) Master’s degree program graduates entering employment

Looking at the change in the percentage of graduates from master’s degree programs in Natural sciences and Engineering entering employment by industry classification, the percentage of employment in “Manufacturing” was at the 70% level in the 1980s. However, it has undergone a transition to a 60% level in recent years. The percentage of employment in the “Service-type industry” of “Non-manufacturing” has increased from a 10% level to a 20 % level, and “Education” in “Service-type industry” has gone from a 4% level to 1%, which is the same as for college graduates. And “Research” is under 1%.

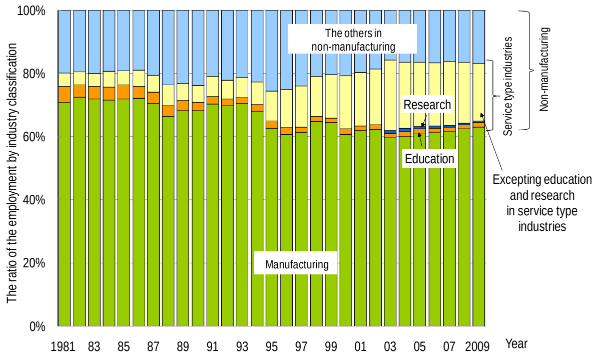
The places of employment of graduates from master’s degree programs in Natural sciences and Engineering recently in “Manufacturing” was nearly 60%, and the other 40% was shared by “Service-type industry” and “Others in Non-manufacturing” (Chart 3-3-5).

(3) Doctoral graduates entering employment

Looking at the change in the percentage of doctoral graduates in Natural sciences and Engineering entering employment by industry classification, it was different from the employment status of undergraduate students and master’s students. The percentage of employment in “Manufacturing” was approximately 30% and the percentage of “Non-manufacturing” was higher than this. Moreover, the percentage in “Service-type industry” in “Non-manufacturing” was large, at around 50%. Although “Education” in “Service-type industry” went from 40% to 50% in the 1980s, it has declined to less than 30% in the 2000s. And the percentage of employment in “Research”, which has been measured since 2003, was also large. It was 21.5% in 2003, however, it decreased to 13.5% in 2008.

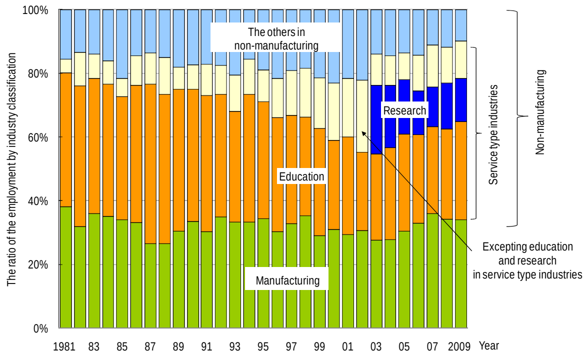
Recent employment of doctoral graduates in Natural sciences and Engineering by industry classification was about 30% in “Manufacturing”, around 30% in “Education” and approximately 10% in “Research” (Chart 3-3-6).

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



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

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



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

3.3.3 The employment status of Natural sciences and Engineering students

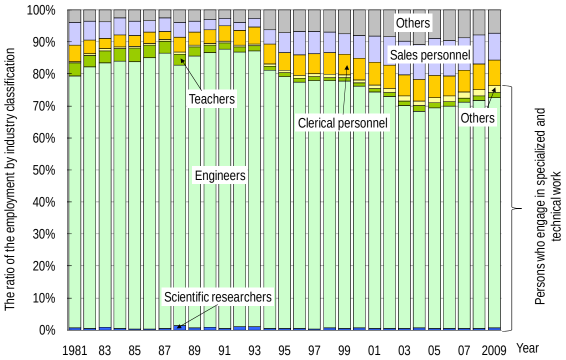
This section shows the place of employment by occupation classification of the students described in section 3.3.1, "The status of employment and education continuance on Natural sciences and Engineering students." Occupation classification referred to herein means the "Japan Standard Occupational Classification"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

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

(1) College graduates entering employment

Looking at the employment percentage of Natural sciences and Engineering college graduates by occupation classification, "persons who engage in specialized and technical work" has changed from 70% to 80% of the total. The breakdown shows a large number of "Engineers", which accounts for 70 % of the total. Persons who engage in "Scientific researchers" have changed to 0.5% of the total (Chart 3-3-7).

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

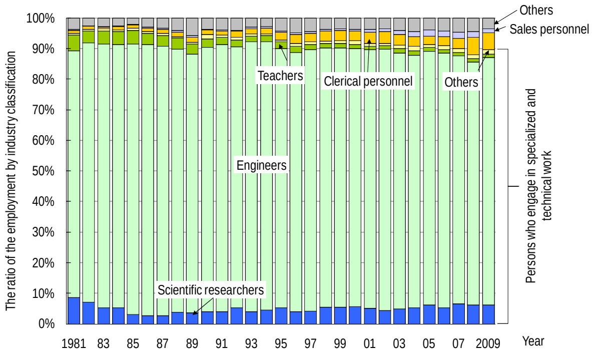


Source: MEXT, "Report on School Basic Survey"

(2) Master's degree program graduates entering employment

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

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

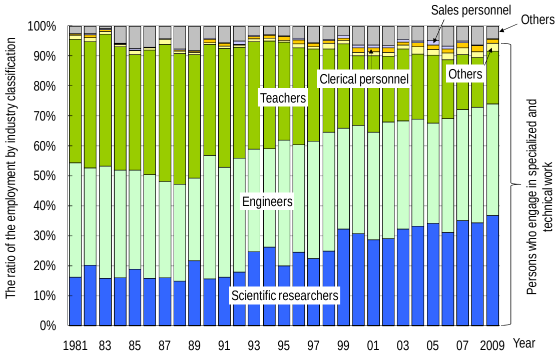


Source: MEXT, "Report on School Basic Survey"

(3) Doctoral graduates entering employment

Looking at the employment percentage of doctoral graduates in Natural sciences and Engineering by occupation classification, “persons who engage in specialized and technical work” comprise a high level of over 90%. The breakdown shows that the percentage of “Scientific researchers” was less than 20% and “Engineers” was consistently 30~40%, however, it has changed to around 30% in recent years. On the contrary, although the percentage of “Teachers” used to be 40%, now it has declined to less than 20% (Chart 3-3-9).

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



Source: MEXT, “Report on School Basic Survey”

3.4 International comparison of degree awarded

Key Points

○Looking at the number of persons who have degrees per one million of the population, bachelor’s degrees awarded in Japan are about 4,400. This is less than U.S. and U.K., however, it greatly surpasses Germany and France. Meanwhile, the number of doctoral degree awarded is about 140, which is half as many as that in U.K. and Germany and falls below that of U.S. and France.

○When the rate of increase of the number of doctoral degree recipients per one million of the population is compared with the rate of increase during the 10 years from 1995, U.K. has been enlarged 1.61 times, which has reached approximately the same level as Germany. During these years, Japan has enlarged 1.29 times, which is a higher increase than U.S. and Germany.

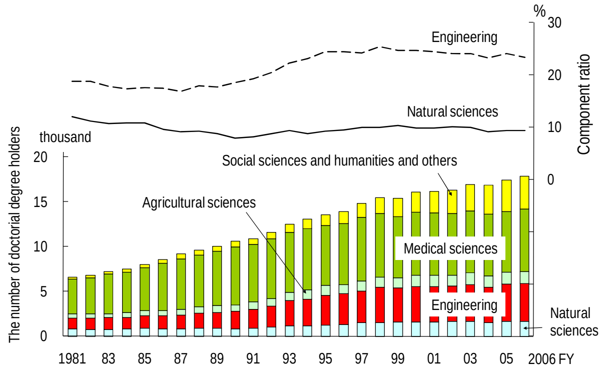
3.4.1 Doctoral degree awarded in Japan

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

Chart 3-4-1 shows the change in the number of doctoral degrees conferred by major field. Conferral of doctoral degrees as used herein is the number of degrees given in the year which is based on degree rules (the so-called new Ph.D. system). This was about 6,000 in the FY 1981, however, it has been increasing after that and it reached 17,860 in 2006.

The breakdown by main subjects of special study of the number of degrees conferred in the FY 2006 shows that “Medical sciences” (science of medicine, dentistry, pharmaceutical sciences and health science) were 6,981, which accounts for 39.1% of the total. “Natural sciences” were 1,669 (9.3%) and “Engineering” was 4,177 (23.4%).

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



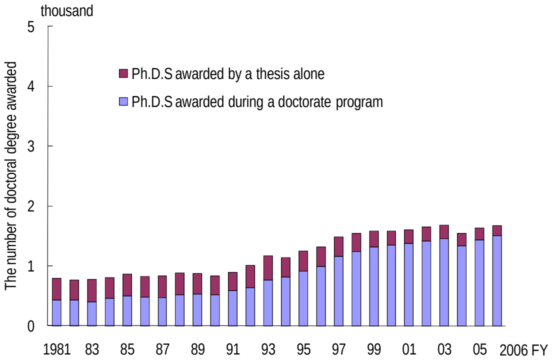
Note: 1) “Medical sciences” is for “Science of medicine”, “Dentistry”, “Pharmaceutical sciences” and “Health sciences”.
2) “Education”, “Art” and “Home economics” are included in “Education”.
Source: Until the FY 1986, surveyed by Education Research Center, Hiroshima University “Higher Education Statistical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

Chart 3-4-2 shows the change in the number of degrees awarded by the breakdown of the number of Ph.D.s awarded during a doctoral program and Ph.D.s awarded by a thesis alone. The number of degrees awarded in “Natural sciences” has been increasing since 1991. 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. Particularly, the increase in the recent number of conferral of degrees is almost entirely brought about by the increase in the number of Ph.D.s awarded during a doctoral program, the percentage of which had grown to 90.1% in the FY 2006.

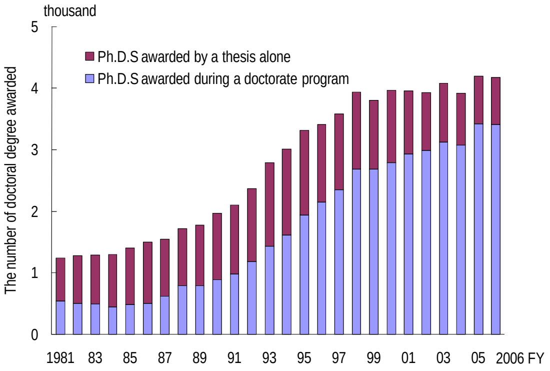
Against this, there has been a strong increase in the number of degrees conferred in “Engineering” since the late 1980s. Looking at the breakdown, the number of Ph.D.s awarded by a thesis alone used to exceed the number of Ph.D.s awarded during a doctoral program till mid-1980s. However, recent years the number of Ph.D.s awarded during a doctoral program has increased remarkably, to account for 81.5% of the total in 2006.

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

(A) Natural sciences



(B) Engineering



Source: The same as Chart 3-4-1

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

Regarding the number of bachelor's degrees, master's degrees and doctoral degrees awarded per one million of the population by country, persons counted 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

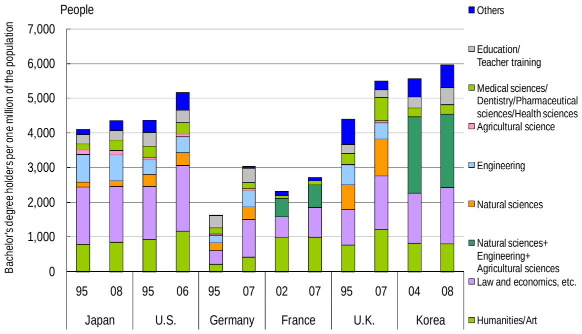
When looking at bachelor's degrees awarded per one million of the population, Japan had about 4,400 in 2008. Korea had about 6,000 (in FY 2008), which was the largest. The second was U.K., which had about 5,500 (in FY 2007) and U.S. which had about 5,200 (in FY 2006). Germany and France had relatively fewer, at about 3,000 and 2,700, respectively.

Regarding the rate of increase when comparing the figures for 1995 (2002 for France) and that of the latest year in each country, U.K. represents an increase of 1.25 times, which is the largest of the countries, and followed by U.S. and France with an increase of 1.18 times. Japan showed an increase of 1.07 times.

When the percentage of the composition is divided by the 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”, and this accounts for about 60% in Japan. That of France was particularly high, which accounts for 70%. On the other hand, Korea accounts for 40%, which is the same level as “Natural science and engineering”. In U.K., there is little difference between “Natural sciences” and “Engineering” and “Social sciences” and “Humanities”, which account for about 50% each.

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

(A) Bachelor’s degrees awarded



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

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

<Germany> For 1995 recipients, the number of successful applicants for the Diplom Examination in winter term of the year indicated and the summer term of the following year.
For 2007 recipients, 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) .
Successful applicants not in Education/Teacher training are also included in “Education/Teacher training”

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

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

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

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

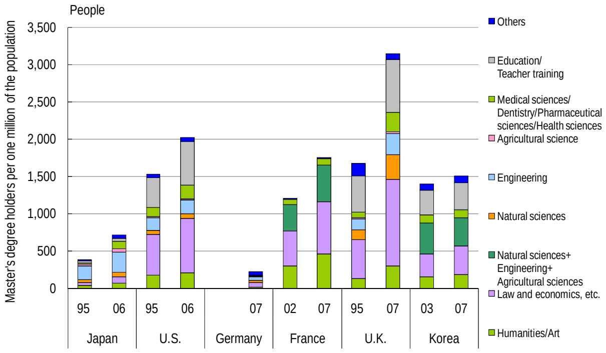
(2) Master’s degrees awarded per one million of the population

When looking at the number of master’s degrees awarded in each country per one million of the population, Japan marked about 700 (in FY 2006), which was less than the other countries. With about 3,000 in FY 2007, U.K. marked the largest figure by far, and U.S. was also large, with around 2,000 in FY 2006.

When the rate of increase was compared between figures for 1995 and those for the latest year in each country, Japan showed the remarkable increase, which was 1.91 times, and U.K. increased 1.88 times. Germany has just adopted a new master’s degree system, so only the most recent year is shown.

Regarding the percentage of the composition by the subject of special study, Japan had about 70% in the field of “Natural science and engineering”, which was the opposite of the ratio for bachelor’s degrees awarded. In the other countries, the ratio was almost the same as that of bachelor’s degrees awarded.

(B) Master’s degrees awarded



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

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

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

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

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

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

Source: The same as Chart 3-4-3

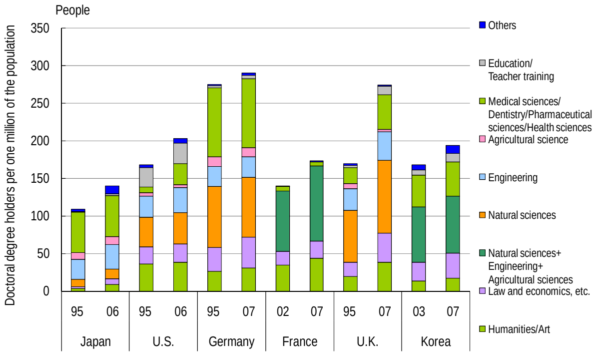
(3) Doctoral degrees awarded per one million of the population

When looking at the number of doctoral degrees awarded in each country per one million heads of the population, Japan had about 140 (in FY 2006), which is less than in other countries. The number for Germany was 290 (in FY 2006), which was the largest of the countries. And that of U.K. was also high, at 272 (in FY 2006).

Regarding the rate of increase when comparing the figures for 1995 and the figures for the latest year in each country, U.K. increased greatly, at 1.61 times. Japan increased by 1.29 times, which was next to U.K.

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

(C) Doctoral degrees awarded



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

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

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

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

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

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

Source: The same as Chart 3-4-3

(4) The percentage of international and foreign students in institutes of higher education

Next, we shall look at the percentage of international and foreign students in the total graduates of higher education in each country. As used here, “international students” are students not residing permanently or long-term in their host countries and “foreign students” are students who are not citizens of their host countries.

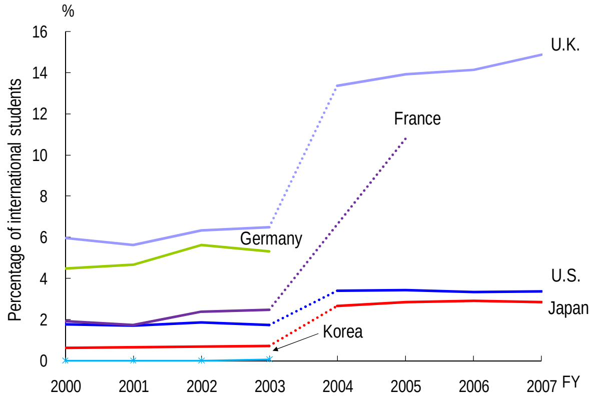
Chart 3-4-4 (A) shows trends in various countries for the percentage of students at institutes of higher education who are international students. U.K. has the highest percentage, at 14.9 % in 2007. In Japan, the percentage was 2.9% in 2007. There was no significant change over time. In U.S., the percentage was 3.4% in 2007, about the same as in Japan. The reason for the disparity between the data in 2003 and that in 2004 is that through 2003, only international students from OECD member and partner countries were counted. Beginning in 2004, students from all countries have been counted. The large increases for U.K., France, etc., in 2004 can be seen as reflecting their already existing acceptance of international students from emerging nations and other non-OECD countries.

Chart 3-4-4 (B) shows trends in various countries for the percentage of students at institutes of higher education who are foreign students. The disparity between the data from 2003 and from 2004 stems from the same reason as for Chart 3-4-4 (A). As with international students, U.K. has the highest percentage of foreign students, at 19.5%. Germany and France are about the same at approximately 11%. Japan’s percentage is 3.1%.

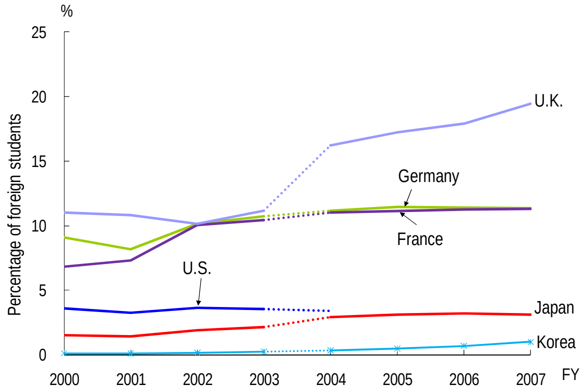
Chart 3-4-4 Percentage of international and foreign students in institutes of higher education

Attention to international comparison

(A) Percentage of international students



(B) Percentage of foreign students



Note: 1) International students: for Japan, U.S. and U.K., indicates students who are not residing permanently or long-term in their host countries; for Germany, indicates students who received their last education before higher education in another country.
2) Percentage of international students for Germany in 2001 - 2003 does not include research programs.
3) Data through 2003 target only OECD member and partner countries.
Source: OECD, "Education at a Glance".

Chart 3-4-5 is a ratio listing which represents the top five national origins of international and foreign students in each country (the former country of residence or the country where received the last education). The top 5 countries account for 83.5% of all such students in Japan, and the percentage of Chinese students in it was 63.7%. Looking at the percentage accounted for by the top 5 in other countries, it reached 52.6% in U.S. In Europe, there was less concentration in other countries toward certain countries, so that the concentration in the top five countries was 34.6% in U.K., 29.8% in Germany and 15.3% in France. In all 5 countries, the largest number of students was from China or had Chinese nationality.

Chart 3-4-5: The national origins and the former country of residence of students overseas and foreign students who are in higher education (2007)

Attention to international comparison

(Unit: %)

	1st	2nd	3rd	4th	5th	Total
Japan	China	Korea	U.S.	Brazil	France	
	63.7	17.6	1.5	0.4	0.4	83.5
U.S.	China	India	Korea	Japan	Canada	
	16.6	14.4	10.7	6.1	4.9	52.6
Germany	China	Poland	Russia	Turkey	France	
	11.5	6.1	5.8	3.5	2.9	29.8
France	China	Germany	Italy	Spain	Poland	
	7.6	2.8	1.9	1.6	1.4	15.3
U.K.	China	India	Ireland	Greece	U.S.	
	14.1	6.8	4.6	4.6	4.5	34.6

Note: 1) Since the definition of students from overseas and foreign students differs in each country, it is necessary to pay attention when making international comparisons.
2) "Foreign students" for Japan and France refers to students who are not citizens of their host countries.
3) "International students" for U.S. and U.K. refers to students who do not reside permanently or long-term in their host countries.
4) "International students" for Germany refers to students who received their last education before higher education in another country.
Source: OECD, "Education at a Glance".

Column: The International Science Olympiads

The International Science Olympiads are international competitions in science and technology for secondary students in participating countries. Their purposes are to find talented students in various countries and provide them with opportunities to develop their talents, to facilitate international interactions among students and educators and to promote the development of the relevant research areas. They originally began with the International Mathematical Olympiad. In addition to mathematics, there are Olympiads for fields such as physics, chemistry, biology and informatics. This column will compare medal counts for the five Olympiads mentioned above.

Chart 3-5-1 shows comparative national medal counts for the Olympiads since 2003.

The International Mathematical Olympiad began in 1959. Japan has been participating since 1990. In this Olympiad, Japan had one Gold Medal, three Silvers and two Bronzes in 2003. In 2009, however, Japan increased its gold medal count with five Golds and one Bronze. Still, China led the Gold Medal count with six, as each member of its team took one.

The International Physics Olympiad began in 1967. Japan only recently began participating, first competing in 2006. In its first year, Japan took no Gold Medals, although four of its five team members did bring home a medal of some type. In 2009, every team member received a medal, including two Golds. China is prominent in the International Physics Olympiad as well, but U.S. and Korea also took home four Gold Medals each in 2009.

The International Chemistry Olympiad was first held in 1968, and Japan began participating in 2003. Japan's four-member team in 2003 captured two Bronze Medals. In 2009, each of the four members took home a medal; two were Gold. Looking at other countries in 2009, China and Korea each received three Gold Medals.

The first International Olympiad in Informatics was held in 1989. Japan first participated in 1994, but did not participate from 1997 through 2005. In its return in 2006, Japan took two Gold Medals and one Bronze. In 2009, with two Golds, one Silver and one Bronze, every team member received a medal. As for other countries, China has captured the most Gold Medals, and every member of U.S. teams every year since 2003 has won a medal.

The International Biology Olympiad began in 1990. Japan's participation in this Olympiad began relatively recently as well, in 2005. Japan's four team members in 2005 took home two Bronze Medals. In 2009, Japan captured its first Gold Medal, along with three Silvers, as every member of its team medaled. Looking at other countries, every member of the American and Chinese teams received a Gold Medal in 2009.

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.

Chart 3-5-1: Medal counts of major countries in the International Science Olympiads

(Unit: medals)

Year held	Medals	Mathematics							Physics						
		Japan	U.S.	Germany	France	U.K.	China	Korea	Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	1	4	1	0	1	5	2	-	3	1	-	-	-	3
	Silver	3	2	2	2	2	1	4	-	2	2	-	-	-	2
	Bronze	2	0	1	2	3	0	0	-	0	1	-	-	-	0
2004	Gold	2	5	0	0	1	6	2	-	2	1	-	0	5	4
	Silver	4	1	3	0	1	0	2	-	2	0	-	1	0	0
	Bronze	0	0	1	4	4	0	2	-	1	3	-	1	0	1
2005	Gold	3	4	1	0	1	5	3	-	2	1	0	0	5	2
	Silver	1	2	3	0	3	1	3	-	2	1	0	0	0	0
	Bronze	2	0	2	4	2	0	0	-	1	1	5	2	0	3
2006	Gold	2	2	4	1	0	6	4	0	4	2	0	0	5	4
	Silver	3	4	0	0	4	0	2	1	1	2	2	0	0	1
	Bronze	1	0	2	3	1	0	0	3	0	1	3	5	0	0
2007	Gold	2	2	1	1	1	4	2	2	2	0	1	1	4	2
	Silver	4	3	3	0	0	2	4	2	3	5	3	1	1	3
	Bronze	0	1	1	2	3	0	0	1	0	0	1	1	0	0
2008	Gold	2	4	1	0	0	5	4	1	4	1	0	0	5	4
	Silver	3	2	2	1	4	1	2	1	1	1	4	0	0	1
	Bronze	1	0	3	4	2	0	0	1	0	3	1	4	0	0
2009	Gold	5	2	1	0	1	6	3	2	4	0	0	0	5	4
	Silver	0	4	4	1	3	0	3	1	1	5	3	3	0	1
	Bronze	1	0	1	3	2	0	0	2	0	0	2	2	0	0

(Unit: medals)

Year held	Medals	Chemistry							Informatics						
		Japan	U.S.	Germany	France	U.K.	China	Korea	Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	0	0	2	0	0	4	2	-	2	0	0	0	1	2
	Silver	0	1	1	2	3	0	2	-	2	2	1	2	2	2
	Bronze	2	3	1	2	1	0	0	-	0	1	1	0	1	0
2004	Gold	1	0	2	0	0	4	3	-	2	1	0	1	4	1
	Silver	0	4	2	1	2	0	1	-	2	0	0	2	0	2
	Bronze	3	0	0	2	2	0	0	-	0	3	3	0	0	0
2005	Gold	0	0	0	0	1	-	4	-	4	0	1	0	4	2
	Silver	1	3	4	1	0	-	0	-	0	2	1	1	0	1
	Bronze	3	1	0	1	3	-	0	-	0	2	1	0	0	1
2006	Gold	1	0	1	0	0	4	3	2	1	0	0	0	4	1
	Silver	3	3	2	2	1	0	1	0	3	0	1	0	0	3
	Bronze	0	1	1	1	3	0	0	1	0	2	2	2	0	0
2007	Gold	0	0	2	1	0	4	3	1	2	1	0	0	4	0
	Silver	0	3	2	0	2	0	1	1	1	0	0	0	0	2
	Bronze	4	1	0	1	2	0	0	1	1	0	3	2	0	2
2008	Gold	0	0	1	0	0	4	3	1	2	1	0	0	3	1
	Silver	0	1	0	1	2	0	0	1	2	0	0	3	1	3
	Bronze	4	3	3	3	2	0	1	2	0	2	1	0	0	0
2009	Gold	2	1	1	1	0	3	3	2	2	1	0	0	3	3
	Silver	1	3	2	1	4	1	0	1	2	0	0	0	1	0
	Bronze	1	0	1	1	0	0	1	1	0	1	4	2	0	1

(Unit: medals)

Year held	Medals	Biology						
		Japan	U.S.	Germany	France	U.K.	China	Korea
2003	Gold	-	0	0	-	0	3	1
	Silver	-	2	2	-	1	1	3
	Bronze	-	2	2	-	3	0	0
2004	Gold	-	4	1	-	2	2	1
	Silver	-	0	2	-	2	2	3
	Bronze	-	0	1	-	0	0	0
2005	Gold	0	2	0	-	1	4	3
	Silver	0	2	3	-	2	0	1
	Bronze	2	0	1	-	1	0	0
2006	Gold	0	2	0	-	0	4	3
	Silver	0	2	2	-	3	0	1
	Bronze	3	0	2	-	1	0	0
2007	Gold	0	4	0	0	2	4	4
	Silver	1	0	1	0	1	0	0
	Bronze	3	0	2	3	1	0	0
2008	Gold	0	4	1	0	0	2	3
	Silver	3	0	1	3	3	2	1
	Bronze	1	0	2	1	1	0	0
2009	Gold	1	4	0	0	1	4	1
	Silver	3	0	3	2	3	0	3
	Bronze	0	0	1	2	0	0	0

Notes: Team sizes for the various Olympiads are six people or fewer for Mathematics, five or fewer for Physics, four or fewer for Chemistry, four or fewer for Biology and four or fewer for Informatics.

<Japan> Data are since 2006 for Physics, since 2005 for Biology and since 2006 for informatics.

<France> Data are from 2005 for Physics and 2007 for Biology.

<U.K.> Data are from 2004 for Physics.

Source: Research by the Japan Science and technology Agency

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 international co-authorship 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 2007–2009), in terms of the "degree of participation in the production of papers in the world" Japan is ranked fifth in the world, after U.S., China, U.K. and Germany. Meanwhile, although in terms of the "degree of contribution to the production of papers in the world" Japan ranks third, behind U.S. and China, it outranks U.K. and Germany.

○China has increased both in terms of the "degree of participation in the production of papers in the world" and the "degree of contribution to the production of papers in the world" since the late 1990s, holding second place in the world during the latter half of the 2000s.

○Looking at the balance of the fields in Japan, the share of Chemistry has decreased and that of Clinical medicine has increased.

○On the other hand, looking at the field portfolios in main countries by world share, Japan has more weight on Chemistry, Material science and Physics, and less weight on Computer science/Mathematics, Environment/Geoscience, Basic life sciences and Clinical medicine. In U.S. and U.K., there is much weight placed on Basic life sciences and Clinical medicine.

○The percentage of international co-authorship for 2009 was 50% for Germany, 51% for U.K. and 51% for France, while U.S. was 32% and Japan was 26%.

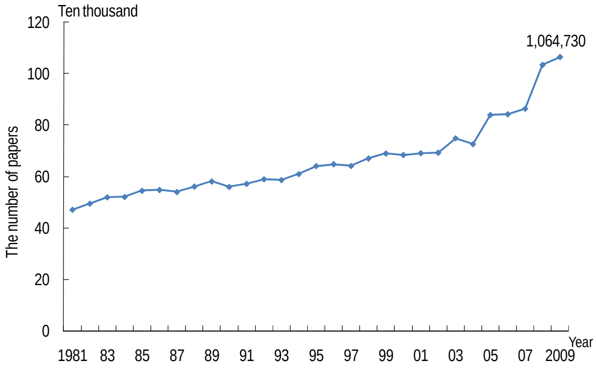
4.1.1 Quantitative and qualitative changes in research activities in the world

(1) The change in the numbers of papers

Chart 4-1-1 shows the change in the quantity of the world's papers. Some revisions to the types of papers included in Thomson Reuters' database are made every year. Changes such as handling some articles as proceedings have been made. It should be noted therefore that the figures in the charts in this report and the figures in Survey Material 170 do not match.

Compared with the early 1980s, the quantity of papers presented in the world has more than doubled, and the world's research activities have a consistent tendency to expand from a quantitative standpoint today. For this period, journals recorded in Databases, which have been used for analysis, were revised in order of precedence, and the numbers of the journals has been enlarged. This factor is contributing to expanding the numbers of papers as well.

Chart 4-1-1: The change in the numbers of papers in the world



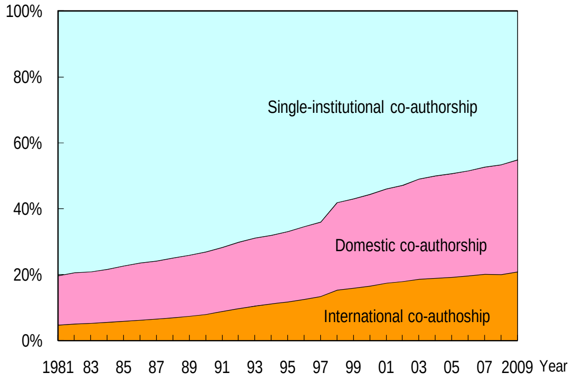
Note: Analyzed article, letter, note, review by whole counting
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

(2) The change in the style of the production of papers

While research activities in the world have moved toward a quantitative expansion, the style of research activities has changed to a large extent. Chart 4-1-2 shows the change in form of the co-authorship of papers in main countries by the three categories: ① Single-institutional co-authorship papers (Papers by authors who belong to a single institute), ② Domestic co-authorship papers (Papers by authors who belong to multiple institutes located in a single country), ③ International co-authorship 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 international co-authorship papers has increased. In the 1980s, single-institutional co-authorship papers accounted for approximately 80%, however, after that, domestic co-authorship papers and international co-authorship papers increased. It can be said that activities for knowledge production have been done by transcending the framework of institutes and countries.

Chart 4-1-2: The change in the ratio of the co-authorship forms in the world



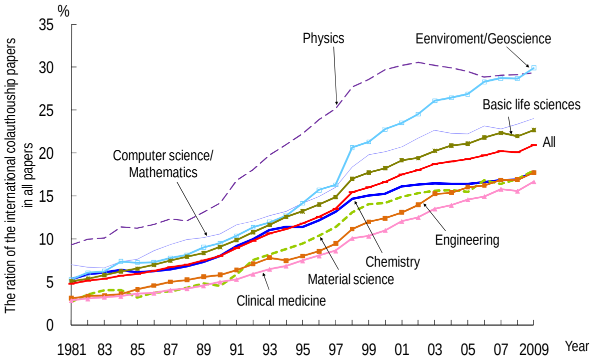
Note: Analyzed article, letter, note, review by whole counting
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

Moreover, since international co-authorship 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 international co-authorship papers by field.

In every field, the ratio of international co-authorship papers has been on an upward trend from the early 1980s up to the present date. And it can be seen that the ratio of international co-authorship papers is higher in Environment/Geoscience and Physics than in the other fields. At the same time, the share of Clinical Medicine is 16.7%, which is the lowest ratio of international co-authorship papers.

Chart 4-1-3: International co-authorship papers by field

(A) The change in the percentage



(B) Classification fields

Category	Consolidated ESI 22 field classification
Chemistry	Chemistry
Material science	Material science
Physics	Physics, Space science
Computer science/ Mathematics	Computer science, Mathematics
Engineering	Engineering
Environment/ Geoscience	Environment/Ecology, Geoscience
Clinical Medicine	Clinical medicine, Psychiatry/Psychology
Basic life sciences	Agricultural science,Biology・Biochemistry, Immunology, Microbiology, Molecular biology・Genetics, Neuroscience・Behavioristics, Pharmacology・Toxicology, Botany・Zoology

Note: 1) Analyzed article, letter, note, review by whole counting
2) Used (B) for the classification fields of (A).
3) Reclassified the papers included in "Web of Science" by ESI22 classification fields and analyzed by field for the classification fields of (B). By http://www.in-cites.com/journal-list/index.html (2010 March) for the classification of journals. Analyzed ESI19 classification fields excluded Economics/Economic & Business, Multidisciplinary and Social science general.

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

4.1.2 A comparison of research activities by country

(1) International comparison of countries by “the degree of participation in the production of papers in the world” and “the degree of contribution to the production of papers in the world”

As an “easily understandable indicator”, the numbers of papers is used for measuring the quantity of a country’s capacity for scientific research, and the number of times cited or the number of top 10% papers is applied to indicate quality. Top 10% papers mean papers which the number of times cited (value at the end of 2009) enter into the top 10% in each field. Since the average number of times cited is different for each field, top 10% papers are analyzed by field in order to standardize differences. The fields are pursuant to Chart 4-1-3.

There are two methods for the counting (Chart 4-1-4), which are the whole counting and the fractional counting. It is considered that the whole counting measures “the degree of participation in the production of papers in the world” and the fractional counting measures “the degree of contribution to the production of papers in the world”.

Chart 4-1-5 shows the numbers of each country or region’s papers, that of Top 10% papers and a ranking in the world by applying the method of whole counting and fractional counting. Since the numbers of each country’s papers is different according to the method of counting, the rankings may be different in each case.

For 1987–1989, differences were not seen on each country’s ranking in the world by the counting method, however, for 1997–1999 and 2007–2009, it is can be seen that differences have appeared. This is the result of international co-authorship papers having increased and differences in intensity by counting of international co-authorship. As shown in Chart 4-1-11, there are large differences between countries with high ratio of international co-authorship and countries with low ratio. The ratio of co-authorship is high in Europe, but trends lower in Japan and U.S.

Chart 4-1-4: The methods of whole counting and fractional counting

	Whole counting method	Fractional counting method
The ways of counting	In the case of international co-authorship papers, 1 is counted for each country. Therefore, when the world shares of the number of papers for each country are summed up, it is over 100%.	In case of international co-authorship papers (for instance, co-authorship by Country A and Country B), the counting is done so that Country A is 1/2 and Country B is 1/2. Therefore, when the world shares of the number of papers for each country are summed up, it totals 100%.
The sorts of targeted papers for analysis	Article, Review, Letter & Note	Article, Review, Letter & Note
The number of papers	Degree of Participation in producing papers in the world	Degree of Contribution to the production of papers in the world
The number of the top 10% papers	Degree of Participation in high impact papers in the world	Degree of Contribution to the production high impact papers in the world

Note: Top 10% papers means the papers which the number of times cited make the top 10% in each field. The fields are made according to the note of Chart4-1-3(B).The value of the end of 2009 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

1987 - 1989 (Average)						
The number of papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	192,730	34.4	1	182,984	32.6	1
U.K.	48,107	8.6	2	44,135	7.9	2
Germany	41,818	7.5	3	37,704	6.7	4
Japan	40,990	7.3	4	39,329	7.0	3
Russia	37,631	6.7	5	36,924	6.6	5
France	30,701	5.5	6	27,502	4.9	6
Canada	25,214	4.5	7	22,594	4.0	7
Italy	15,630	2.8	8	13,899	2.5	8
India	14,219	2.5	9	13,676	2.4	9
Australia	11,975	2.1	10	10,967	2.0	10
Netherlands	10,989	2.0	11	9,700	1.7	11
Sweden	9,546	1.7	12	8,300	1.5	12
Spain	8,468	1.5	13	7,762	1.4	13
Switzerland	7,756	1.4	14	6,282	1.1	14
China	6,742	1.2	15	6,077	1.1	15
Israel	6,109	1.1	16	5,195	0.9	16
Poland	5,710	1.0	17	4,985	0.9	17
Belgium	5,411	1.0	18	4,568	0.8	18
Denmark	4,568	0.8	19	3,921	0.7	19
Czechoslovakia	4,138	0.7	20	3,769	0.7	20
Finland	3,682	0.7	21	3,271	0.6	22
South Africa	3,575	0.6	22	3,350	0.6	21
Austria	3,479	0.6	23	3,012	0.5	23
Brazil	2,907	0.5	24	2,541	0.5	24
Hungary	2,905	0.5	25	2,456	0.4	25

1987 - 1989 (Average)						
The number of Top 10% papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	30,937	56.5	1	29,043	53.0	1
U.K.	5,440	9.9	2	4,715	8.6	2
Germany	3,568	6.5	3	2,917	5.3	4
Japan	3,470	6.3	4	3,200	5.8	3
Canada	3,029	5.5	5	2,542	4.6	5
France	2,831	5.2	6	2,286	4.2	6
Netherlands	1,433	2.6	7	1,188	2.2	7
Australia	1,342	2.5	8	1,152	2.1	8
Sweden	1,305	2.4	9	1,063	1.9	9
Italy	1,256	2.3	10	968	1.8	10
Switzerland	1,158	2.1	11	846	1.5	11
Israel	645	1.2	12	471	0.9	12
Denmark	560	1.0	13	431	0.8	13
Belgium	529	1.0	14	387	0.7	14
Spain	436	0.8	15	338	0.6	15
Russia	374	0.7	16	320	0.6	16
Finland	374	0.7	16	305	0.6	17
India	291	0.5	18	248	0.5	18
China	286	0.5	19	207	0.4	21
Norway	286	0.5	19	227	0.4	19
Austria	276	0.5	21	198	0.4	22
New zealand	258	0.5	22	210	0.4	20
Poland	218	0.4	23	148	0.3	23
South Africa	159	0.3	24	133	0.2	24
Brazil	135	0.2	25	90	0.2	26

1997 - 1999 (Average)						
The number of papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	210,357	31.5	1	187,706	28.1	1
Japan	60,347	9.0	2	55,147	8.3	2
U.K.	60,289	9.0	3	49,753	7.5	3
Germany	54,632	8.2	4	44,008	6.6	4
France	41,367	6.2	5	33,378	5.0	5
Canada	28,467	4.3	6	22,950	3.4	6
Italy	26,399	4.0	7	21,632	3.2	7
Russia	24,316	3.6	8	20,680	3.1	8
China	21,098	3.2	9	18,440	2.8	9
Spain	19,126	2.9	10	15,915	2.4	10
Australia	17,945	2.7	11	14,769	2.2	12
India	16,086	2.4	12	14,838	2.2	11
Netherlands	15,742	2.4	13	12,181	1.8	13
Sweden	12,925	1.9	14	9,871	1.5	14
Switzerland	11,577	1.7	15	7,996	1.2	15
Korea	9,105	1.4	16	7,896	1.2	16
Belgium	8,358	1.3	17	6,057	0.9	20
Taiwan	8,221	1.2	18	7,497	1.1	17
Israel	7,912	1.2	19	6,188	0.9	19
Brazil	7,683	1.2	20	6,228	0.9	18
Poland	7,169	1.1	21	5,539	0.8	21
Denmark	6,561	1.0	22	4,712	0.7	22
Finland	6,008	0.9	23	4,705	0.7	23
Austria	5,746	0.9	24	4,311	0.6	24
Turkey	4,409	0.7	25	3,969	0.6	25

1997 - 1999 (Average)						
The number of Top 10% papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	32,535	50.1	1	28,422	43.8	1
U.K.	7,480	11.5	2	5,574	8.6	2
Germany	6,218	9.6	3	4,434	6.8	3
Japan	4,883	7.5	4	4,058	6.2	4
France	4,508	6.9	5	3,182	4.9	5
Canada	3,650	5.6	6	2,619	4.0	6
Italy	2,749	4.2	7	1,877	2.9	7
Netherlands	2,377	3.7	8	1,666	2.6	8
Australia	1,941	3.0	9	1,411	2.2	9
Switzerland	1,926	3.0	10	1,177	1.8	10
Sweden	1,696	2.6	11	1,132	1.7	12
Spain	1,665	2.6	12	1,146	1.8	11
China	1,137	1.8	13	838	1.3	13
Belgium	1,046	1.6	14	629	1.0	14
Denmark	983	1.5	15	621	1.0	15
Israel	894	1.4	16	582	0.9	16
Finland	769	1.2	17	525	0.8	17
Russia	719	1.1	18	331	0.5	22
Austria	613	0.9	19	383	0.6	21
Korea	604	0.9	20	455	0.7	19
Taiwan	571	0.9	21	470	0.7	18
India	511	0.8	22	389	0.6	20
Norway	495	0.8	23	307	0.5	23
Poland	377	0.6	24	193	0.3	26
New zealand	375	0.6	25	263	0.4	24

2007 - 2009 (Average)						
The number of papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	275,625	27.9	1	230,412	23.3	1
China	104,157	10.5	2	92,123	9.3	2
U.K.	75,914	7.7	3	53,687	5.4	4
Germany	73,849	7.5	4	53,174	5.4	5
Japan	69,300	7.0	5	59,911	6.1	3
France	53,707	5.4	6	38,308	3.9	6
Canada	44,379	4.5	7	32,283	3.3	8
Italy	43,528	4.4	8	33,430	3.4	7
Spain	35,716	3.6	9	27,309	2.8	10
India	35,437	3.6	10	31,742	3.2	9
Australia	30,085	3.0	11	22,111	2.2	12
Korea	30,016	3.0	12	25,759	2.6	11
Russia	25,166	2.5	13	20,465	2.1	14
Brazil	25,081	2.5	14	21,587	2.2	13
Netherlands	23,981	2.4	15	16,410	1.7	17
Taiwan	19,882	2.0	16	17,696	1.8	15
Turkey	18,623	1.9	17	16,994	1.7	16
Switzerland	18,051	1.8	18	10,636	1.1	20
Sweden	16,633	1.7	19	10,839	1.1	19
Poland	14,885	1.5	20	11,785	1.2	18
Belgium	13,386	1.4	21	8,579	0.9	22
Iran	11,171	1.1	22	10,019	1.0	21
Israel	9,956	1.0	23	7,335	0.7	23
Denmark	9,421	1.0	24	5,977	0.6	25
Greece	9,353	0.9	25	7,259	0.7	24

2007 - 2009 (Average)						
The number of Top 10% papers						
Country	Whole counting			Fractional counting		
	The number of papers	Share	World rank	The number of papers	Share	World rank
U.S.	35,900	43.2	1	29,173	35.1	1
U.K.	9,840	11.8	2	6,047	7.3	2
Germany	9,111	11.0	3	5,642	6.8	3
China	6,669	8.0	4	5,291	6.4	4
France	5,940	7.1	5	3,517	4.2	6
Japan	5,283	6.4	6	3,977	4.8	5
Canada	5,103	6.1	7	3,107	3.7	7
Italy	4,630	5.6	8	2,834	3.4	8
Netherlands	3,553	4.3	9	2,058	2.5	11
Spain	3,492	4.2	10	2,162	2.6	10
Australia	3,447	4.1	11	2,183	2.6	9
Switzerland	2,955	3.6	12	1,482	1.8	12
Sweden	2,041	2.5	13	1,040	1.3	15
Korea	1,890	2.3	14	1,392	1.7	13
Belgium	1,785	2.1	15	936	1.1	17
India	1,557	1.9	16	1,204	1.4	14
Denmark	1,370	1.6	17	713	0.9	18
Taiwan	1,279	1.5	18	1,004	1.2	16
Austria	1,125	1.4	19	562	0.7	22
Brazil	1,122	1.3	20	701	0.8	19
Israel	1,012	1.2	21	581	0.7	21
Finland	968	1.2	22	528	0.6	23
Norway	841	1.0	23	423	0.5	27
Russia	816	1.0	24	327	0.4	30
Greece	763	0.9	25	448	0.5	26

Source: Complied d by NISTEP based on Thomson Reuters Scientific “Web of Science”

(2) A comparison of the share of the numbers of papers

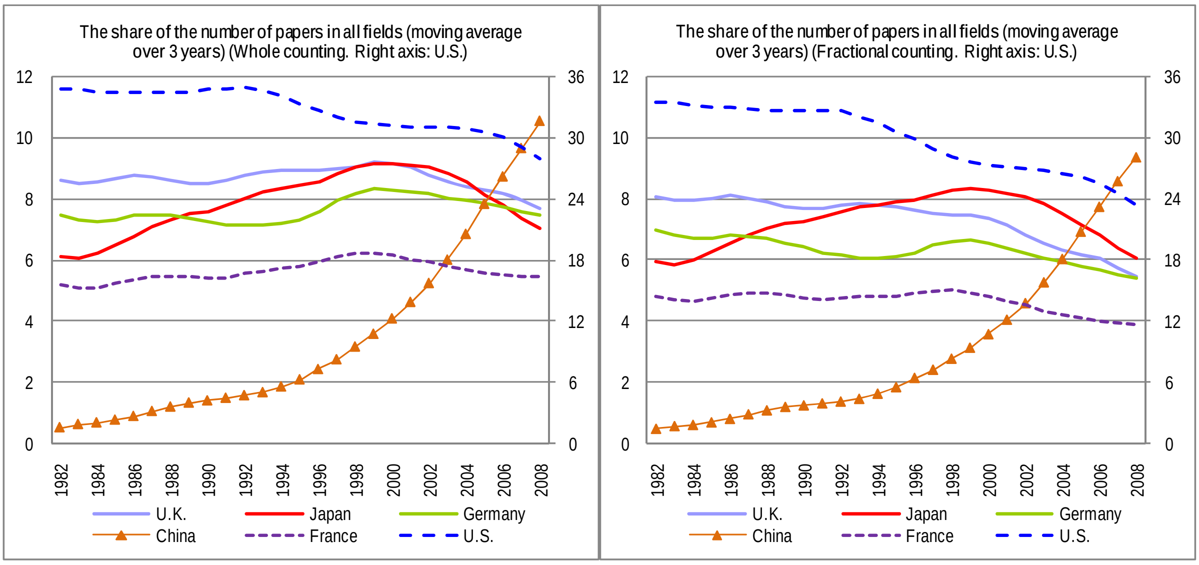
First, Chart 4-1-6 shows each county's share in the number of papers in the world, in order to grasp the quantitative aspect of each country's research activities. The results of the whole counting, degree of participation in the production of papers, and of the fractional counting, degree of contribution to the production of papers, were shown. Looking at the "degree of participation in the production of papers in the world", U.S. largely outperforms the other countries and it can be said that 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, U.K., Japan, Germany and France continued to follow after U.S. However, China has increased the quantity of its production of papers since the late 1990s. Japan ranked fifth in the world in 2008 (2007–2009 average), behind U.S., China, U.K. and Germany.

On the other hand, Japan became the world second largest in terms of the "degree of contribution to producing papers in the world" after 1995, and maintained the same position for about 10 years. However, it was surpassed by China and became the world's third largest country in 2008 (2007–2009 average). In addition, the gap between Japan and U.K. and Germany is shrinking.

Chart 4-1-6**:** The change in the share of the numbers of papers in main countries (All fields, moving average over 3 years)

(A) Degree of participation in the production of papers in the world

(B) Degree of contribution to the production of papers in the world



Note: Moving average over 3 years of the share of the papers in all fields (if the year is 2008, the average value from 2007 to 2009). (A) is whole counting; (B) is fractional counting.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

(3) A comparison of the numbers of Top 10% papers

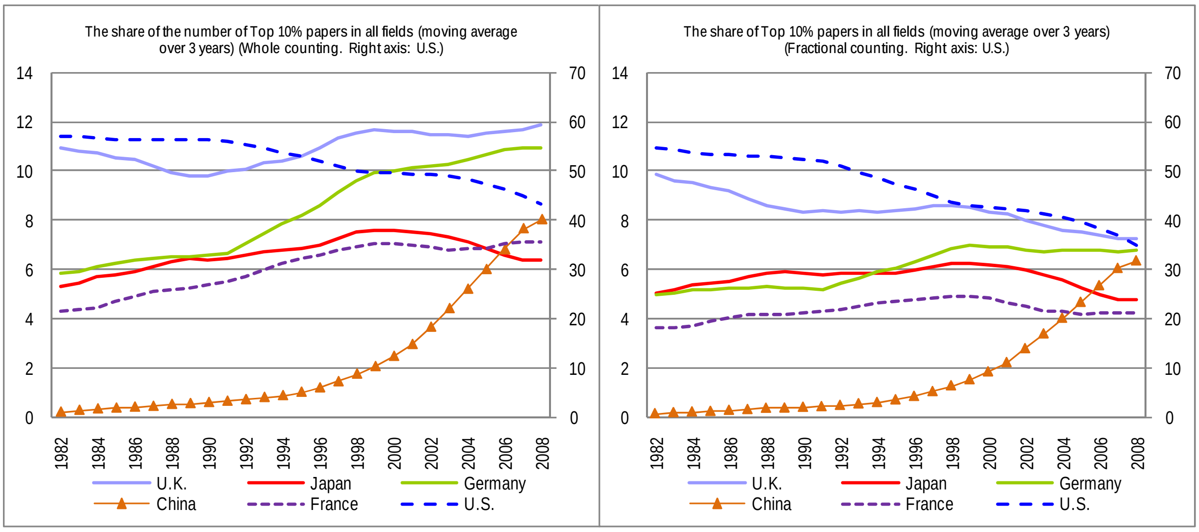
Next, Chart 4-1-7 shows each county's share in the number of top 10% papers in the world, in order to understand the qualitative aspect of each country's research activities. The results of the whole counting, degree of participation in the production of top 10% papers, and of the fractional counting,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

Regarding the “degree of participation in high impact papers in the world”, U.K. and Germany have sharply increased their share since the 1990s, and gotten a big lead on Japan. Japan is sixth, behind U.S., U.K., Germany, China and France.

On the other hand, regarding the “degree of contribution to the production of high impact papers in the world”, U.S. and U.K. have had a downward turn over the past 20 years, and Germany has moderately increased its share, but during the 2000s the trend has been flat.

Japan’s share dropped suddenly during the 2000s. It now ranks fifth, behind U.S., U.K., Germany and China.

Chart 4-1-7**:** The change in the share of the numbers of Top 10% papers in main countries
(All fields, moving average over 3 years)



(A) The degree of participation in high impact papers in the world

(B) The degree of contribution to the production of high impact papers in the world

Note: Moving average over 3 years on the share of the papers in all fields was applied(if the year is 2008, the average value from 2007 to 2009). (A) is whole counting; (B) is fractional counting. The number of citations is the value as of the end of 2009.
Source: Compiled by NISTEP based on Thomson Reuters Scientific “Web of Science”

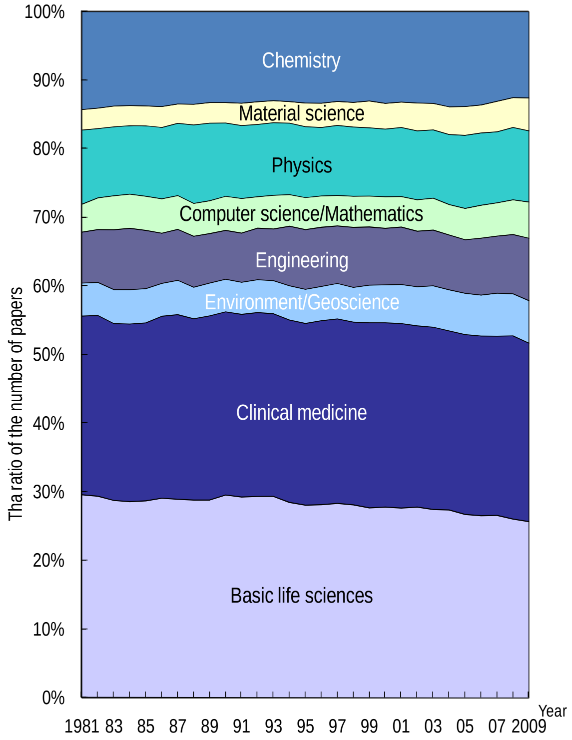
4.1.3 The characteristics of the research activities of main countries

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

While there are a variety of fields of research activities, the number of papers and the number of times cited are influenced by whether emphasis is placed on the production of papers in each field of research activities, by whether the number of researchers is large or small, and by whether the numbers of past papers that each paper refers to is large or small on average. Therefore, in the case of comparing countries, it is also important not only to look at the total number of papers and the number of times cited but also to understand the research activities of each field. Here, the method of whole counting is used in order to see the percentage of each field in the world and for every country.

First, Chart 4-1-8 shows the change in the ratio of the numbers of papers which each field occupies throughout the world. Comparing 1981 with 2009, the ratios of Basic life sciences (3.5%) and Chemistry (1.5%) have slightly declined, while Material science, Computer science/Mathematics, Engineering, Environment/Geoscience have somewhat increased. However, Life sciences such as Basic life sciences and Clinical medicine account for approximately half of papers, even though their shares are on a downward trend.

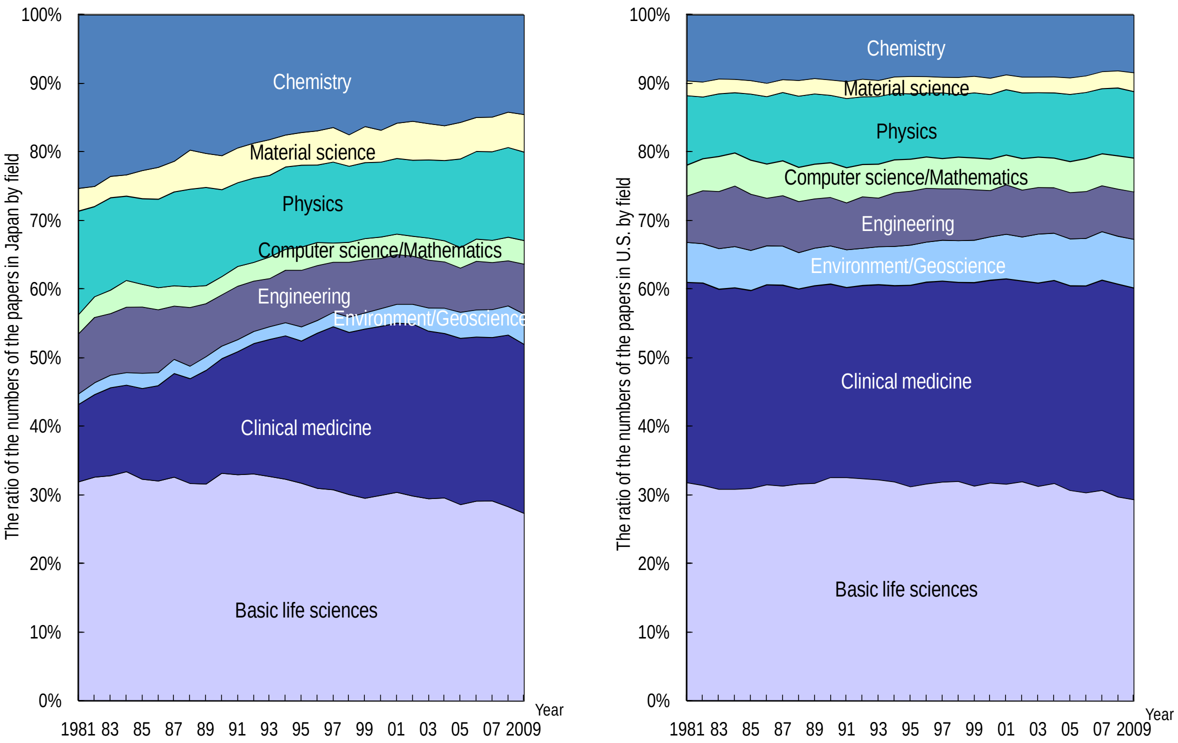
Chart 4-1-8: The change in the ratio of the numbers of the papers in the world by field



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

Next, Chart 4-1-9 provides the change in the share of papers in the main countries for each field, in order to see the internal structure of main countries. Japan had large shares in Basic life sciences, Chemistry and Physics in the early 1980s. Comparing 1981 with the most recent available year, however, Chemistry has fallen by 9.4 percentage points and Basic life sciences by 3.0 percentage points.. On the other hand, Clinical medicine has risen by 13.7 percentage points, and Environment/Geoscience and Material science have been on an expanding trend. U.S. has not shown a big change from the 1980s until now. In Germany, the shares of Chemistry and Basic life sciences declined, while that of Environment/Geoscience, Clinical medicine and Physics somewhat increased. In U.K. and France, the ratio of Basic life sciences declined, and those of Environment/Geoscience and Physics increased. Regarding Asia, the ratio of the field of Life sciences such as Basic life sciences and Clinical medicine in Korea and China was somewhat low compared with other main countries.

Chart 4-1-9**:** The change in the ratio of the numbers of the papers in main countries by field

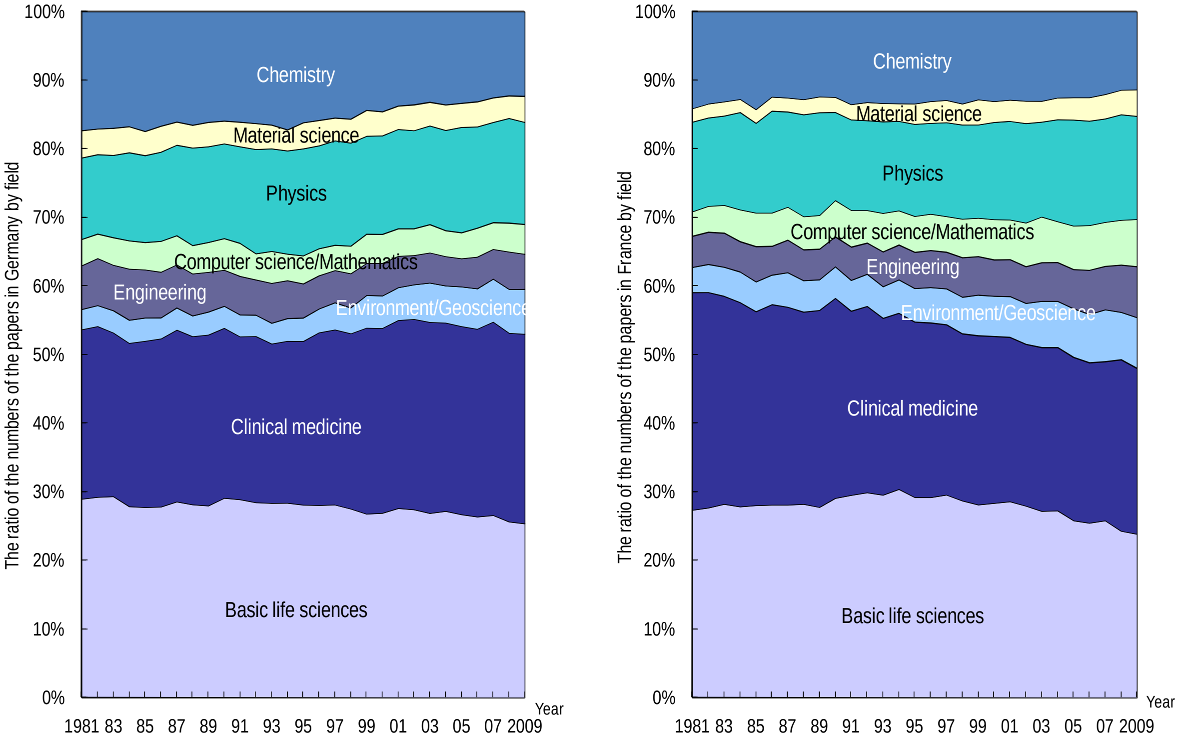


(A) Japan

(B) U.S.

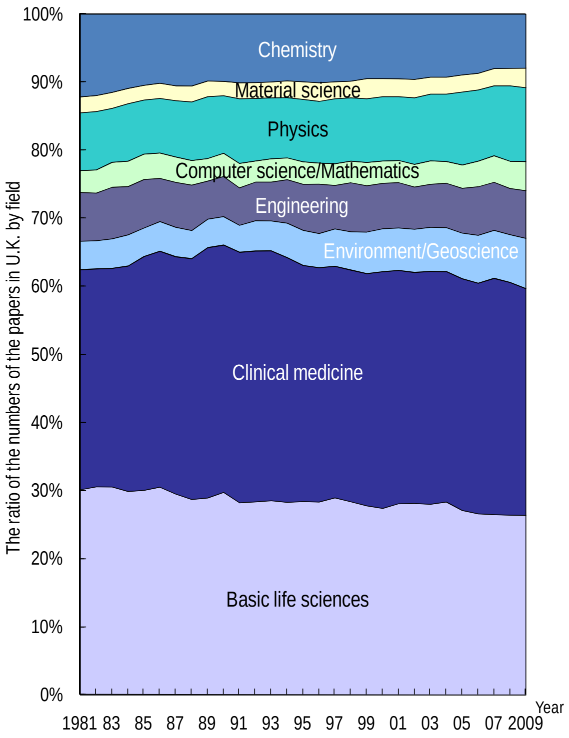
(C) Germany

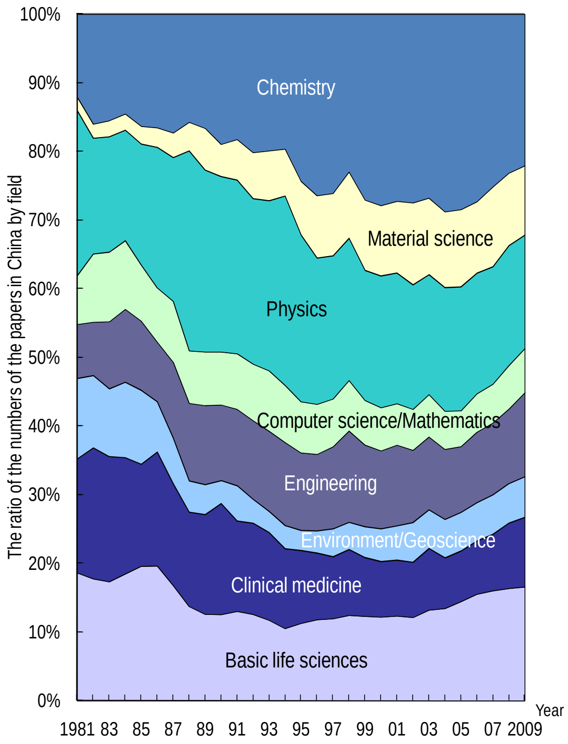
(D) France



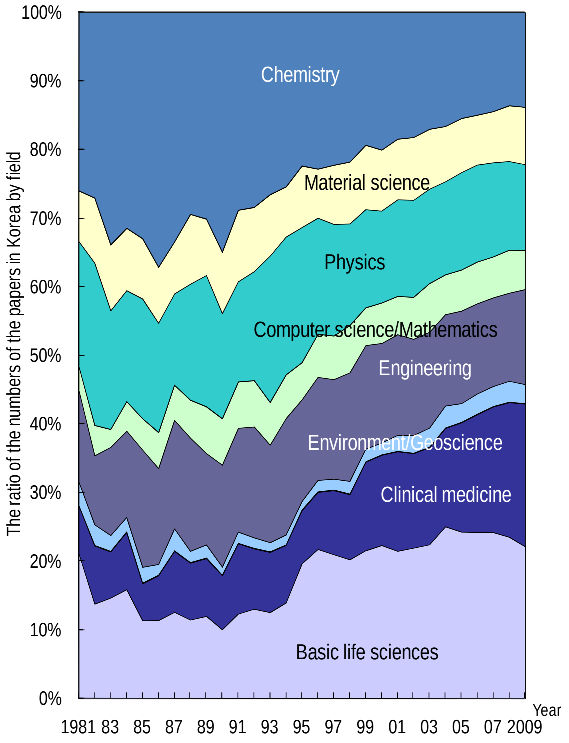
(E) U.K.

(F) China





(G) Korea



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

(2) A comparison of the field balance by quantity and quality in the main countries

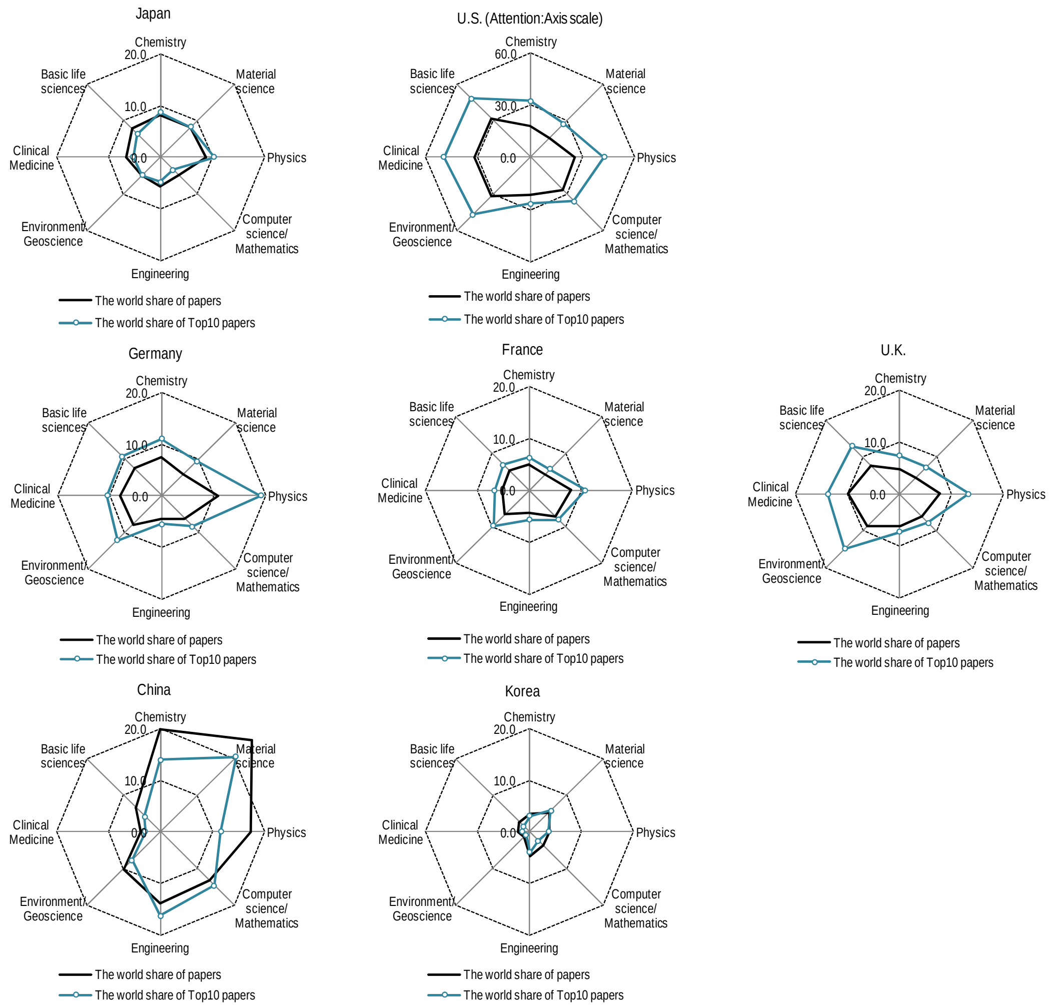
In Chart 4-1-10, a comparison is shown, which is the results of field portfolio (2007–2009) of the share of papers and the share of Top 10% papers. Here the whole counting method is used, in order to find the ratio that is occupied by each field in the world and in each country from the viewpoint of participation.

Comparing the papers share and Top 10% papers share, the countries can be divided into those where the Top 10% papers share is higher than the overall papers share (U.S., U.K., Germany and France) and the countries where the Top 10% share is lower than the overall papers share (Japan, China and Korea). Looking at the Top 10% papers share, the strengths and weaknesses of each country are more highlighted than in the field balance by paper share.

Japan shows a portfolio where the weight of Chemistry, Material science and physics are high, and Computer science, Environment/Geoscience, Basic life sciences and Clinical medicine are low. 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 U.K. are Basic life sciences, Clinical medicine and Environment/Geoscience, while those of Germany and France are Physics and Environment/Geoscience. China shows a presence in shares of papers and Top 10% papers in Chemistry, Material science and Physics.

Chart 4-1-10: A comparison of the share of the papers and Top 10% papers in main countries by field (%, 2007–2009)

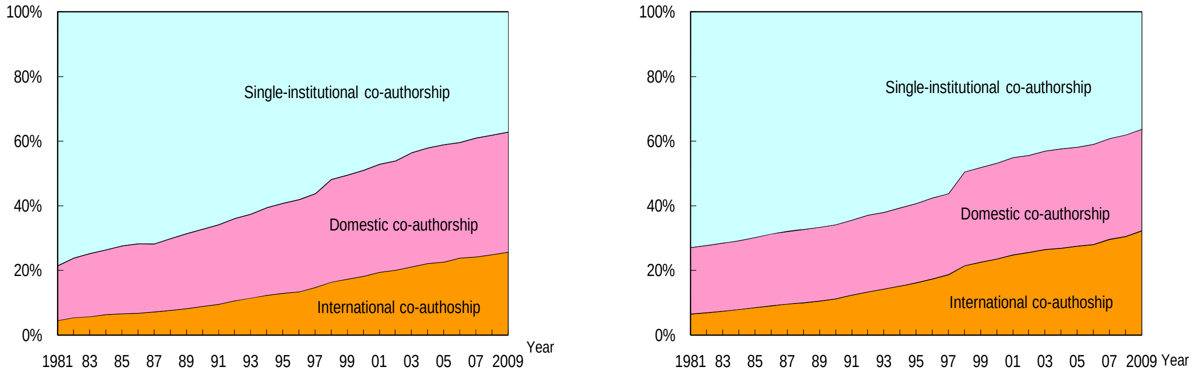


Note: Analyzed article, letter, note and review by the whole counting method. The fields are in accordance with the note of Chart 4-1-3 (B). The number of citations is the value as of the end of 2009.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

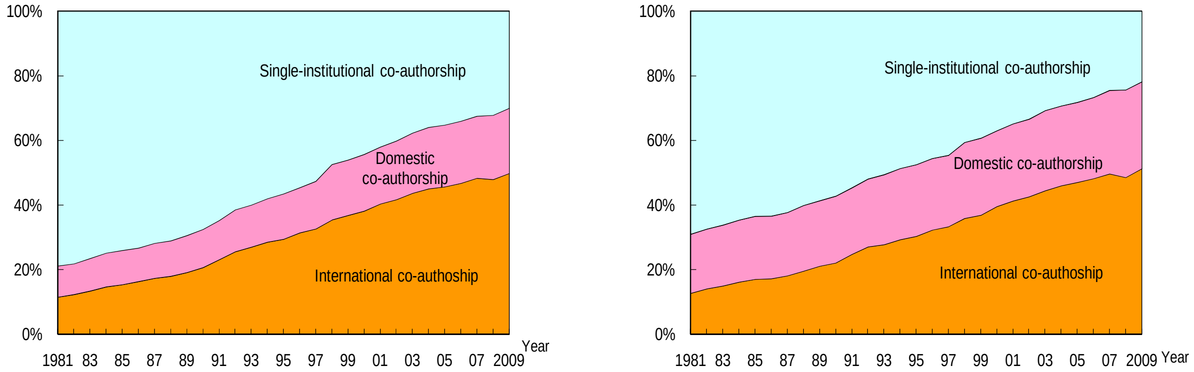
(3) The change in the production styles of papers in main countries

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 international co-authorship papers is common to every country; however, compared with Japan at 25.8% and U.S. at 32.4%, the ratio is very high in Germany at 49.8%, France at 51.3% and U.K. at 50.7%. In Japan and U.S., the ratio of domestic co-authorship papers has increased together with international co-authorship papers. However, no big change can be seen in Germany, France and U.K.

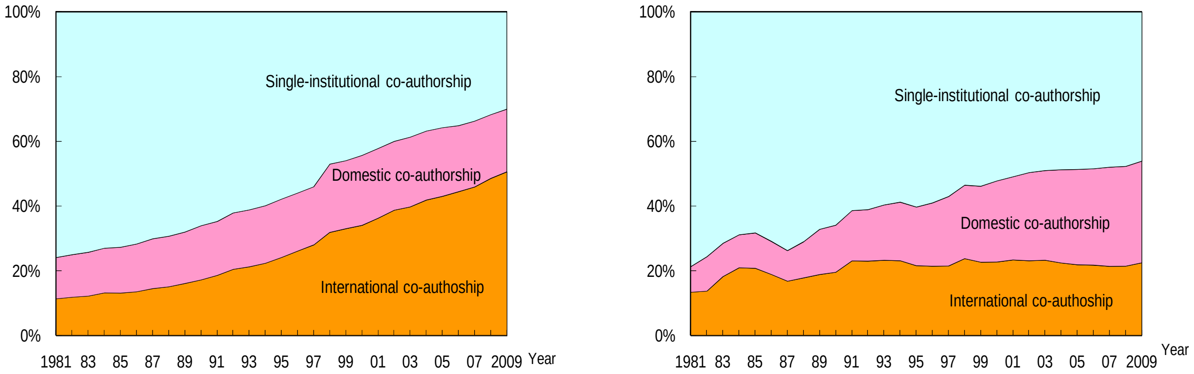
Chart 4-1-11**:** The change in the ratio of the numbers of papers in main countries by co-authorship form


(A) Japan

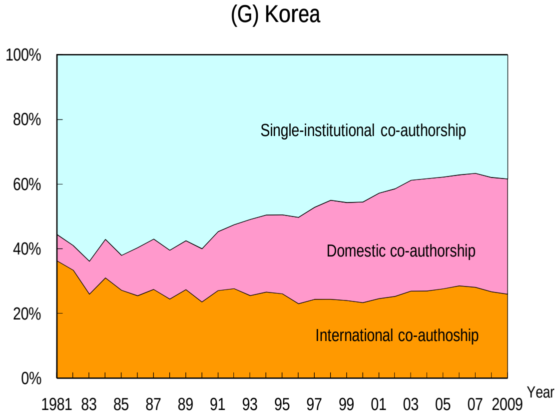
(B) U.S.


(C) Germany

(D) France


(E) U.K.

(F) China



Note: Analyzed article, letter, note and review by the whole counting method.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

Column: Times cited in domestic co-authorship papers and international co-authorship papers

What sorts of influence has the expansion of research activities across national borders given the qualitative indicator of research, that is, the number of Top 10% papers and the number of times cited? What sorts of differences exist between the research papers produced by domestic institutes (for instance, in case of Japan, it means papers produced by Japan's institutes alone) and internationally co-authored papers produced across countries (for instance, in case of Japan, co-authored papers produced by institutes in both Japan and U.S.)?

In Chart 4-1-12, a comparison was conducted whereby the papers of main countries were divided into the research papers produced by domestic institutes (hereinafter "domestic papers") and internationally co-authored papers. As it takes certain amount of time for the number of times cited to become stable, the period of 1996-2000 was targeted.

First, the ratios of domestic papers to all papers and of internationally co-authored papers to all papers were compared (Chart 4-1-12 (2)). It can be seen that European countries, such as U.K., Germany and France, maintain high ratio of internationally co-authored papers.

Next, the ratio occupied by Top 10% papers within domestic papers and internationally co-authored papers was compared (Chart 4-1-12 (3)). Basically, if a Top 10% papers share is higher than 10%, a country can be said to be producing high quality papers.

The ratio of Top 10% papers of internationally co-authored papers, compared with domestic papers alone, was higher in every country. This indicates that citation frequencies of internationally co-authored papers are higher than that of domestic papers alone.

Also, the times cited per paper in domestic papers and internationally co-authored papers was compared (Chart 4-1-12 (4)). This showed that every country had more number of times cited in internationally co-authored papers than in domestic papers. This trend was the same as that for the percentage of Top 10% papers.

Also in Japan, just as the same as in U.S., U.K. and Germany, the number of times cited in internationally co-authored papers was higher than that of domestic papers in the case of the percentage of Top 10% papers ((3)) and the number of times cited per paper ((4)). However, as shown in Chart 4-1-12 (2), the percentage of internationally co-authored papers was low in Japan, and it is considered that this is one of the reasons why the number of times cited of entire papers was lower than for U.K. and Germany.

Chart 4-1-12: A comparison of papers in main countries, when divided into domestic papers and internationally co-authored papers (1996-2000)

Country	(1) The number of papers (Volume)			(2) The ratio of the number of papers (%)			(3) The ratio of Top 10 % papers (%)			(4) The number of times cited per paper		
	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers	All papers	Domestic papers	Internationally co-authored papers
U.S.	1,244,956	995,373	249,583	100.0	80.0	20.0	14.5	13.5	18.4	21.2	20.0	25.9
U.K.	357,832	250,920	106,912	100.0	70.1	29.9	11.4	9.1	16.8	16.9	13.6	24.4
Japan	353,123	295,925	57,198	100.0	83.8	16.2	7.9	6.7	14.0	12.6	11.1	20.7
Germany	327,538	215,081	112,457	100.0	65.7	34.3	11.1	8.6	15.8	15.9	12.7	22.0
China	116,052	89,240	26,812	100.0	76.9	23.1	5.4	3.9	10.2	7.2	5.7	12.0
France	243,775	157,884	85,891	100.0	64.8	35.2	10.4	7.8	15.2	15.2	11.7	21.7

Note: The objects for analysis are article, letter, note, and review. Analyzed by whole counting.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

4.2 Patents

Key Points

○The numbers of patent applications had been increasing with an annual average growth rate of about 5% since the mid 1990s, and reached 1.85 million for 2007.

○The numbers of patent applications to the Japan Patent Office (hereinafter “JPO”) have been about 400,000 over these past several years. The numbers of patent applications to U.S. Patent and Trademark Office (hereinafter “USPTO”) have been rapidly increasing, and it was more than that to JPO in 2006. The applications to JPO from Non-Residents have been increased, and accounted for over 15% of all in 2006. However, this ratio is small compared with that of USPTO, about a half of whose applications are from Non-Residents.

○All main countries including Japan have increased their numbers of patent applications. However, there has been a slight leveling off over the past few years. Even under these circumstances, Patent applications from China have steadily increased. Many Chinese applications, however, are to the State Intellectual Property Office of the P.R.C. (hereinafter SIPO), and China’s presence in the world is still small. Korea has been applying for patents to patent offices in main country and has strengthened its world presence.

○Looking at the numbers of patent applications to JPO, USPTO and The European Patent Office (hereinafter EPO), Japan has shown a big presence since 10 years ago. Looking at the applications by technical field, Japan has a big share in Nanotechnology and Information and communication technology.

○The relation between patents and scientific papers has been getting stronger. The Science Linkage, which indicates the degree to which patent literature cites scientific literature, has been increasing. From 1996-1998 to 2006–2008, the Science Linkage in all fields increased from 1.9 to 3.1. The value of Medical and chemical manufacturing is highest. Science Linkage has recently increased in “Petroleum/Coal product manufacturing.”

4.2.1 The patent applications in the world

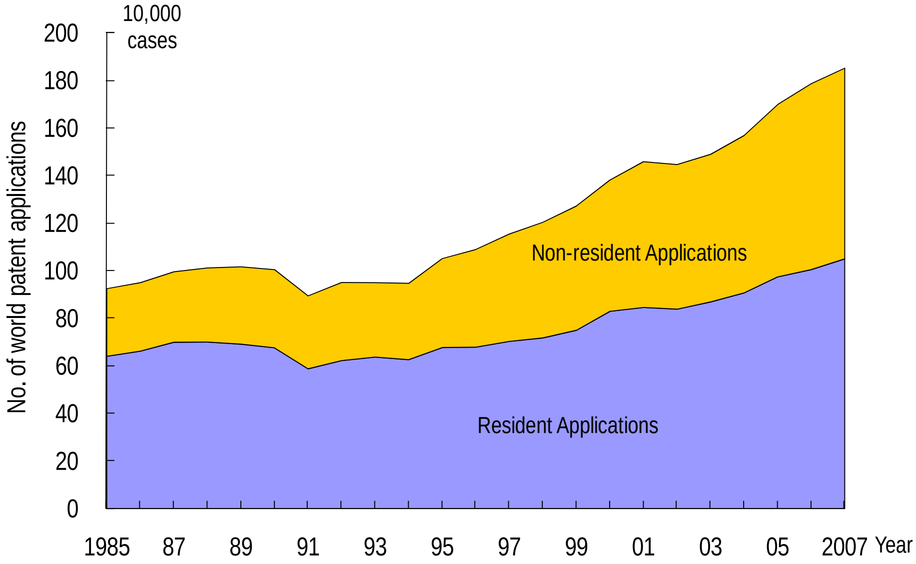
(1) The number of patent applications in the world

Chart 4-2-1 shows the change in the numbers of patent applications for about 230 countries and regions as of December 2009. The data is obtained from the “Statistics on Patents” by WIPO (World Intellectual Property Organization). Here, the applications are divided to show Resident Applications, which mean that the first applicants make applications directly to countries or regions in where they live, and Non-Resident Applications, which mean that the first applicants make applications to countries and regions where they do not have residency.

The numbers of patent applications are counted by both direct applications to patent authorities in each country or region; and PCT (Patent Cooperation Treaty) applications. As for PCT applications, applications have been transferred to the national/regional phase, were counted.

The numbers of patent application in the entire world have increased at an annual average rate of 5% since the mid 1990s, and it reached 1.85 million in 2007. 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.

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: WIPO, “Statistics on Patents” (Last update: December 2009)

(2)The situation of patent applications in main countries

Next, the breakdown of Chart 4-2-1 is described. Here, the situation of the patent applications to and from the main countries is shown.

Chart 4-2-2 (A) shows the situation of patent applications to the main countries. The patent applications to Japan, U.S., Europe, China, Korea, Germany, France and 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 numbers of applications to JPO are considerably large compared with the other countries. Looking at the breakdown, the applications to JPO from applicants, who have their residency in Japan, accounts for over 80%. On the other hand, applications from Non-Residents were less than 20%.

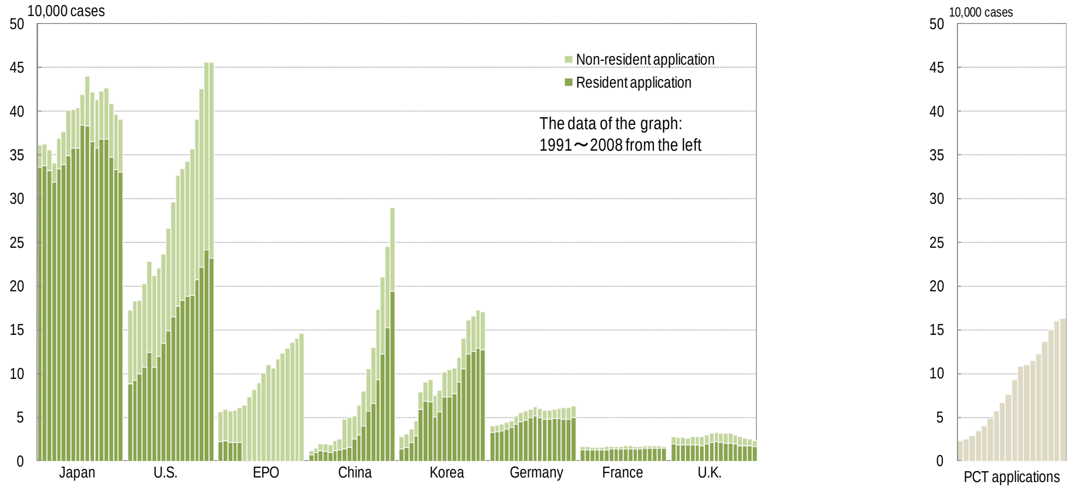
The numbers of applications to USPTO have become almost double over the past 10 years. The ratio of applications from Residents and Non-Residents has been consistently half each. This is considered to show that U.S. market is always attractive to overseas. The provisional application, which was introduced in 1995, is considered to be a reason that the numbers of applications has increased.

The number of applications to EPO has also increased. However, the numbers of applications to Germany and France have been broadly flat and that to U.K. has declined. Since patent applications to the countries which have ratified European Patent Convention can be made through the applications for European Patent Office, the numbers of applications to each country are on a flat or decreasing trend.

The number of applications to SIPO has drastically increased. They increased by an annual average of about 20% over 10 years (1998–2008). In 2008, there were about 290,000 patent applications. The number of applications from residents was about 50% from 2000 to 2002, however, it became about 60% from 2006 to 2008. This indicates that applications from applicants in China have especially increased.

The applications based on PCT have been increasing. PCT applications can be seen a bundle of patent applications to the various patent authorities, and its feature is that a PCT application is enough to obtain the priority of designated patent authorities. Chart 4-2-2 (B) shows the numbers of PCT applications. This indicates that the numbers of PCT applications have been steadily increasing. It was about 160,000 in 2008, about 2.4 times what it was 10 years earlier.

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



(A) The numbers of patent applications to main countries (1991–2008)

(B) The change in the numbers of patent applications (1991–2008)

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 JPO, which is from those who live in Japan, and "direct applications from Non-residents" to JPO, which is from those who do not live in Japan (for instance, those who live in U.S.).

2) The value of "applications from Residents" of EPO has not been included since 1996.

Source: WIPO, "Statistics on Patents" (Last update: December 2009)

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 EPO were counted as Non-Resident Applications.

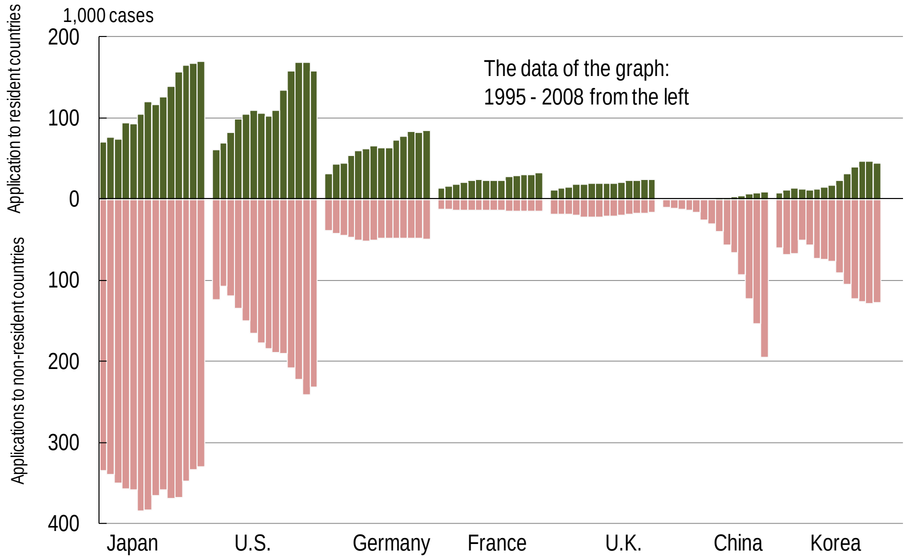
The results shown here are from WIPO “Statistics on Patents” as of December 2009. This analysis calculates the share for each country by using the country that the first applicant or assignee belongs to. For instance, if there is a joint application with an applicant (the first) in Japan and an applicant (the second) in U.S., only Japan is counted.

In Japan, U.S., China and Korea, the numbers of applications to the country of residence are more than those to countries of non-residence. Approximately 70% of the total numbers of applications from Japan are to JPO.

Paying attention to the change in the numbers of applications to the country of residence, Japan has been decreasing recently. China has been greatly increasing. U.S. and Korea increased through 2007, but leveled off in 2008. In Germany, France and 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 EPO.

Looking at the numbers of applications to countries of non-residence, it can be seen that the number of applications from Japan to overseas has increased in these years. As for U.S. and Korea, the numbers of applications to other countries were also increasing, but they have plateaued during the past few years. Although China has increased its domestic patent applications, its number of applications to overseas is still small.

(C)The numbers of patent applications from main countries (1995–2008)



Note: 1) Regarding the breakdown of the numbers of applications, in the case of Japan, "Applications to resident countries" refer the applications to 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 EPO.
Source: WIPO, “Statistics on Patents” (Last update: December 2009)

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 international comparability in light of this point, the applications to the trilateral patent offices, JPO, EPO and USPTO, are analyzed here.

The number of the world's patent applications in 2007 was approximately 1.85 Million, as shown in Chart 4-2-1. The numbers of applications to the trilateral patent offices accounted for about 54% of the world's patent applications. In recent years, the numbers of patent applications to China and Korea have been rapidly increasing, and the weight of the trilateral patent offices in the world has been declining.

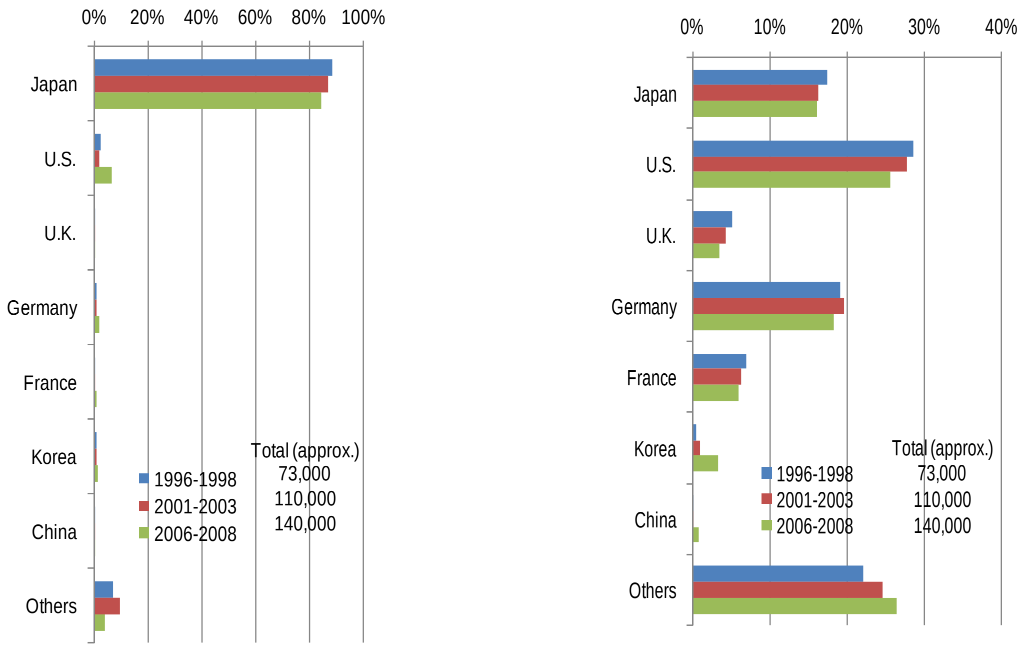
Chart 4-2-3 shows the share of the main countries of patent applications to JPO, EPO and USPTO. The results shown here are from WIPO, "Statistics on patents," December 2009. In this analysis, when there are multiple applicants, the country of the first applicant or assignee is used to calculate each 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 85% from 2006 to 2008. 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 2006–2008). The number of applications from Korea have grown recently (approximately 1.6% during 2006–2008), and now it is closing in on Germany.

Looking at national shares of applications to EPO (Chart 4-2-3 (B)), Japan presented the next largest number to U.S. and Germany. By main countries' shares of patent applications from 2006 to 2008, U.S. share was about 26%, which is in first place. Germany's share was about 18%, while Japan's was around 16%. France (about 6%) and U.K. (about 4%) followed them. Also here, the growth of Korea was shown, it became about 3% from 2006 to 2008.

Looking at national shares of applications to USPTO (Chart 4-2-3 (C)), the share of U.S. was the largest. It has accounted for at least 50% since 1996. Japan has had the second largest share, at about 20% since 1996. The share of Germany was in third place, which was at about 5% from 2006 to 2008. Korea has been steadily expanding its share. At about 5%, almost the same as Germany's share, it was in fourth place.

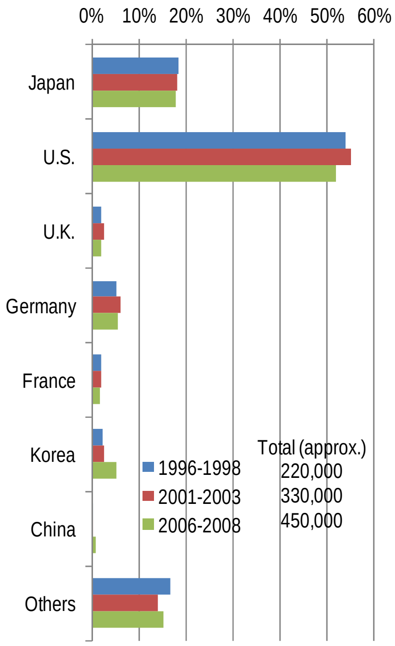
Chart 4-2-3**:** The share of the patent applications of the main countries to JPO, EPO and USPTO



(A) JPO

(B) EPO

(C) USPTO



Note: Number of applications is based on application date. Country is country of residence of first applicant or assignee. Values are three-year moving averages.
Source: WIPO, "Statistics on Patents" (last update: December 2009)

4.2.3 The patent applications by technological field

Next, the result of the analysis of the parent applications by technological field is described. The applications to EPO and USPTO were analyzed in order to do an international comparison by technological field. Technological fields for analysis are targeted in four technological fields: Biotechnology; Renewable energy; Information and communication technology; and Nanotechnology.

The patent applications for Biotechnology, Renewable energy 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. The patent applications for USPTO are classified by United States Patent Classification (USPC). Therefore, the technological classification was done by using the concordance table of USPC and International Patent Classification (IPC) and transforming International Patent Classification (IPC) into USPC.

Regarding Nanotechnology, the classification called Y01N by EPO was used. At present, there is no unified definition for Nanotechnology in the world. Therefore, EPO defines Nanotechnology on it own accord. And then, based on it, the applications relating to Nanotechnology are extracted from the patent applications to major patent authorities in the world and given the tag of Y01N. The patent applications with Y01N tags for EPO and USPTO were analyzed.

The patent applications to JPO were excluded here. The reason was that due to a problem on the patent database, the extraction accuracy of the patent applications on Nanotechnology was low.

(1) The patent applications to EPO by field

Looking at the situation of applications to EPO by technological field, Japan has a large share in Nanotechnology and Information and communication technology. The share of Nanotechnology was approximately 30% from 1996 to 1998; however, it was approximately 20% from 2006 to 2008. The share of Japan in Biotechnology is about 10%, and it was less than about 17% of Japan’s share as a whole.

Shares for Biotechnology and Nanotechnology are large for U.S., while Germany had a relatively large share in Renewable energy and 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).

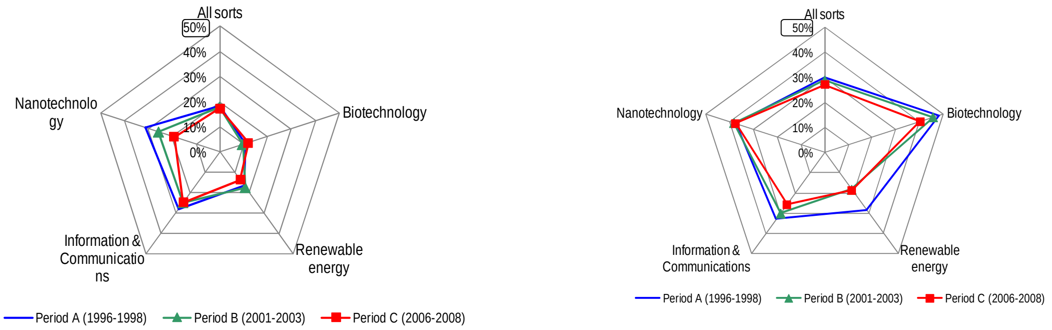
Although China’s shares are increasing, it still has a small presence compared with the other six countries.

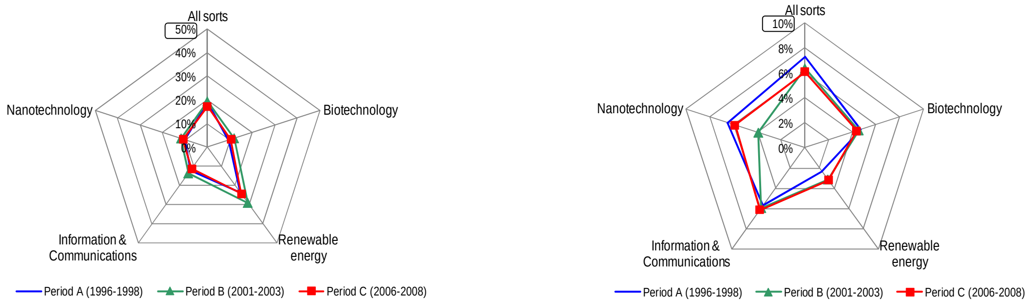
(2) The granted patents in USPTO by field

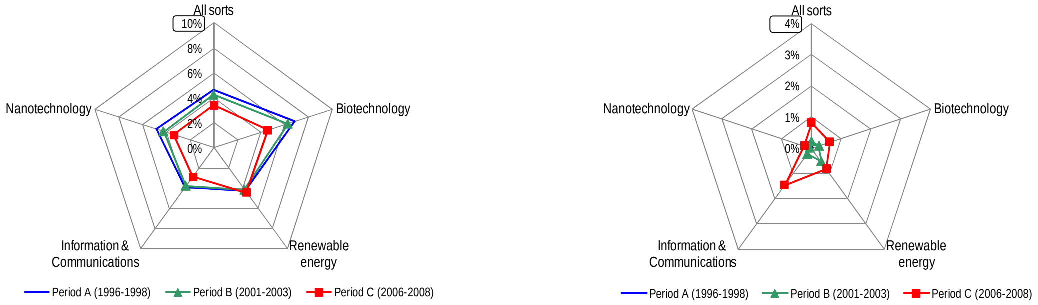
Looking at the granted patent in USPTO by field, Japan has a large share in Nanotechnology and Information and communication technology, the same as in the case of EPO. Its share of Nanotechnology from 2006 to 2008 was about 26%.

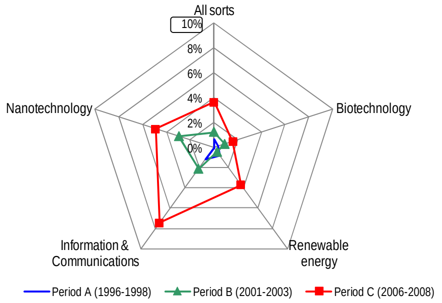
Germany has a relatively large share in Renewable energy, as does U.K. in Biotechnology and Renewable energy. Regarding Korea, it is apparent that growth in its shares in Information and communications technology and Nanotechnology are especially large (Chart 4-2-5).

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


(A) Japan (B) U.S.


(C) Germany (D) France

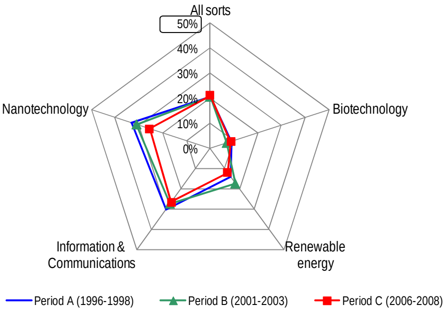

(E) U.K. (F) China


(G) Korea

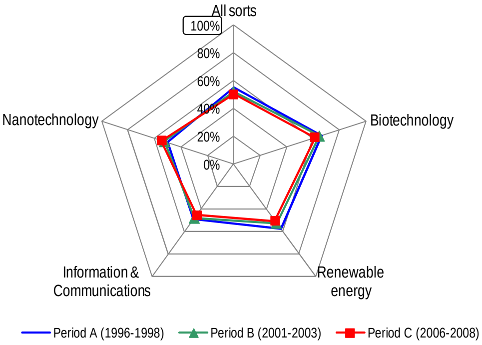
Note: 1) Counted unexamined publications (A1, A2) for the numbers of the applications. Counted by publication data. The share of main countries is the average over 3 years
2) Used International Patent Classification for the technological classification about Information and communications, Biotechnology and Renewable energy. Y01N was used for the technological classification of Nanotechnology.
3) The ratio of applicants was counted by fractional counting per applicant.
Source: Compiled by NISTEP based on PATSTAT (September 2009 edition version)

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

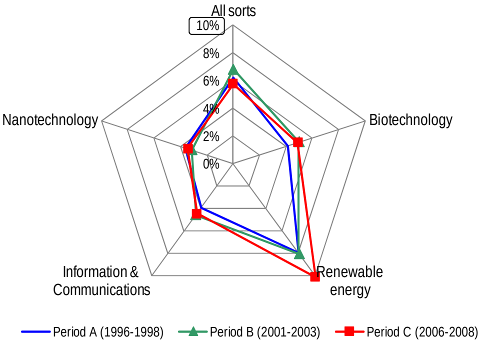
(A) Japan



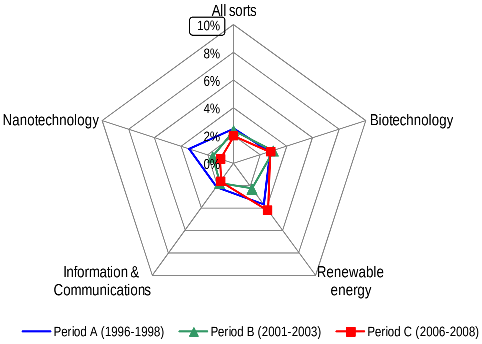
(B) U.S.



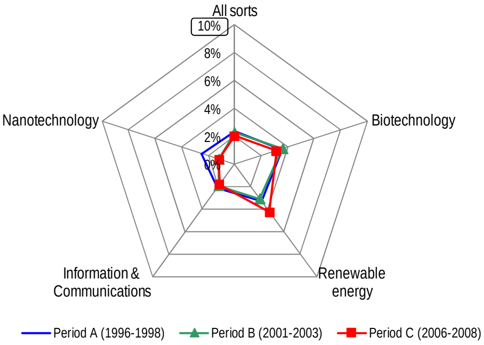
(C) Germany



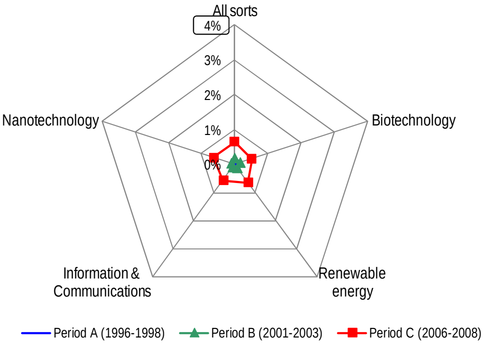
(D) France



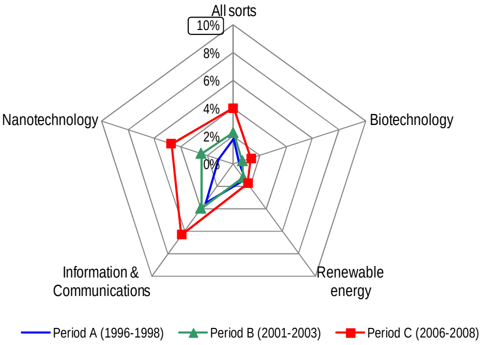
(E) U.K.



(F) China



(G) Korea



Note: 1) Counted by granted dates. The share of main countries is the average over 3 years.
2) Uses International Patent Classification for the technological classification about Information and communications, Biotechnology and Renewable energy. Y01N was used for the technological classification about Nanotechnology.
3) The ratio of inventors was counted by fractional counting per inventor.
Source: Compiled by NISTEP based on PATSTAT (September 2009 version)

4.2.4 The analysis of Science Linkage and Technological Cycle Time for US Patents

The following describes “Science Linkage” which is an indicator for showing a close relationship between the patents and scientific literature, and “Technological Cycle Time” which is an indicator for the velocity of technological development.

Science Linkage means the numbers of the citations to scientific literature per patent on U.S. Patent Examination Reports. U.S. Patent Examination Reports have citations of various documents and existing patents that are in close relation to the patent application. The citation to scientific literature in patents shows relevance to the relationship between technology (Patents) and science. Therefore, Science Linkage is considered to indicate closeness between science and patents.

The concordance table of USPC and Standard Industrial Classification System by USPTO was used to analyze changes in Science Linkage of U.S. Patents by the industrial classification. It is possible to analyze by International Patent Classification (IPC), in which patent documents are categorized by the types of technology, however, the image of the technology is not easily seen by this method. Therefore, the following shows the correspondence with the industrial classification.

From 2006 to 2008, the largest numbers of granted patents were for “Communication equipment and electronics components manufacturing,” followed by “Machinery manufacturing (excluding Electrical);” and “Professional equipment and scientific instrument manufacturing.” Paying attention to the annual average growth rate, “Communication equipment and electronics components manufacturing” is the largest at about 7%, and the second largest is “Petroleum and natural gas extraction and refining” at about 6% (Chart 4-2-6).

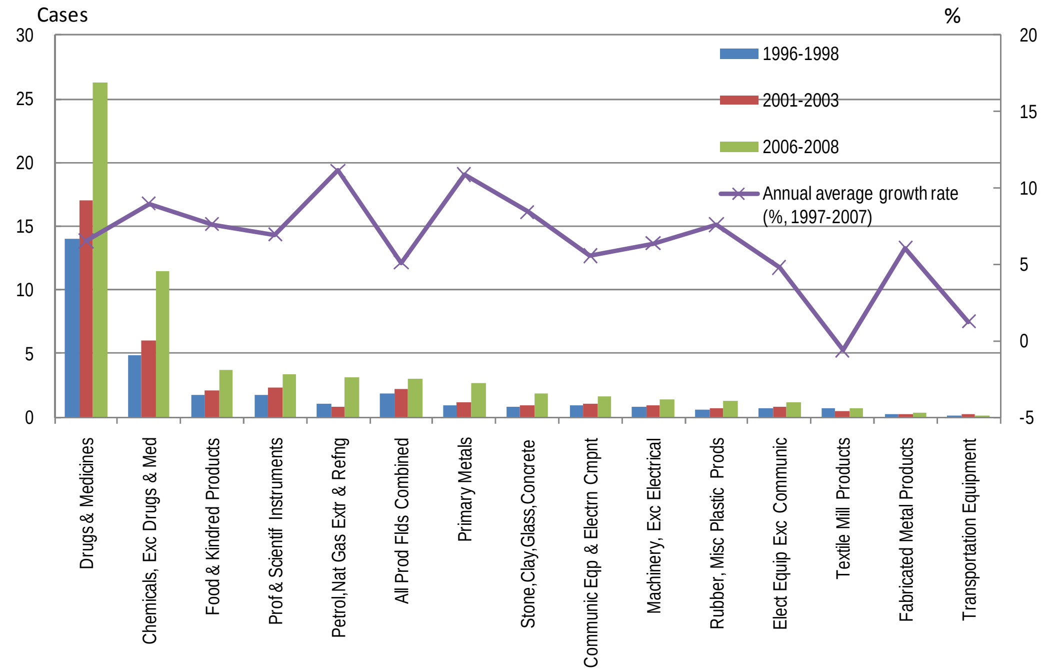
The value of Science Linkage tends to be increasing in all industrial classifications (Chart 4-2-7). From 1996-1998 to 2006–2008, the value of Science Linkage in all manufacturing increased from 1.9 to 3.1. “Drug and medicines manufacturing” had a much higher value for Science Linkage, marking 26.3 from 2006 to 2008. “Chemicals and related products (excluding drugs and medicines)” followed after it; however, the value of Science Linkage was less than half the value for “Drug and medicines manufacturing.” “Regarding Petroleum and natural gas extraction and refining,” the value of Science Linkage was 0.9 from 2001 to 2003, which was not so high; however, it rapidly increased to 3.2 from 2006 to 2008. Science Linkage of “Primary metals manufacturing” grew to about 2.4 times as large over 10 years (Chart 4-2-7).

Chart 4-2-6: The numbers of registrations of patents by industrial classification (the average value over 3 years)

	1996-1998	2001-2003	2006-2008	Annual average growth rate (%, 1997-2007)
All Prod Flds Combined	123,044	167,461	162,942	2.8
Communic Eqp & Electrn Cmpnt	22,235	37,579	44,902	7.3
Machinery, Exc Electrical	26,702	36,254	40,498	4.3
Prof & Scientif Instruments	17,056	21,922	21,275	2.2
Elect Equip Exc Communic	7,921	11,507	11,473	3.8
Chemicals, Exc Drugs & Med	12,227	13,825	10,194	-1.8
Transportation Equipment	5,009	7,522	6,464	2.6
Fabricated Metal Products	6,610	8,125	5,594	-1.7
Drugs & Medicines	5,122	6,281	4,908	-0.4
Rubber, Misc Plastic Prods	4,337	5,060	2,857	-4.1
Stone,Clay,Glass,Concrete	1,890	2,396	1,500	-2.3
Petrol,Nat Gas Extr & Refng	523	760	894	5.5
Primary Metals	852	1,231	793	-0.7
Textile Mill Products	705	674	429	-4.8
Food & Kindred Products	615	778	328	-6.1

Note: Annual average growth rate indicates the growth rate for 1997–2007. Values for 1997 are the average for the three years 1996–1998, and those for 2007 are from the three years 2006–2008.
Source: Compiled by NISTEP based on ipIQ, “Global Patent Scorecard 2009”

Chart 4-2-7: Science Linkage in US Patents



Note: Annual average growth rate indicates the growth rate for 1997–2007. Values for 1997 are the average for the three years 1996–1998, and those for 2007 are from the three years 2006–2008.
Source: Compiled by NISTEP based on ipIQ, "Global Patent Scorecard 2009

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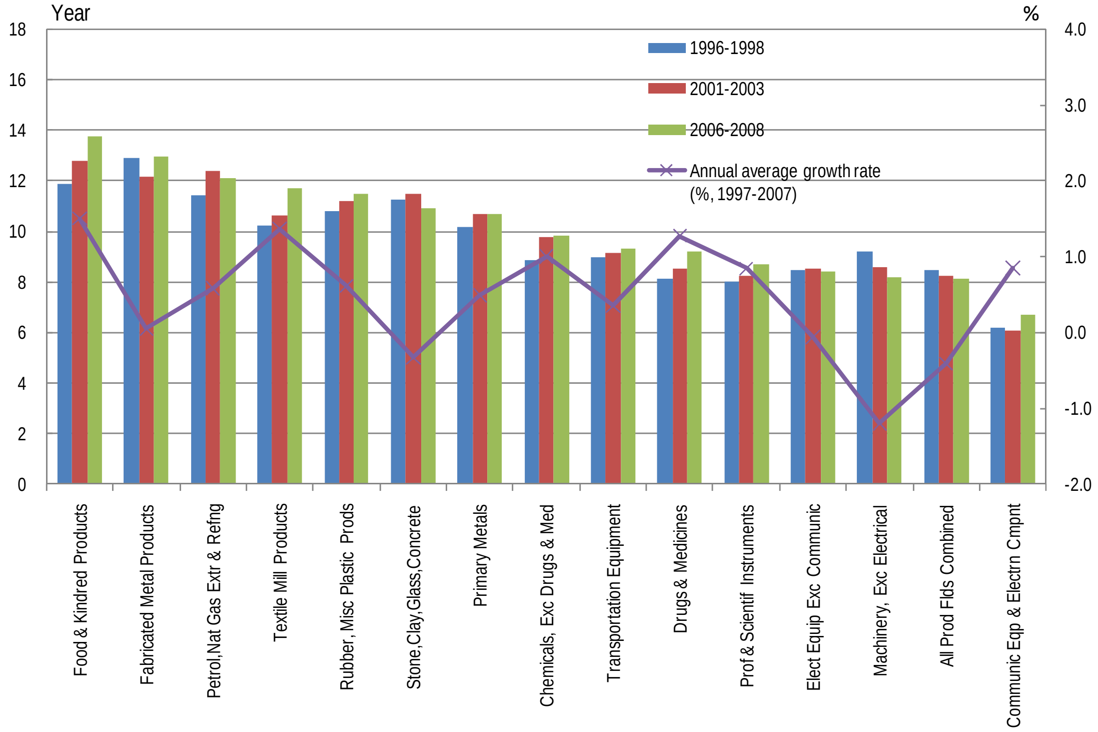
Next, the results of the analysis of Technology Cycle Time are described. Technology Cycle Time is an indicator to show that the patent literature of how long before in the past is cited in examination reports. To be more precise, Technology Cycle Time is calculated by taking the time lags between examination reports and the publication year of patent literature cited in them and then calculating the median value of the time lags. The fields which have a shorter Technology Cycle Time have a shorter length of time between a certain patent being made and the next patents being created based on it. The length of time lags between creating new patents is dependent on factors such as the characteristics of the technological field or the patent strategy of business enterprises. Technology Cycle Time is also considered to depend on these factors.

By industry, "Food & kindred products," "Fabricated metal products," "Petroleum and natural gas extraction and refining," "Textile mill products" and "Rubber, misc plastic products manufacturing" had Technology Cycle Times of more than 11 years in recent years. In contrast, Technology Cycle Time of "Communication equipment and electronics components manufacturing" was the shortest, whose value was about 7 years during 2006–2008 (Chart 4-2-8).

Chart 4-2-8: Technology Cycle Time for US Patents



Note: Annual average growth rate indicates the growth rate for 1997–2007. Values for 1997 are the average for the three years 1996–1998, and those for 2007 are from the three years 2006–2008.
Source: Compiled by NISTEP based on ipIQ, "Global Patent Scorecard 2009"

Chapter 5：The outcome of R&D

The R&D outcome does not refer simply to direct results such as papers and patents. Usually, it refers to the actual economic and social impact of results. However, it is inherently difficult to measure the outcome of R&D, and there are few indicators at the present time. In this chapter, technology trade, which shows international competitiveness in terms of technical strength; high technology trade; and Total Factor Productivity (TFP), which is frequently used as a proxy for the outcome of innovation, are used.

5.1 Technology trade

Key Points

○ Japan’s technology trade balance was 3.71 in 2008, with an export surplus continuing since 1993. Technology trade exclusive of trade with overseas affiliates, i.e., that between parent companies and subsidiaries, can be considered a more appropriate indicator of technology strength. Using that criterion, Japan’s technology trade balance in 2008 was 1.3, which represents a slight rise from 2001.

5.1.1 International comparison of technology trade

In general, technology exports means that the rights of using a technology(1), are given to business enterprises or individuals located in or having residence overseas in exchange for payment, and technology imports (technology introduction) means that the rights of using a technology are received from business enterprises or individuals located in or having residence in overseas in exchange for payment. This is called technology trade. It is used as an indicator for international measurement of countries' technology levels. The size of technology exports (receipts) or its ratio to the size of technology imports (payments), i.e., the technical trade balance, is used as an indicator that reflects technology strength. As the technology trade of each country is different in various contexts, the comparison cannot be made simply. Thus, here it is considered by focusing on changes over time and the correlation between the amounts for technology exports and technology imports of each country.

Looking at the amount of the technology trade in major countries (Chart 5-1-1 (A)), the trend for each country is not the same; however, it has generally been increasing on the whole. Looking at the trend by country, the amount of technology exports for Japan has shown an export surplus since FY 1993, which means that the amount of technology exports is higher than that of technology imports. The amount of technology exports was approximately approx. ¥2.23 trillion and that of technology imports was about 0.60 trillion in FY 2009.

The amount of technology exports of U.S. was overwhelmingly high: the amount for 2008 was five times that of Japan. Looking at the changes over time, both technology imports and technology exports have been consistently increasing. The amount of technology imports is less than that of technology exports, and the technology trade balance shows an export surplus.

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, however, had been fluctuating beginning in 2002, but more recently has been flat.

Of the countries in the Chart, France is one of the countries which have a small amount of both technology exports and technology imports. Looking at the change over time, its amount of technology exports has tended to increase after 1998, and its amount of technology exports has remained flat. The technology trade balance has

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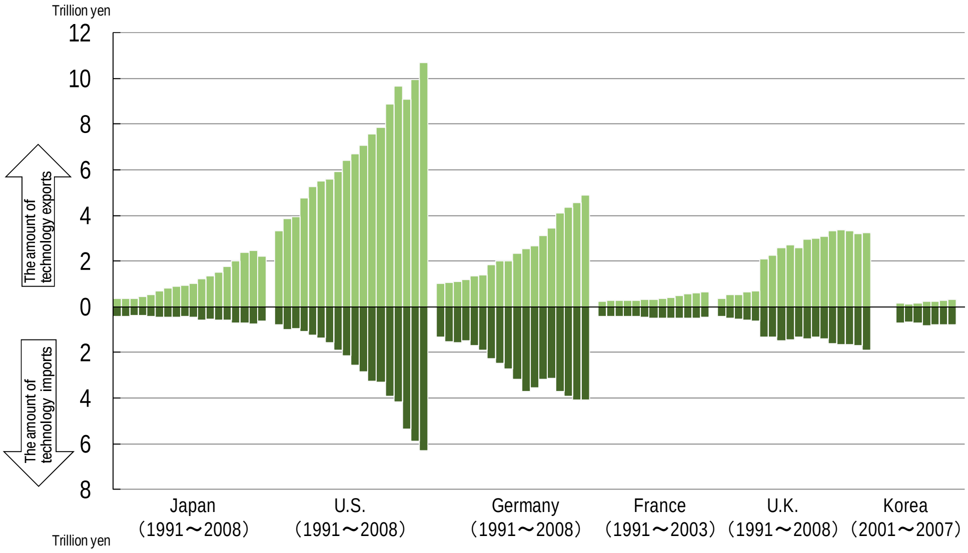
(1) Including rights related to the technologies of intellectual property rights, engineering drawings, blueprints and so-called know-how as provided for by the laws of patent rights, utility model rights, trademark rights, design rights and copy rights.

had an export surplus since 2000. (Note that the most recent year for which French statistics were available is 2003.)

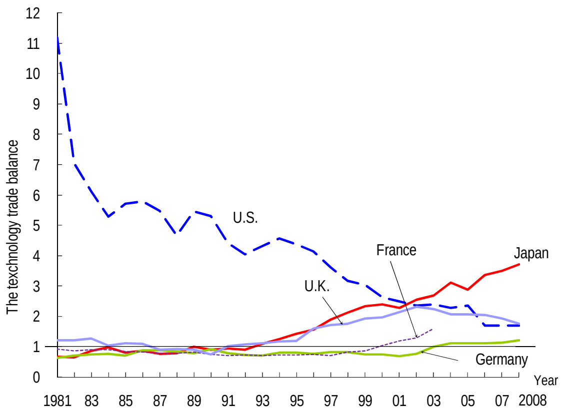
Regarding U.K., it is necessary to be careful when looking at the change over time because the ways of gathering statistics was changed after 1996. However, the amount of technology exports has tended to be flat in recent years.

Chart 5-1-1: The technology trade of main countries

(A) The trend in the amount of technology trade



(B) The trend in the technology trade balance



Note :<Japan> Data are for fiscal years.
The sorts of technology trade are as follows (excluding trademark rights):
(1) Patent rights, utility model rights and copy rights
(2)Design rights
(3)Each kind of technological know-how provision and technical guidance (excluding free provision)
(4)Technological aid for developing countries (including government-commissioned works)
<U.S.> Through 2000, only royalties and licenses. For 2001–2005, research, development and testing services were added. Since 2006, computers, data processing services, etc., have been included.
<Germany>West Germany until 1990. Until 1985 includes patents, know-how, trademarks, and design. From 1986, additionally included technical services, computer services and R&D in industrial fields.
<U.K.>from 1984, included oil companies. From 1996, includes patents, inventions, know-how, trademarks, design and services related to technology and R&D.
Statistical reference E was used for purchasing power parity conversion.

Source :<Japan> Ministry of Internal Affairs and Communications, “Report on the Survey of Research and Development.”
<U.S., Germany, France, U.K. and Korea>OECD, “Main Science and Technology Indicators 2009/2.”

Looking at the technology trade balance (the amount of technology exports/the amount of technology imports), the technology trade balance of Japan has increased since it was more than 1 for the first time in 1993, and the amount of the FY 2008 marked the high figure of 3.71.

The technology trade balance of 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 1.70 in 2008.

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.

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

When the data on technology trade is looked at, it can be seen that a significant ratio of technology trade among nations is accounted for technology transfers within corporate groups such as technology trade with affiliated companies overseas. Technology trade with affiliated companies is an indicator for international transfer of technical knowledge; however, it is not a strong indicator for the international competitiveness of technological strength. When technology trade is used as an indicator for seeing each country's technological strength, it is better to consider it by excluding technology transfers within corporate groups. Thus, regarding the amount of technology exports and imports of Japan and 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.

The amount of technology exports in Japan, for which the export between parent companies and subsidiaries were excluded, was approx. ¥0.66 trillion in the FY 2008, which accounted for 29.4% of the total. In the FY 2001, it was approx. ¥0.54 trillion and accounted for 43.3% of the total. Compared with the FY 2008 and the FY 2001, there was a decrease of 13.9 points. However, technology exports greatly increased. The amount of technology trade was ¥0.6 trillion in the FY 2008, and companies excluding parent companies and subsidiaries accounted for 85.4% for the total. Looking at the ratio of the total in the long run, it has consistently had a proportion of over 80%.

In the data for U.S., technology trade of "associated companies" is defined as the companies which own directly or indirectly 10% or more of voting rights or shares.

The amount of technology exports of companies excluding associated companies in 2007 was approx. ¥2.85 trillion and accounted for 28.7% of the total. Compared with 1999 (approx.¥1.68 trillion, 26.2%) at the time of changing U.S. industry classification to the current one, the amount of technology exports of companies excluding associated companies has increased to 1.7 times as much; however, the percentage of the total is 28.7%, which shows less change. Regarding the amount of technology imports, the amount of technology imports of companies excluding associated companies was approx. ¥0.65 trillion in 2007, which accounted for 21.5% of the total. Compared with it being approx. ¥0.44 trillion and 20.9% of the total in 1999, the amount of technology imports of companies excluding associated companies has increased by to 1.5 times, with a slight increase of 0.7 percentage points in the ratio.

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(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.

Regarding technology trade of companies excluding parents companies and subsidiaries or associated companies, both exports and imports of U.S. account for 20-30% of the total. However, differences can be seen in the technology imports and exports of Japan: exports are about 30%, and imports are about 80% (Chart 5-1-2 (A)).

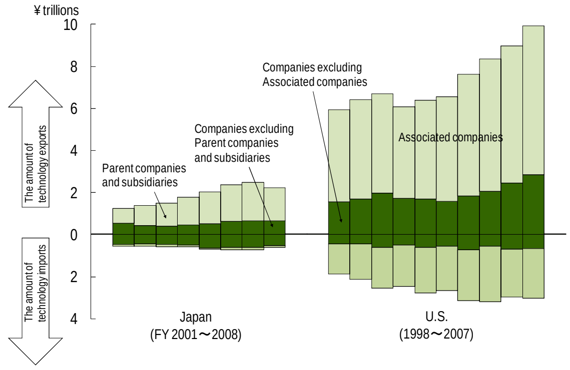
Also, looking at the technology trade balance of companies excluding parent companies, subsidiaries and affiliates, Japan has fluctuated around 1, and U.S. has moved around 3. The amount of U.S. in 2007 was an export surplus of 4.4 (Chart 5-1-2 (B)).

Since definitions for parent companies and subsidiaries in Japan or associated companies in U.S. are different, a simple comparison cannot be made. However, the data indicates that the technological strength of U.S. surpasses that of Japan (Chart 5-1-2 (C)).

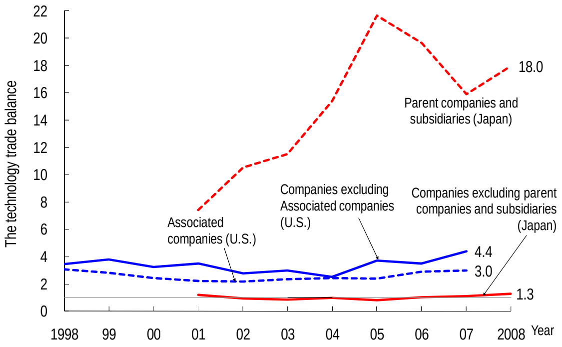
Chart 5-1-2: The change in the amount of technology trade in Japan and U.S. (Technology trade among parent companies and subsidiaries, associated companies and others)

Attention to international comparison

(A) The amount of technology trade



(B) Technology trade balance



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

(Unit ¥trillions)

	Japan		U.S.		
	Technology Exports	Technology imports	Technology Exports	Technology imports	
Capital ties And/over 50% ↑	1.8	0.1	7.1	2.8	Capital ties ↑ And/over 10%
Under 50% ↓	0.7	0.6	2.4	0.6	↓ Under 10%

Note: Attention should be paid to when international comparisons are done, because definitions for parent companies and subsidiaries (affiliated companies) are different in Japan and in U.S. Differences are as follows:
1) Japan's parent companies and subsidiaries are companies whose controlling share is over 50%.
2) U.S.'s associated companies are companies which own directly or indirectly 10% or more voting rights or shares.
<Japan> 1) Types of technology are the same as in Chart 5-1-1.
2) For classifying industries, the industry classification of the "Survey of Research and Development" based on the Japan Standard Industry Classification was used. For before 2006, the Japan Standard Industry Classification revised edition 2002 (the 11th) was used. For the FY 2008, Japan Standard Industry Classification revised edition 2008 (the 12th) was used.
<U.S.> 1) Types of technology trade are royalties and licenses only.
2) NAICS was used for industry classification.
3) Excludes FFRDCs from 2001.

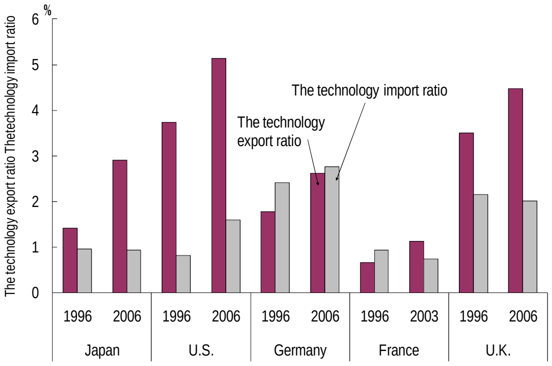
Source :<Japan>Ministry of Internal Affairs and Communications, "Report on the Survey of Research and Development."
<U.S.>NSF, "Science & Engineering Indicators 2010."

Chart 5-1-3 is the ratio of the amount of the technology trade against the whole amount of trade. The level of the amount of the technology trade is shown by comparison with the entire trade amount of goods and services. Hereinafter, the ratio of the amount of technology exports which it occupies out of total exports is called the "Technology export ratio," and that for technology imports is called the "Technology import ratio."

The technology export ratio of U.S. was the highest. It was 5.1% in 2006, and had increased 1.4 points compared with that of 1996 (3.7%). U.K. was 4.5% in 2006, which was an increase of 1 point compared with that of 1996 (3.5%). The technology export ratio of Japan in 2006 was 2.9%, which was increased of over double compared with that of 1996 (1.4%). Japan was the country where the technology export ratio was most extended.

On the other hand, the technology import ratio of Germany (in 2006, 2.8%) was high, moreover, it was higher than its technology export ratio. Compared with 1996 (2.4%), it increased by 1 point. Next to Germany was U.K.(2006, 2.0%); however, the technology import ratio of U.K. declined by 0.2 point compared with that of 1996. That of U.S. was 1.6% in 2006, which was extended more than double that of 1996 (0.8%). That of Japan was 1.0% in 1996 and 0.9 in 2006, which did not change much.

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



Note: 1) The sorts of technology trade are the same as in Chart 5-1-1.
2) The amount of technology imports and exports is the same as in Chart 5-1-1.
Source: <The amount of technology imports and exports>is the same as in Chart 5-1-1.
<The amount of the whole imports and exports>
OECD, "Annual National Accounts 2008/1

5.1.2 The Technology Trade of Japan

Key Points

○Looking at the amount of technology exports of Japan, “Transportation equipment manufacturing” accounts for about 50% of all industries, and it is followed by “Drugs and medicines”, which accounts for about 10% of all industries. Regarding “Transportation equipment manufacturing”, the ratio of parent companies and subsidiaries is approximately 90%. However, that of “Drugs and medicines” remains at approximately 50%. “Drugs and medicines” can be said to be an industry involving more international technology transfer for technology exports in Japan, many of which transactions are made among parent companies and subsidiaries.

○Most transactions for technology imports in Japan are made in companies excluding parent companies and subsidiaries.

○Looking at the partners of technology exports from Japan, U.S. accounts for 36.7% of them all, which is first, and China follows it at 12.1%. U.K. accounts for 5.6%, which is third place. On the other hand, regarding technology imports, U.S. accounts for 68.9% of the total, and Germany, France and U.K. follow it with about 5% each.

(1) Technology trade by industry classification

Looking at the technology trade of Japan by industry classification, the industry which had the largest amount of technology exports in the FY 2008 was “Transportation equipment manufacturing.” The amount was approx. ¥1.05 trillion and accounted for 47.2% of the entire industries. It was followed by “Drugs and medicines” (approx. ¥0.29 trillion 12.9%) and “Information and communication electronics equipment” (approx. ¥0.24 trillion, 11.0%). Compared with the FY 2003, there was an 11.09 point decrease in the ratio of “Transportation equipment manufacturing”, a 3.9 point increase in that of “Drugs and medicines” and a 1.4 point increase in that of “Information and communication electronics equipment.”

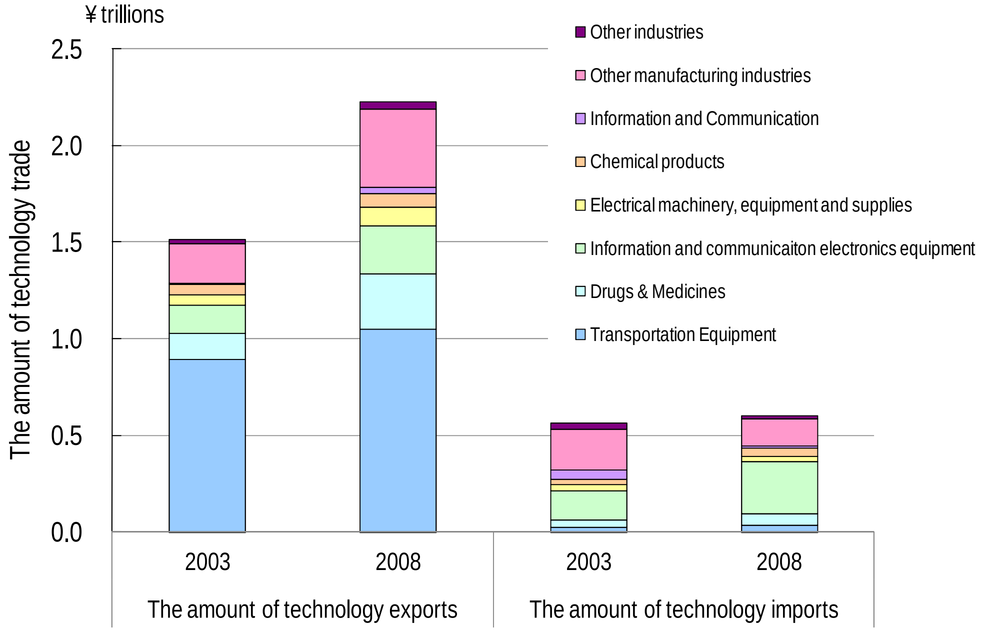
On the other hand, looking at in the FY 2008, the industry which had the large amount of technology imports was “Information and communication electronics equipment.” The amount was approx. ¥0.27 trillion and accounted for 45.3% of the entire industries. It was followed by “Drugs and medicines” (¥58.7 billion, 9.8%), and “Chemical products” (¥39.6 billion, 6.6%). Compared with the FY 2003, there was a large increase of 18.5 points in the ratio of “Information and communication electronics equipment”, and a 6.5 point decline in “Information and communications”(Chart 5-1-4 (A)).

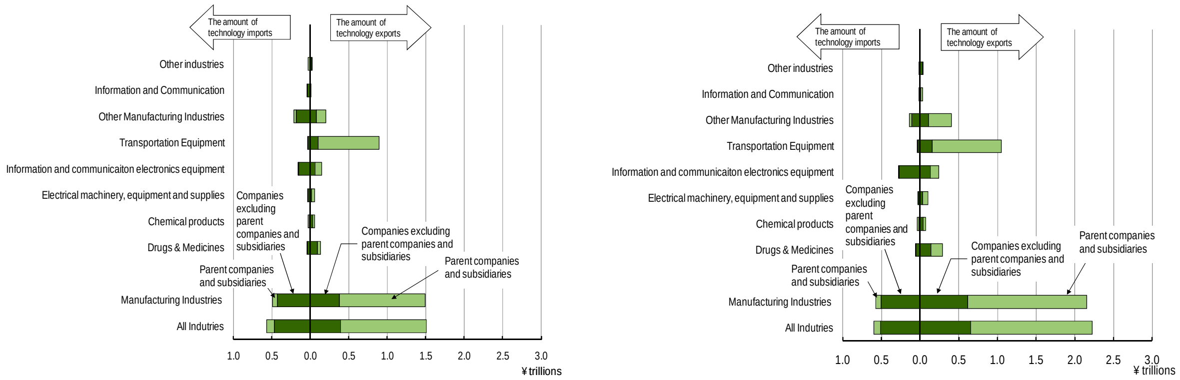
Looking at the amount of technology trade of parent companies and subsidiaries and that of companies excluding parent companies and subsidiaries by industry classification, parent companies and subsidiaries in most industries have a large amount for technology trade. The trade among parent companies and subsidiaries in “Transportation equipment manufacturing” accounts for about 90% of trade in the industry, and that in the “Information and communications” accounts for about 80%. In the FY 2003, the trade among parent companies and subsidiaries in the “Information and communications” was about 60%. Compared to this, it can be said that transactions among parent companies and subsidiaries increased more. In contrast, the ratio of technology trade among companies excluding parent companies and subsidiaries in “Drugs and medicines” and “Chemical products” is large. “Drugs and medicines” accounts for about 50%, and “Chemical products” for approximately 60%. That of “Drugs and medicines” in the FY 2003 was around 70%.

In technology imports, the ratio of companies excluding parent companies and subsidiaries was dominant in most industries (Chart 5-1-4 (B and C)).

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 2003).

(C) The amount of technology trade of parent companies and subsidiaries, and that of companies excluding parent companies and subsidiaries (the FY 2008)

Note: 1) For the names of the components, the names of the components in the latest Survey of Research and Development are used.
2) For the industry classification for the FY 2003, the industry classification of the Survey of Research and Development based on Japan Standard Industry Classification revised edition 2002 (the 11^{th}) is used.
3) For the industry classification for the FY 2008, used the industry classification of the Survey of Research and Development based on Japan Standard Industry Classification revised edition 2008 (the 12^{th}) 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, the relations in terms of technology between Japan and other countries are explained, by using technology trade statistics looking from the view point of industry classification and partner.

Chart 5-1-5 (A and B) shows how much trade Japan does in terms of technology trade with main countries and whether its partners are parent companies and subsidiaries or companies excluding these. Japan's amount of technology exports, which means the amount received from partners, was exceptionally large from U.S. It was approx.¥0.82 trillion. Of this, the amount from companies excluding parent companies and subsidiaries was approx. ¥0.22 trillion which accounted for 26.8% of the total. China followed it with approx.¥0.27 trillion. Of this, the amount from companies excluding parent companies and subsidiaries was ¥0.12 trillion, which accounted for 44.2% of the total. Germany showed a large ratio of companies excluding parent companies and subsidiaries, which accounted for 57.8% of the total. The total amount of technology trade with the other countries except the 6 countries described herein was greater than that of U.S. Thailand, Taiwan and Canada, etc. were included in the other countries.

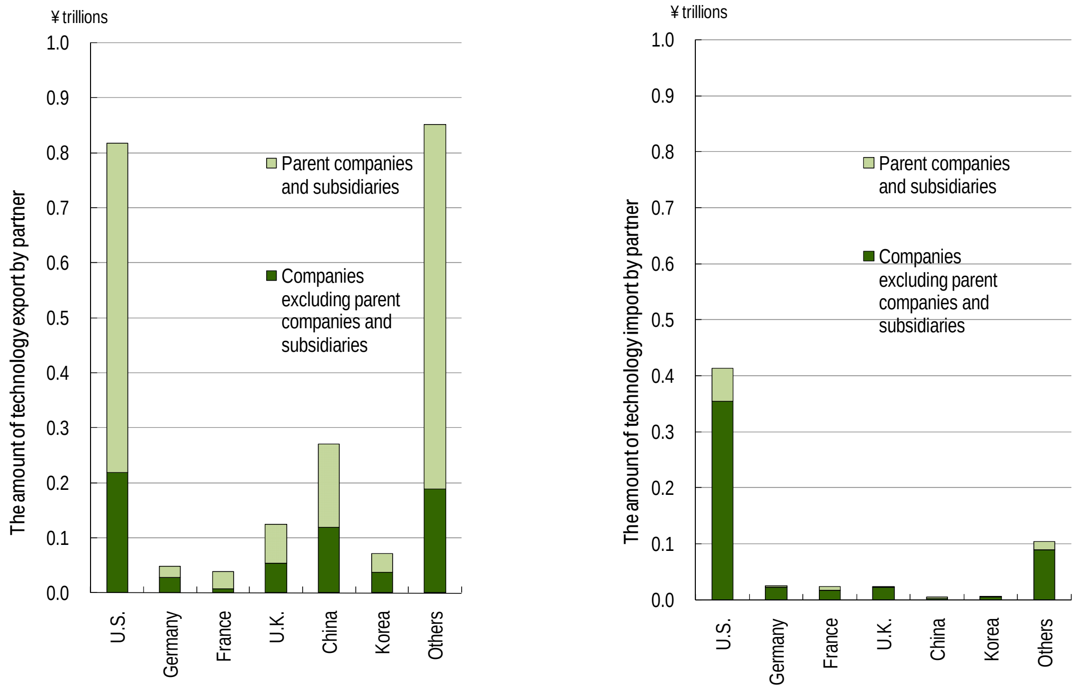
Japan's amount of technology imports, which means the amount paid to partners, was also exceptionally large toward U.S. It was approx. ¥0.41 trillion. The ratio of companies excluding parent companies and subsidiaries accounted for 85.8%. Germany followed it, with ¥25.3 billion. The ratio of companies excluding parent companies and subsidiaries accounted for 89.0%.

The left side of Chart 5-1-5 (C) is for the amount of technology exports, and the right side of the Chart is for the amount of technology imports showing partners, industry classification, and whether parent companies and subsidiaries or companies excluding parent companies and subsidiaries.

Looking at technology exports by partner country, U.S. had a large amount in "Transportation equipment manufacturing," but almost all transactions in this industry were between parent companies and subsidiaries. In "Information and communication electronics equipment", trade exclusive of that between parent companies and subsidiaries was common, accounting for 85.7%. As for trade with U.K., "Drugs and medicines" was large, as was trade exclusive of that between parent companies and subsidiaries, at 82%. There was a large amount of trade with China in "Transportation equipment manufacturing", with transactions exclusive of that between parent companies and subsidiaries, which accounted for 75.6%. "Other industries" accounted for the largest value of trade with Korea. Those industries included "Ceramics, stone and clay products", and "Electronic parts, devices and electronics circuits".

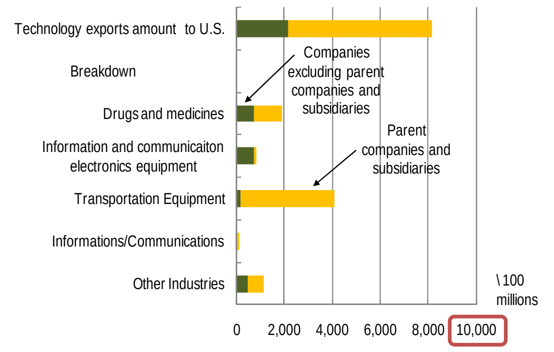
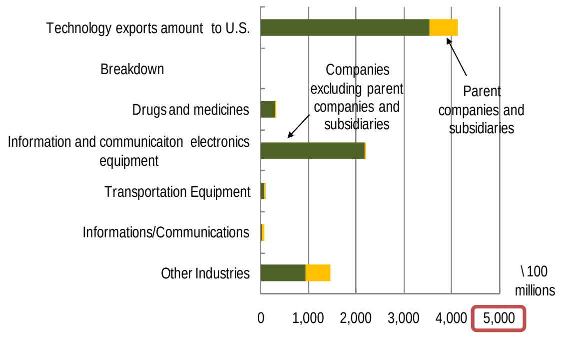
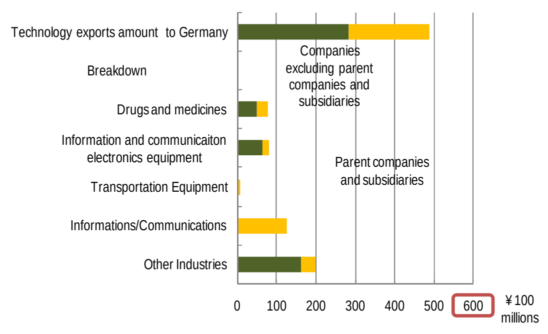
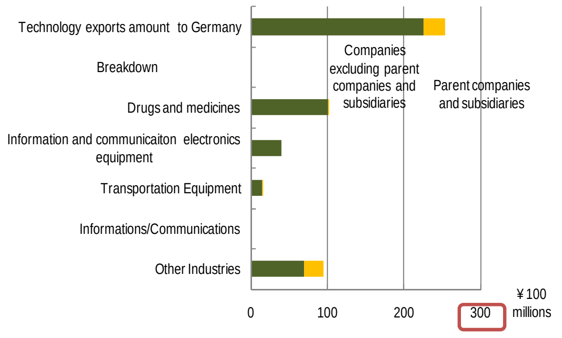
As for technology imports, the largest amount from U.S. was in "Information and communication electronics equipment". From Germany, the largest amount was in "Pharmaceutical manufacturing," and from U.K. it was in "Information and communication electronics equipment". With each country, trade exclusive of that between parent companies and subsidiaries accounted for almost all transactions.

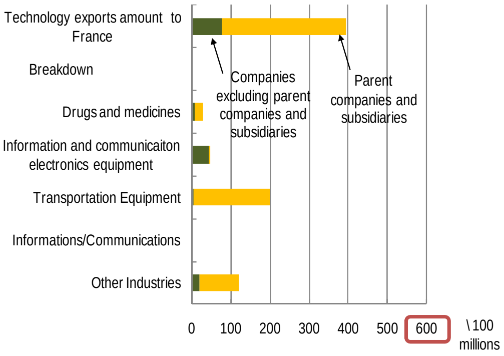
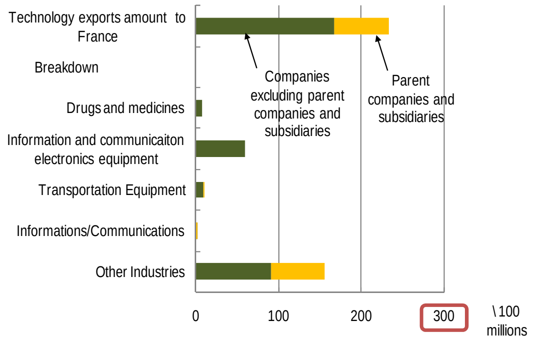
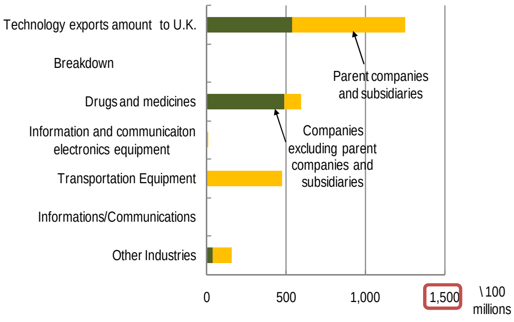
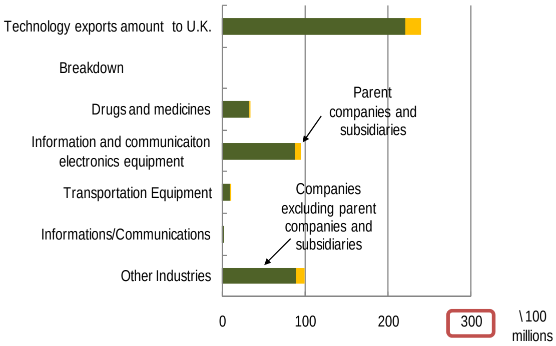
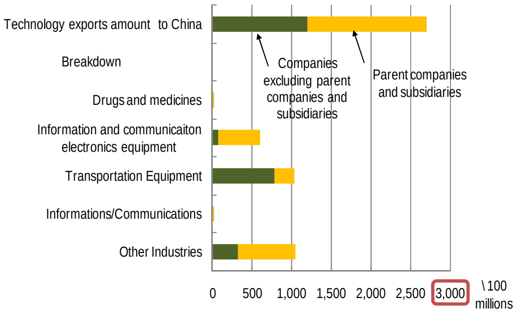
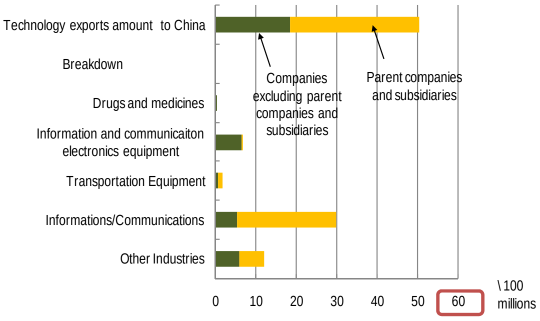
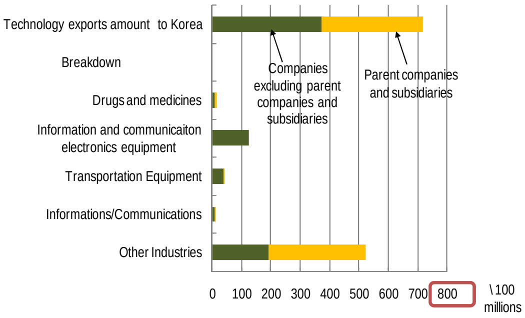
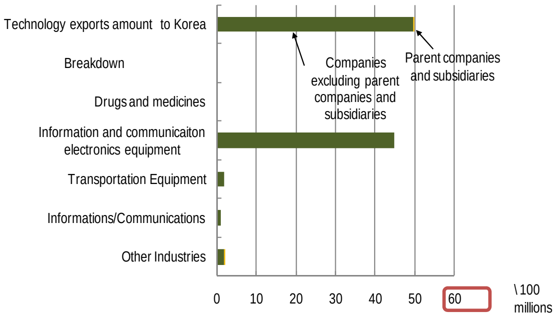
Chart 5-1-5: The amount of technology trade of Japan by partner (FY 2008)


(A) The amount of technology exports by partner

(B) The amount of technology imports by partner

(C) The breakdown of the amount of technology trade by partner and major industry (FY 2008)

Country	The amount of Japan's technology exports	The amount of Japan's technology imports
(A) With U.S.		
(B) With Germany		

<table>
<tr><th>Country</th><th>The amount of Japan’s technology exports</th><th>The amount of Japan’s technology imports</th></tr>
<tr><td>(C)
With
France</td><td>
</td><td>
</td></tr>
<tr><td>(D)
With
U.K.</td><td>
</td><td>
</td></tr>
<tr><td>(E)
With
China</td><td>
</td><td>
</td></tr>
<tr><td>(F)
With
Korea</td><td>
</td><td>
</td></tr>
</table>

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

- ○The high-technology industry trade of the entire world increased by 70 percent in the past six years. Especially, the “Radio, Television and Communication Equipment” industry was the largest, which accounted for about 40% of the total.
- ○Looking by country, the trade scale of 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 U.S. The trade amount of Germany has also rapidly expanded. Japan has followed it, and is in fourth place.
- ○The trade balance of Japan’s high-technology industry had an export surplus of over 3 in the early 1990s. After that, the trade balance tended to decrease and it was an export surplus of over 1.3 in 2008. Korea has been on an upward trend in recent years and passed Japan in 2003. China’s 2008 figure was even with Japan’s at 1.3. Europe has moved around 1 since 1990s, and U.S. has shifted to less than 1 since 2000, which means it now has an import surplus.
- ○Looking at it by field, the “Radio, Television and Communication Equipment” industry showed a large ratio, and particularly the amount of the imports and the exports of China have been larger than those of 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 “Aircraft and Spacecraft” industry of U.S. has an export surplus, and the “Pharmaceuticals,” “Medical, Precision and Optical Instruments” and “Aircraft and Spacecraft” industries of Germany have an export surplus.

The trade amount of the high-technology industry is not the direct data of knowledge in science and technology like the technology trade, but is an indirect indicator of the knowledge which has been turned to practical use in product development. High-technology industry referred to herein follows the classifications found in the OECD statistics: “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 30 OECD member-countries and 17 Non-OECD countries and regions (3), the change in the total amount of the trade amount(4) (export amount and import amount) of high-technology industry is shown. This can be considered as the high-technology trade of the entire world. In this, the “Radio, Television and Communication Equipment” is the largest. The ratio in the total is also large; however, it has been tending to decrease compared with 2000. On the other hand, “Pharmaceuticals” and “Medical, Precision and Optical Instruments” have been tending to increase. Chart 5-2-2 shows the change in the trade balance of the entire high-technology industry. Japan’s trade balance is large, however, it has been tending to decrease in the long run since its peak in 1984. And it was overtaken by Korea in 2003. In 2008, China’s trade balance pulled even with Japan’s at 1.3. The trade balance of U.S., Germany, France and U.K. has been fluctuating around 1.

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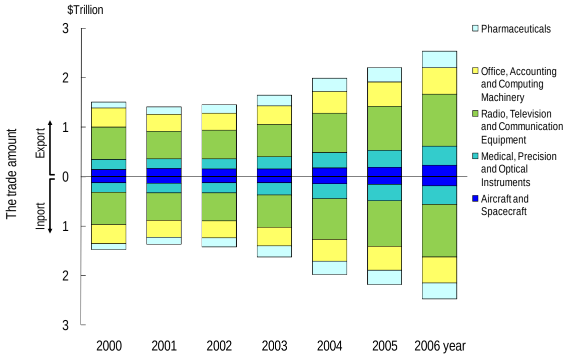
(3) Algeria, Brazil, Chile, China, Estonia, Hong Kong, India, Indonesia, Israel, Malaysia, the Philippines, Russia, Singapore, Slovenia, Thailand, Taiwan, and South Africa

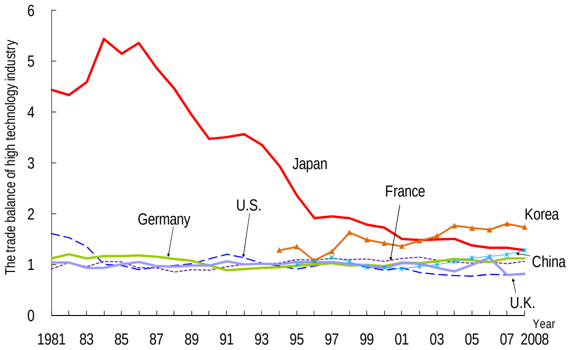
(4) Summed up the amount which each country trades with other countries.

Chart 5-2-1: The change of the trade amount of the high-technology industry of 30 OECD member-countries and 17 Non-OECD countries and regions



Source: OECD, "STAN BILATERAL TRADE DATABASE (EDITION 2010)"

Chart 5-2-2: The trade balance of High-Technology industries in main countries

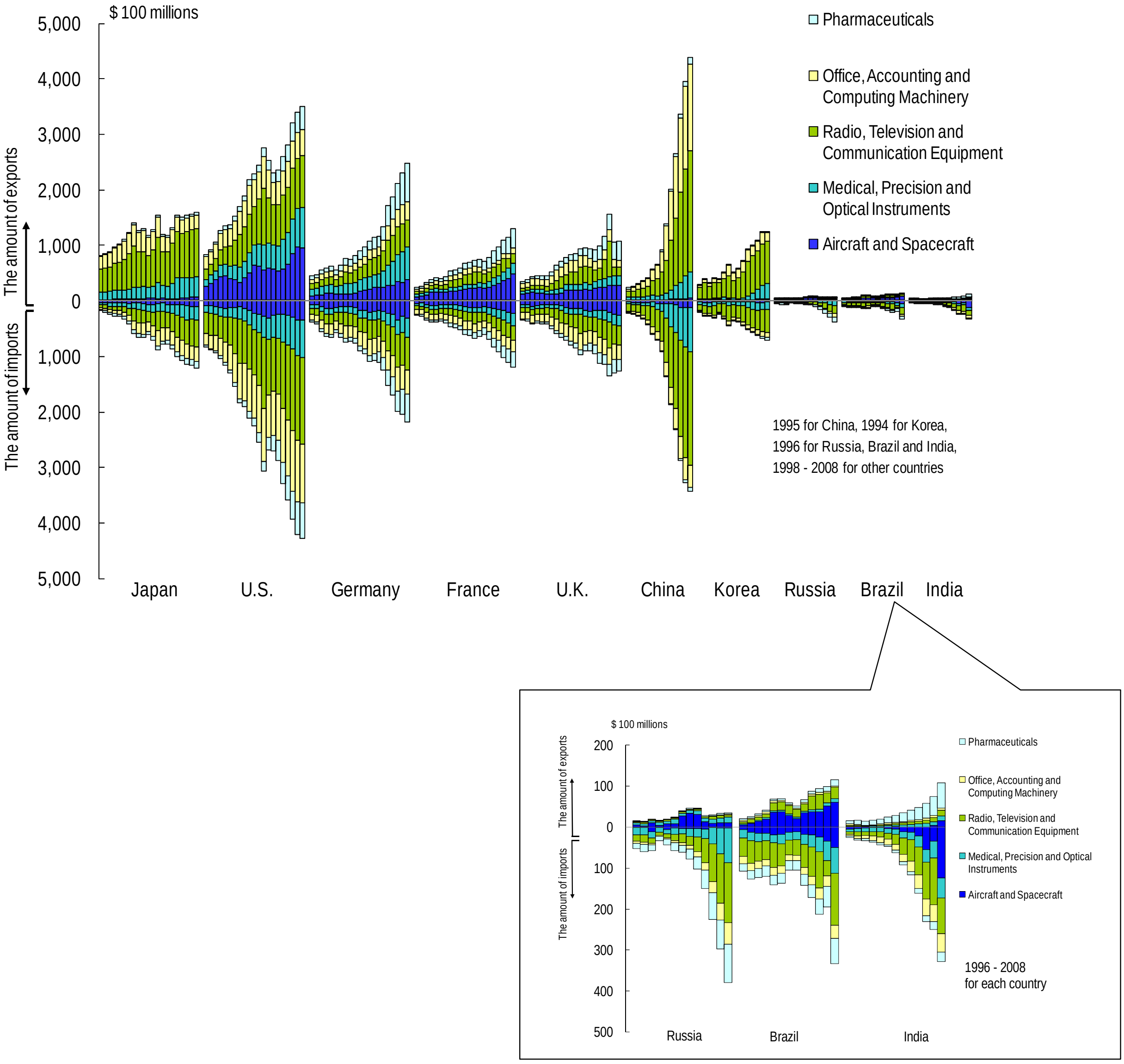


Source: OECD, "Main Science and technology Indicators 2009/2"

Looking at the breakdown of each country's high-technology industry, "Radio, Television and Communication Equipment" contributes significantly to the trade surplus of Japan's high-technology industry. "Medical, Precision and Optical Instruments" also has an export surplus; however, "Office, Accounting and Computing Machinery" has tended to have an import surplus since 2003. The "Aircraft and Spacecraft" industry and "Pharmaceuticals" have an import surplus.

The "Pharmaceuticals" and "Aircraft and Spacecraft" industries of U.S. have export surpluses. The "Pharmaceuticals," "Medical, Precision and Optical Instruments" and "Aircraft and Spacecraft" industries of Germany have export surpluses. France and U.K. have export surpluses in "Aircraft and Spacecraft" and "Pharmaceuticals". (However, U.K. had an import surplus in "Aircraft and Spacecraft" in 2008.) The amount of the high-technology trade of China has expanded largely. Particularly, its "Radio, Television and Communication Equipment" industry has dramatically increased, with the trade balance passing 1 and becoming a surplus in 2008. The increase of the "Radio, Television and Communication Equipment" industry of Korea is also prominent. Looking at the data for the BRICs whose economic development is remarkable, the import amount is large. Focusing on the export amounts, that of "Pharmaceuticals" is large in Russia, while and "Aircraft and Spacecraft" are big in Brazil, "Medical, Precision and Optical Instruments" are large in India.

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 2009/2”
<Brazil and India> OECD, “STAN Bilateral Trade Database (Edition 2008)”

5.3 Total Factor Productivity (TFP)

Key points

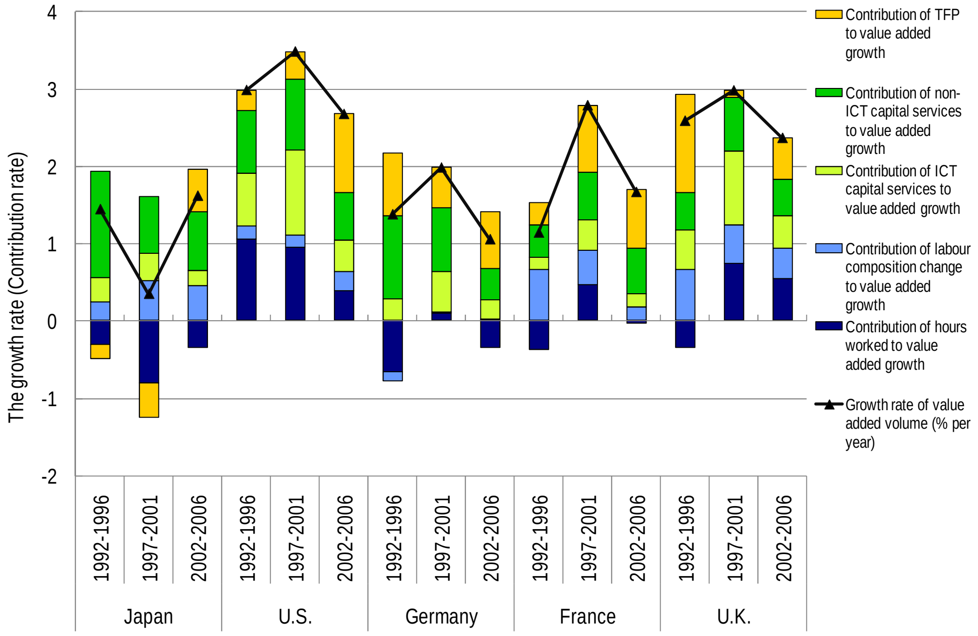
○The contribution of Total Factor Productivity (TFP) to economic growth during 2002–2006 was highest in U.S. (1.2%). Following U.S. were France (0.77%) and Germany (0.73%) at levels roughly equal to each other. Japan (0.55%) and U.K. (0.54%) were also roughly equal to one another.

Total Factor Productivity (TFP) is a figure indicating that portion of economic growth that cannot be explained by the contributions of increased investment in capital and labor. It is often used as an indicator showing the outcome of innovation through technological advancement. In this section, the factors of economic growth of countries are divided by 5 factors (Contribution of hours worked, Contribution of labor composition change, Contribution of ICT capital services, Contribution of non-ICT capital services and Contribution of TFP) based on EU-KLEMS Database, and the data is looked at by average amount every 5 years (Chart 5-2-4).

Japan's growth rate of value added volume declined during 1997–2001, but it rose during 2002–2006. The pattern was reversed in U.S., Germany, France and U.K.; the rate rose during 1997–2001, but fell during 2002–2006.

The contribution of TFP to economic growth during 2002–2006 was highest in U.S. (1.2%). Following U.S. were France (0.77%) and Germany (0.73%) at levels roughly equal to each other. Japan (0.55%) and U.K. (0.54%) were also roughly equal to one another.

Chart 5-2-4: The breakdown of the factors of economic growth rates in main countries



Note: 1) Amounts are 5-year averages. For instance, in the case of 1992–1996, the amount for the 5 years 1992, 1993, 1994, 1995 and 1996
2) Regarding data for Japan, some variables in the JIP Database 2009, which is the original data of the EU-KLEMS Database, were changed, so the trend differs from the S&T Indicators for 2009.
Source: Made by EU-KLEMS Database, November 2009

Reference materials

Reference Materials: Indicators for the regions

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

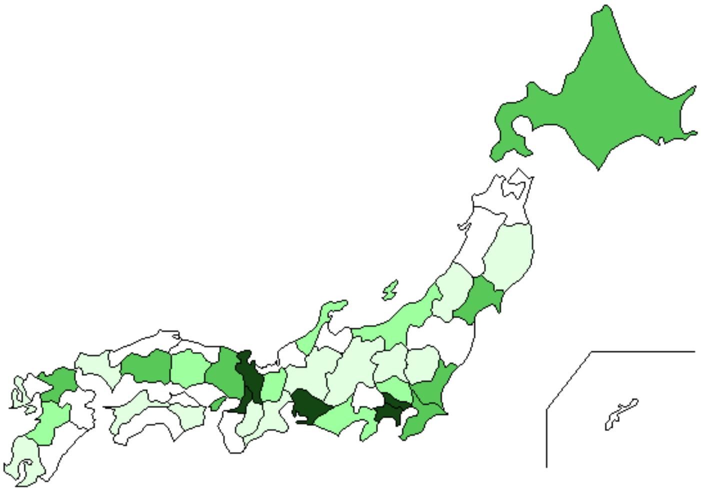
1. The number of graduate students in national, public and private Universities and Colleges
2. The number of papers (all fields)
3. The number of papers (the field of Life sciences)
4. The number of papers (the field of Natural sciences and Engineering)
5. The balance of the papers between the field of Life sciences and the field of Natural sciences and Engineering
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 2006–2008



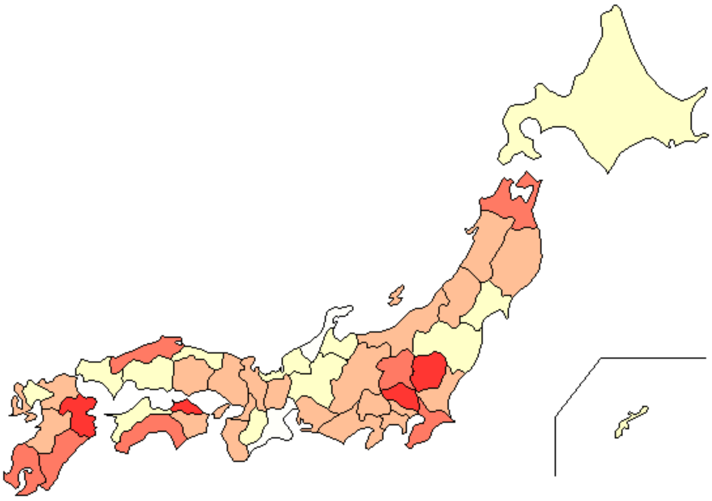
Legend	Classification			The number of prefectures
⬛	5.00% or over	～		5
🟩	2.00%	～	Under 5.00%	7
🟩	1.00%	～	2.00%	7
🟩	0.50%	～	1.00%	13
⬜		～	0.50%	15

Top 5	Share	Low rank 5	Share
Tokyo	26.56%	Akita	0.28%
Osaka	6.92%	Miyazaki	0.30%
Kyoto	6.77%	Wakayama	0.30%
Aichi	5.82%	Shimane	0.32%
Kanagawa	5.49%	Fukushima	0.34%

Source: MEXT, “School Basic Survey”

Chart 1-2: The share increase rate of the number of graduate students in national, public and private universities and colleges

The comparison of the average values between 2001–2003 and 2006–2008



Legend	Classification			The number of prefectures
🟥	1.15 or over	～		4
🟥	1.05	～	Under 1.15	7
🟧	0.95	～	1.05	21
🟨	0.85	～	0.95	13
⬜		～	0.85	2

Top 5	Growth rate	Low rank 5	Growth rate
Kagawa	1.35	Mie	0.79
Oita	1.24	Ishikawa	0.85
Saitama	1.19	Ehime	0.86
Tochigi	1.16	Toyama	0.87
Chiba	1.13	Fukui	0.88

Source: MEXT, “School Basic Survey”

【Key Points】

- The prefecture, which has major metropolitan areas, have more graduate students(Chart 1-1).
- Looking at the share increase rate from 2001–2003 to 2006–2008, they were high in Shikoku, Kyushu and the Prefectures around Tokyo, with Kagawa Prefecture highest at 1.35. On the other hand, there were 15 prefectures whose share increase rate were less than 0.95% (Chart 1-2).

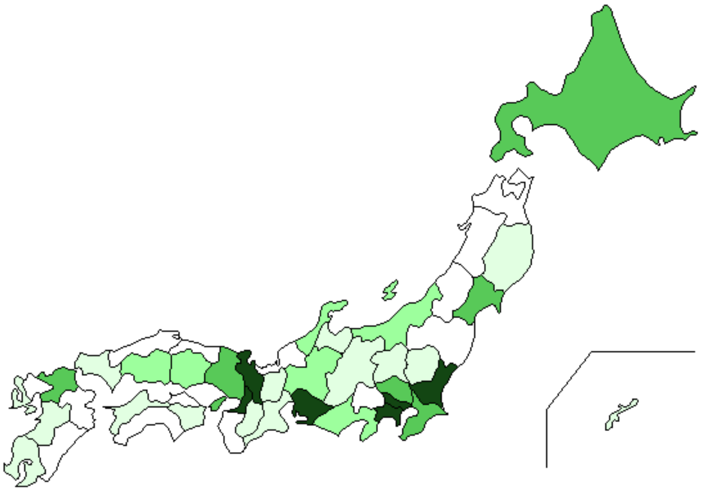
Table 1: The number of graduate students in national, public and private universities and colleges

Prefectures	3-year moving average				
	2001-2003 Unit: case	2006-2008 Unit: case	2001-2003 Share (A)	2006-2008 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	8,295	9,207	3.71%	3.50%	0.945
Aomori	757	935	0.34%	0.36%	1.051
Iwate	1,197	1,343	0.53%	0.51%	0.955
Miyagi	7,060	7,736	3.15%	2.94%	0.933
Akita	618	738	0.28%	0.28%	1.017
Yamagata	1,303	1,500	0.58%	0.57%	0.980
Fukushima	845	883	0.38%	0.34%	0.889
Ibaraki	6,112	7,006	2.73%	2.66%	0.976
Tochigi	1,474	2,017	0.66%	0.77%	1.165
Gunma	1,496	1,981	0.67%	0.75%	1.127
Saitama	3,554	4,977	1.59%	1.89%	1.192
Chiba	7,187	9,534	3.21%	3.63%	1.129
Tokyo	57,520	69,831	25.70%	26.56%	1.033
Kanagawa	12,733	14,424	5.69%	5.49%	0.964
Niigata	4,000	4,725	1.79%	1.80%	1.005
Toyama	1,244	1,266	0.56%	0.48%	0.866
Ishikawa	3,953	3,934	1.77%	1.50%	0.847
Fukui	1,069	1,102	0.48%	0.42%	0.877
Yamanashi	936	1,117	0.42%	0.42%	1.016
Nagano	1,953	2,364	0.87%	0.90%	1.031
Gifu	1,991	2,154	0.89%	0.82%	0.921
Shizuoka	2,399	2,735	1.07%	1.04%	0.970
Aichi	13,076	15,292	5.84%	5.82%	0.995
Mie	1,415	1,319	0.63%	0.50%	0.794
Shiga	2,294	2,712	1.03%	1.03%	1.006
Kyoto	14,956	17,797	6.68%	6.77%	1.013
Osaka	16,179	18,199	7.23%	6.92%	0.957
Hyogo	8,433	9,891	3.77%	3.76%	0.998
Nara	2,168	2,352	0.97%	0.89%	0.923
Wakayama	669	783	0.30%	0.30%	0.996
Tottori	1,060	1,121	0.47%	0.43%	0.900
Shimane	634	835	0.28%	0.32%	1.122
Okayama	3,845	4,493	1.72%	1.71%	0.994
Hiroshima	5,576	6,027	2.49%	2.29%	0.920
Yamaguchi	1,785	1,930	0.80%	0.73%	0.920
Tokushima	2,142	2,455	0.96%	0.93%	0.975
Kagawa	584	925	0.26%	0.35%	1.349
Ehime	1,358	1,365	0.61%	0.52%	0.855
Kouchi	892	1,122	0.40%	0.43%	1.071
Fukuoka	10,129	12,125	4.53%	4.61%	1.019
Saga	942	1,005	0.42%	0.38%	0.908
Nagasaki	1,447	1,707	0.65%	0.65%	1.004
Kumamoto	2,314	2,786	1.03%	1.06%	1.024
Oita	766	1,113	0.34%	0.42%	1.236
Miyazaki	618	780	0.28%	0.30%	1.074
Kagoshima	1,641	2,085	0.73%	0.79%	1.081
Okinawa	1,156	1,200	0.52%	0.46%	0.884
Whole	223,774	262,929	100.00%	100.00%	

Note: "The number of graduate students" is the total of national, public and private universities and colleges. Surveyed by the address with graduate courses in which students enroll.
Source: MEXT, "School Basic Survey"

2. The number of papers (all fields)

Chart 2-1: The share of the number of papers (all fields) The average value of 2006–2008

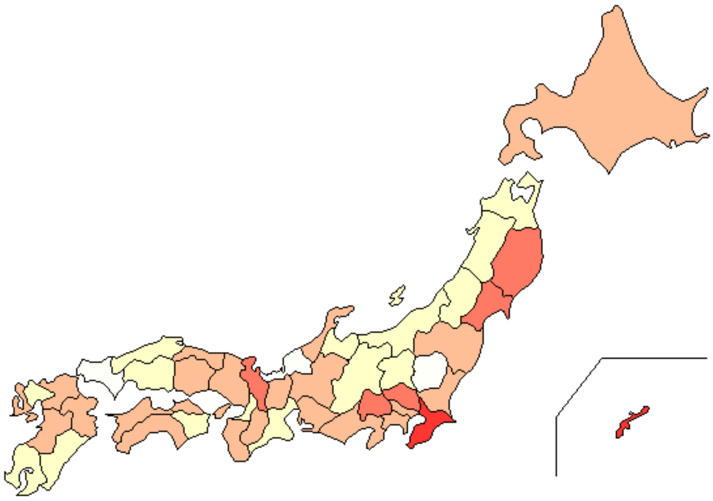


Legend	Classification			The number of prefectures
🟩	5.00% or over	～		6
🟩	2.00%	～	Under 5.00%	6
🟩	1.00%	～	2.00%	6
🟩	0.50%	～	1.00%	15
⬜		～	0.50%	14

Top 5	Share	Low rank 5	Share
Tokyo	19.55%	Wakayama	0.32%
Osaka	7.80%	Shimane	0.35%
Ibaraki	6.80%	Miyazaki	0.36%
Kanagawa	6.74%	Fukushima	0.37%
Kyoto	6.18%	Yamanashi	0.37%

Source: Compiled by NISTEP based on Thomson Reuters Scientific “Web of Science”

Chart 2-2: The share increase rate of the number of papers (all fields)
The comparisons of the average value between 2001–2003 and 2006–2008



Legend	Classification			The number of prefectures
🟥	1.15 or over	～		2
🟥	1.05	～	under 1.15	5
🟧	0.95	～	1.05	22
🟨	0.85	～	0.95	15
⬜		～	0.85	3

Top 5	Growth rate	Low rank 5	Growth rate
Okinawa	1.25	Yamaguchi	0.79
Chiba	1.16	Tochigi	0.82
Saitama	1.14	Fukui	0.84
Kyoto	1.08	Mie	0.86
Miyagi	1.07	Shimane	0.87

Source: Compiled by NISTEP based on Thomson Reuters Scientific “Web of Science”

【Key Points】

- Looking at the distributions of the share of the number of papers, the value is higher in the prefectures which have major metropolitan areas (Chart-2-1).
- Looking at the share increase rate, Chiba Prefecture (3.20%, the 10th place) and Saitama Prefecture (2.59%, the 12th place), whose shares of papers during 2001–2003 were comparatively high, increased the shares during 2006–2008 and they ranked in the top 5. On the other hand, there were 18 prefectures whose shares decreased; the share increase rate of these prefectures were less than 0.95% (Chart 2-2).

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

Prefectures	3-year moving average				
	2001-2003 Unit: case	2006-2008 Unit: case	2001-2003 Share (A)	2006-2008 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	2,651	2,750	4.13%	4.10%	0.992
Aomori	314	296	0.49%	0.44%	0.899
Iwate	330	366	0.52%	0.55%	1.059
Miyagi	2,439	2,725	3.80%	4.06%	1.068
Akita	289	282	0.45%	0.42%	0.930
Yamagata	337	319	0.52%	0.48%	0.907
Fukushima	236	249	0.37%	0.37%	1.007
Ibaraki	4,327	4,564	6.74%	6.80%	1.008
Tochigi	614	524	0.96%	0.78%	0.816
Gunma	612	584	0.95%	0.87%	0.913
Saitama	1,661	1,974	2.59%	2.94%	1.136
Chiba	2,056	2,497	3.20%	3.72%	1.161
Tokyo	12,236	13,121	19.07%	19.55%	1.025
Kanagawa	4,358	4,525	6.79%	6.74%	0.993
Niigata	832	773	1.30%	1.15%	0.889
Toyama	513	498	0.80%	0.74%	0.928
Ishikawa	877	878	1.37%	1.31%	0.957
Fukui	340	297	0.53%	0.44%	0.836
Yamanashi	223	249	0.35%	0.37%	1.067
Nagano	622	571	0.97%	0.85%	0.879
Gifu	653	675	1.02%	1.01%	0.988
Shizuoka	1,016	1,028	1.58%	1.53%	0.967
Aichi	3,563	3,769	5.55%	5.62%	1.011
Mie	472	425	0.74%	0.63%	0.860
Shiga	462	482	0.72%	0.72%	0.998
Kyoto	3,679	4,146	5.73%	6.18%	1.078
Osaka	5,447	5,236	8.49%	7.80%	0.919
Hyogo	1,756	1,915	2.74%	2.85%	1.042
Nara	524	566	0.82%	0.84%	1.033
Wakayama	208	216	0.32%	0.32%	0.991
Tottori	290	311	0.45%	0.46%	1.027
Shimane	262	237	0.41%	0.35%	0.865
Okayama	1,136	1,161	1.77%	1.73%	0.977
Hiroshima	1,268	1,233	1.98%	1.84%	0.930
Yamaguchi	531	441	0.83%	0.66%	0.793
Tokushima	552	519	0.86%	0.77%	0.899
Kagawa	284	302	0.44%	0.45%	1.018
Ehime	395	430	0.62%	0.64%	1.041
Kouchi	308	325	0.48%	0.49%	1.012
Fukuoka	2,804	2,835	4.37%	4.22%	0.967
Saga	319	301	0.50%	0.45%	0.901
Nagasaki	538	570	0.84%	0.85%	1.011
Kumamoto	578	617	0.90%	0.92%	1.022
Oita	261	266	0.41%	0.40%	0.972
Miyazaki	253	243	0.39%	0.36%	0.918
Kagoshima	425	401	0.66%	0.60%	0.901
Okinawa	257	337	0.40%	0.50%	1.253
Unknown	50	78	0.08%	0.12%	1.501
Whole	64,156	67,107	100.00%	100.00%	

Note: 1) The papers of the prefectures are done by fractional counts by the locations of the prefectures those institutions (faculties, research courses) to which the authors of papers belong. Especially, in case of international co-authorship papers, which institutions overseas are engaged in, the parts of Japan's institutions alone are done by fractional counts. As for the parts of institutions overseas, they are not counted. For example, if a paper is written collectively by Tokyo University (the faculty of Engineering department) (Tokyo), Tokyo University (the faculty of Natural sciences) (Tokyo), Keio University (Tokyo), Chiba University (Chiba Prefecture), Stanford University (the U.S.), the result of the count becomes third-quarters of Tokyo and a quarter of Chiba.

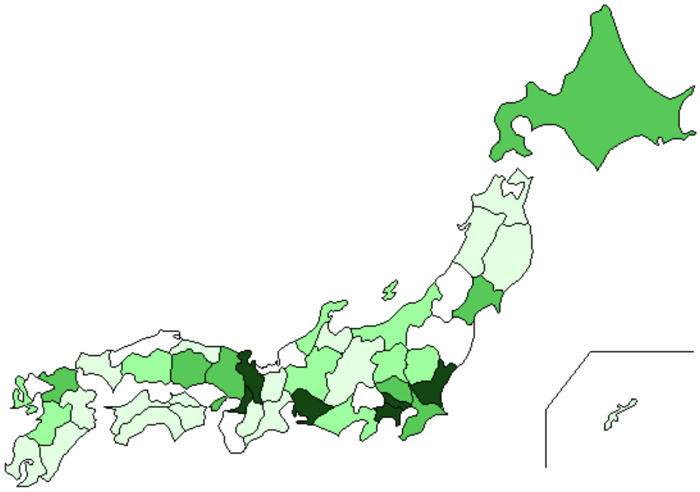
2) Since there are some magazines that can not be classified, the total of Chart 3 and Chart 4 is not added up to the entire figures (Chart 2).

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

3. The number of papers (the field of Life sciences)

Chart 3-1: The share of the number of papers (the field of Life sciences)

The average value of 2006–2008



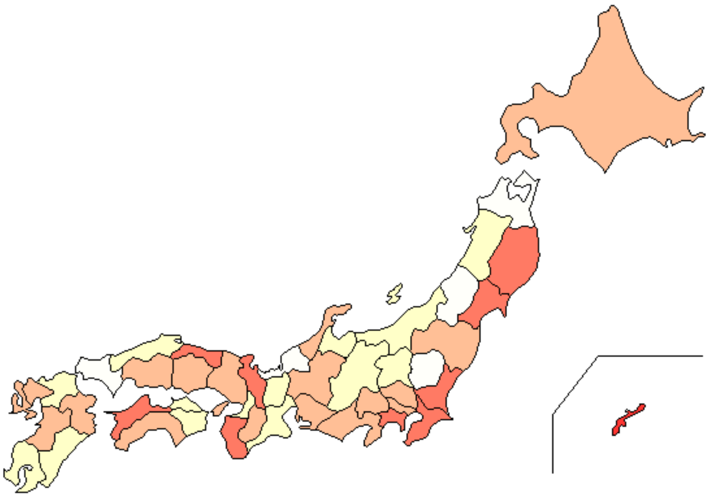
Legend	Classification	The number of prefectures
🟩	5.00% or over ～	6
🟩	2.00% ～ under 5.00%	7
🟩	1.00% ～ 2.00%	9
🟩	0.50% ～ 1.00%	18
⬜	～ 0.50%	7

Top 5	Share	Low rank 5	Share
Tokyo	19.97%	Saga	0.41%
Osaka	7.28%	Yamagata	0.41%
Kanagawa	5.37%	Yamanashi	0.42%
Kyoto	5.36%	Fukui	0.43%
Aichi	5.07%	Shimane	0.45%

Source: Collected by NISTEP based on Thomson Reuters Scientific “Web of Science”

Chart 3-2: Share increase rate for number of papers (Life sciences)

Comparison of average values for 2001–2003 and 2006–2008



Legend	Classification	The number of prefectures
🟥	1.15 or over ～	1
🟥	1.05 ～ under 1.15	9
🟧	0.95 ～ 1.05	18
🟨	0.85 ～ 0.95	14
⬜	～ 0.85	5

Top 5	Growth rate	Low rank 5	Growth rate
Okinawa	1.26	Fukui	0.79
Chiba	1.14	Tochigi	0.80
Kanagawa	1.12	Yamagata	0.82
Ehime	1.11	Yamaguchi	0.84
Miyagi	1.10	Aomori	0.85

Source: Collected by NISTEP based on Thomson Reuters Scientific “Web of Science”

【Key Points】

- Here, data for Life sciences are shown, after the fields of papers dividing into the two fields of Life sciences and the fields of Natural sciences and Engineering. 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%-1.00% (18). Half as many prefectures had shares of less than 0.5% as had shares from 0.5–1.00%. The figure for all papers (Chart 2-1) was similar, while the figure for Natural sciences and engineering (Chart 4-1) was about double.
- Looking at the share increase rate, attention should be paid to the fact that Kanagawa Prefecture (4.82%, 7th place) and Chiba Prefecture (3.11%, 9th place), whose shares of papers during 2001–2003 were comparatively high, then increased their shares more during 2006–2008 and as a result ranked in the top 5. On the other hand, there were 19 prefectures whose shares decreased and whose share increase rate was less than 0.95% (Chart 3-2).

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

	3-year moving average				
Prefectures	2001-2003 Unit case	2006-2008 Unit case	2001-2003 Share (A)	2006-2008 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	1,803	1,873	4.97%	4.92%	0.990
Aomori	259	231	0.71%	0.61%	0.850
Iwate	241	265	0.66%	0.70%	1.051
Miyagi	938	1,084	2.59%	2.85%	1.102
Akita	216	192	0.59%	0.51%	0.851
Yamagata	182	157	0.50%	0.41%	0.822
Fukushima	162	171	0.45%	0.45%	1.010
Ibaraki	1,702	1,905	4.70%	5.01%	1.067
Tochigi	502	420	1.39%	1.10%	0.796
Gunma	395	389	1.09%	1.02%	0.940
Saitama	976	1,000	2.69%	2.63%	0.978
Chiba	1,126	1,343	3.11%	3.53%	1.138
Tokyo	7,000	7,594	19.31%	19.97%	1.034
Kanagawa	1,746	2,043	4.82%	5.37%	1.116
Niigata	517	490	1.43%	1.29%	0.903
Toyama	335	313	0.92%	0.82%	0.891
Ishikawa	541	580	1.49%	1.52%	1.021
Fukui	198	165	0.55%	0.43%	0.793
Yamanashi	155	161	0.43%	0.42%	0.992
Nagano	386	352	1.07%	0.93%	0.870
Gifu	390	426	1.08%	1.12%	1.040
Shizuoka	675	698	1.86%	1.84%	0.986
Aichi	1,767	1,927	4.87%	5.07%	1.040
Mie	343	330	0.95%	0.87%	0.918
Shiga	295	282	0.81%	0.74%	0.912
Kyoto	1,830	2,037	5.05%	5.36%	1.062
Osaka	2,930	2,770	8.08%	7.28%	0.901
Hyogo	988	1,065	2.72%	2.80%	1.028
Nara	355	360	0.98%	0.95%	0.965
Wakayama	156	179	0.43%	0.47%	1.092
Tottori	224	249	0.62%	0.66%	1.060
Shimane	192	171	0.53%	0.45%	0.851
Okayama	786	811	2.17%	2.13%	0.984
Hiroshima	735	747	2.03%	1.96%	0.968
Yamaguchi	326	288	0.90%	0.76%	0.840
Tokushima	360	357	0.99%	0.94%	0.946
Kagawa	228	219	0.63%	0.58%	0.915
Ehime	276	320	0.76%	0.84%	1.105
Kouchi	242	249	0.67%	0.65%	0.981
Fukuoka	1,777	1,702	4.90%	4.48%	0.913
Saga	157	157	0.43%	0.41%	0.952
Nagasaki	430	462	1.19%	1.21%	1.023
Kumamoto	418	436	1.15%	1.15%	0.996
Oita	214	218	0.59%	0.57%	0.969
Miyazaki	205	196	0.57%	0.52%	0.911
Kagoshima	338	319	0.93%	0.84%	0.900
Okinawa	204	268	0.56%	0.71%	1.256
Unknown	37	58	0.10%	0.15%	1.498
Whole	36,260	38,030	100.00%	100.00%	

Note: The method of counting the papers is in accordance with the note for Table 2.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science".

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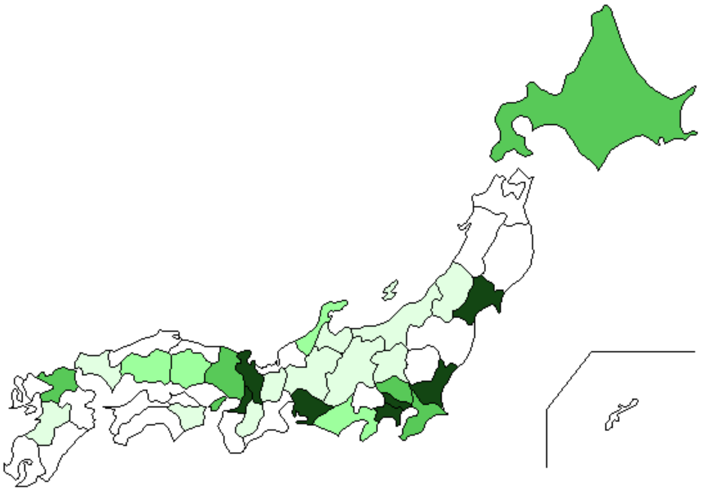
(1) Refer to NISTEP, "Benchmarking Research & Development Capacity of Japan Based on Dynamic Alteration of Research Activity in the World" p.3

4. The number of papers (the field of Natural sciences and Engineering)

Chart 4-1: The share of the number of papers (the field of Natural sciences and Engineering)

The average value for 2006–2008



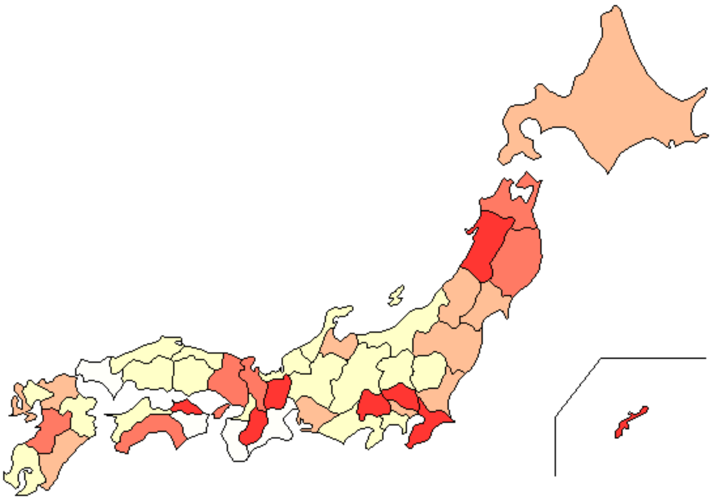
Legend	Classification			The number of prefectures
🟩	5.00% or over	～		7
🟩	2.00%	～	under 5.00%	5
🟩	1.00%	～	2.00%	4
🟩	0.50%	～	1.00%	11
⬜		～	0.50%	20

Top 5	Share	Low rank 5	Share
Tokyo	18.81%	Wakayama	0.12%
Ibaraki	9.24%	Oita	0.16%
Kanagawa	8.58%	Miyazaki	0.16%
Osaka	8.50%	Tottori	0.21%
Kyoto	7.20%	Okinawa	0.22%

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

Chart 4-2: The share increase rate of the number of papers (the field of Natural sciences and Engineering)

A comparison of average values between 2001–2003 and 2006–2008



Legend	Classification			The number of prefectures
🟥	1.15 or over	～		8
🟥	1.05	～	under 1.15	6
🟧	0.95	～	1.05	11
🟨	0.85	～	0.95	18
⬜		～	0.85	4

Top 5	Growth rate	Low rank 5	Growth rate
Kagawa	1.51	Wakayama	0.67
Saitama	1.37	Yamaguchi	0.72
Yamanashi	1.31	Mie	0.72
Akita	1.25	Tokushima	0.83
Chiba	1.18	Gunma	0.86

Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

【Key points】

- The fields of Natural sciences and Engineering are Chemistry, Material science, Physics, Space science, Computer Mathematics, Engineering, Environment/Ecology, Geoscience.(2)
- Regarding the share of the number of papers of the fields of Natural sciences and Engineering, Ibaraki Prefecture, which ranks in the second place can be mentioned as characteristic of this. And the top 5 shares of the prefectures account for 52.3% (The total for all papers is 47.1%, and papers in the fields of Life sciences alone is 43.1%) (Chart 4-1).
- Looking at the share increase rate, Chiba Prefecture (3.37%, 9th place) and Saitama Prefecture (2.43%, the 12th place), which had comparatively large shares of papers during 2001–2003, extended their share more during 2006–2008 and ranked in the top 5 of the Prefectures. On the other hand, there were 22 prefectures whose shares were decreased and whose share increase rate was less than 0.95% (Chart 4-2).

Table 4: The number of papers (the field of Natural sciences and Engineering)

Prefectures	3-year moving average				
	2001-2003 Unit: case	2006-2008 Unit: case	2001-2003 Share (A)	2006-2008 Share (B)	The growth rate of the share (B)/(A)
Hokkaido	815	861	3.06%	3.03%	0.990
Aomori	52	63	0.20%	0.22%	1.129
Iwate	86	99	0.32%	0.35%	1.078
Miyagi	1,448	1,620	5.44%	5.70%	1.049
Akita	65	86	0.24%	0.30%	1.245
Yamagata	152	160	0.57%	0.56%	0.988
Fukushima	70	76	0.26%	0.27%	1.017
Ibaraki	2,517	2,624	9.45%	9.24%	0.978
Tochigi	104	100	0.39%	0.35%	0.908
Gunma	208	191	0.78%	0.67%	0.858
Saitama	648	949	2.43%	3.34%	1.372
Chiba	896	1,133	3.37%	3.99%	1.185
Tokyo	4,989	5,344	18.73%	18.81%	1.004
Kanagawa	2,478	2,438	9.30%	8.58%	0.923
Niigata	289	277	1.09%	0.98%	0.899
Toyama	167	183	0.63%	0.64%	1.024
Ishikawa	318	291	1.19%	1.03%	0.860
Fukui	135	132	0.51%	0.46%	0.911
Yamanashi	63	87	0.23%	0.31%	1.311
Nagano	223	215	0.84%	0.76%	0.904
Gifu	255	246	0.96%	0.87%	0.905
Shizuoka	321	322	1.20%	1.13%	0.941
Aichi	1,722	1,804	6.46%	6.35%	0.983
Mie	120	93	0.45%	0.33%	0.725
Shiga	158	194	0.59%	0.68%	1.154
Kyoto	1,782	2,045	6.69%	7.20%	1.076
Osaka	2,401	2,415	9.02%	8.50%	0.943
Hyogo	727	827	2.73%	2.91%	1.067
Nara	157	198	0.59%	0.70%	1.182
Wakayama	49	35	0.18%	0.12%	0.673
Tottori	61	61	0.23%	0.21%	0.934
Shimane	67	65	0.25%	0.23%	0.911
Okayama	342	342	1.28%	1.20%	0.938
Hiroshima	518	478	1.95%	1.68%	0.864
Yamaguchi	195	149	0.73%	0.53%	0.719
Tokushima	177	156	0.67%	0.55%	0.825
Kagawa	51	82	0.19%	0.29%	1.507
Ehime	112	109	0.42%	0.38%	0.908
Kouchi	63	75	0.23%	0.26%	1.124
Fukuoka	992	1,107	3.72%	3.90%	1.047
Saga	153	140	0.58%	0.49%	0.858
Nagasaki	99	102	0.37%	0.36%	0.965
Kumamoto	152	179	0.57%	0.63%	1.106
Oita	45	45	0.17%	0.16%	0.947
Miyazaki	44	45	0.16%	0.16%	0.965
Kagoshima	84	80	0.32%	0.28%	0.894
Okinawa	50	62	0.19%	0.22%	1.158
Unknown	12	19	0.05%	0.07%	1.454
Whole	26,635	28,405	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”

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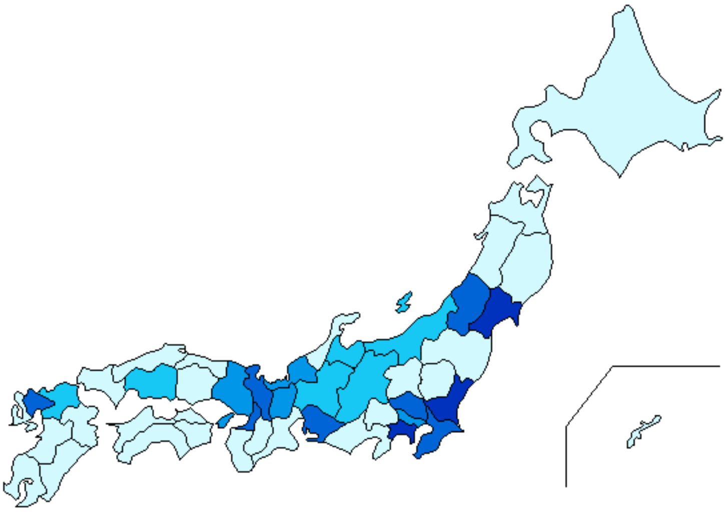
(2) Refer to NISTEP, “Benchmarking Research & Development Capacity of Japan Based on Dynamic Alteration of Research Activity in the World” p.3

5. The balance of papers between the field of Natural sciences and Engineering and the field of Life sciences

Chart 5: The balance of papers between the field of Natural sciences and Engineering and the field of Life sciences (Natural sciences and Engineering/Life sciences)



Legend	Classification			The number of prefectures	
🟦	1.500 or over	～		3	The number of Natural sciences and Engineering is very large (Approximately over twice)
🟦	1.100	～	under 1.500	7	The number of Natural sciences and Engineering is slightly large
🟦	0.900	～	1.100	4	The number of Natural sciences and Engineering, and Life sciences are fifty-fifty split
🟦	0.750	～	0.900	6	The number of Life sciences is slighly large
⬜		～	0.750	27	The number of Life sciences is very large (The number of Natural sciences and engineering is under half of that of Life sciences)

Source: Compiled by NISTEP based on Thomson Reuters Scientific :Web of Science:

【Key Points】

- The balance of the share of the papers between the field of Natural sciences and Engineering and the field of Life sciences is shown by each prefecture (Chart 5). To calculate the balance, the share of papers in the field of Natural sciences and Engineering during 2006–2008 was divided by the share of papers in the field of Life sciences.
- There were many prefectures whose shares of papers in the field of Life sciences were larger than those for the field of Natural sciences and Engineering. In contrast, the prefectures with a balance of over 1 among the Prefectures having over 1% of the share of the papers of the fields of Natural sciences and Engineering alone, were limited to Miyagi Prefecture (2.00), Ibaraki Prefecture (1.84), Kanagawa Prefecture (1.60) and Kyoto Prefecture (1.34).

Table 5: The shares of and the balance between papers in the field of Natural sciences and Engineering and the field of Life sciences

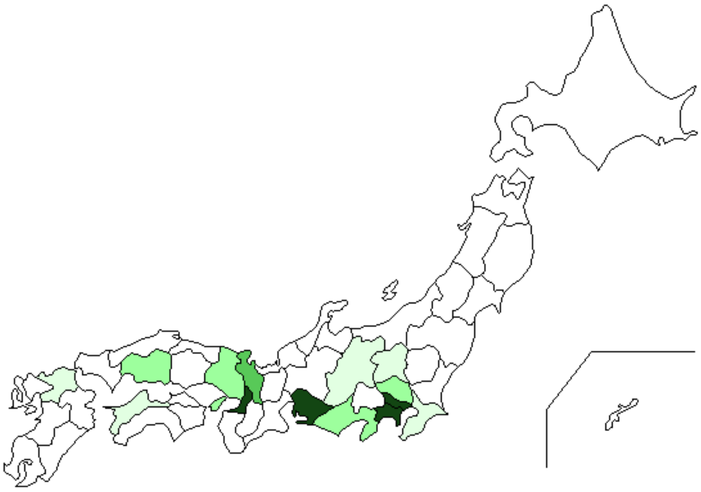
Prefectures	Natural sciences and Engineering 3-year moving average			Life sciences 3-year moving average			Balance
	2001-2003 Share (A)	2006-2008 Share (B)	The growth rate of the share (B)/(A)	2001-2003 Share (C)	2006-2008 Share (D)	The growth rate of the share (D)/(C)	Natural sciences and Engineering (B)/ Life sciences (D)
Hokkaido	3.06%	3.03%	0.99	4.97%	4.92%	0.990	0.615
Aomori	0.20%	0.22%	1.13	0.71%	0.61%	0.850	0.365
Iwate	0.32%	0.35%	1.08	0.66%	0.70%	1.051	0.501
Miyagi	5.44%	5.70%	1.05	2.59%	2.85%	1.102	2.001
Akita	0.24%	0.30%	1.25	0.59%	0.51%	0.851	0.599
Yamagata	0.57%	0.56%	0.99	0.50%	0.41%	0.822	1.368
Fukushima	0.26%	0.27%	1.02	0.45%	0.45%	1.010	0.593
Ibaraki	9.45%	9.24%	0.98	4.70%	5.01%	1.067	1.844
Tochigi	0.39%	0.35%	0.91	1.39%	1.10%	0.796	0.321
Gunma	0.78%	0.67%	0.86	1.09%	1.02%	0.940	0.656
Saitama	2.43%	3.34%	1.37	2.69%	2.63%	0.978	1.270
Chiba	3.37%	3.99%	1.18	3.11%	3.53%	1.138	1.129
Tokyo	18.73%	18.81%	1.00	19.31%	19.97%	1.034	0.942
Kanagawa	9.30%	8.58%	0.92	4.82%	5.37%	1.116	1.598
Niigata	1.09%	0.98%	0.90	1.43%	1.29%	0.903	0.758
Toyama	0.63%	0.64%	1.02	0.92%	0.82%	0.891	0.781
Ishikawa	1.19%	1.03%	0.86	1.49%	1.52%	1.021	0.673
Fukui	0.51%	0.46%	0.91	0.55%	0.43%	0.793	1.069
Yamanashi	0.23%	0.31%	1.31	0.43%	0.42%	0.992	0.727
Nagano	0.84%	0.76%	0.90	1.07%	0.93%	0.870	0.817
Gifu	0.96%	0.87%	0.90	1.08%	1.12%	1.040	0.774
Shizuoka	1.20%	1.13%	0.94	1.86%	1.84%	0.986	0.618
Aichi	6.46%	6.35%	0.98	4.87%	5.07%	1.040	1.253
Mie	0.45%	0.33%	0.72	0.95%	0.87%	0.918	0.377
Shiga	0.59%	0.68%	1.15	0.81%	0.74%	0.912	0.922
Kyoto	6.69%	7.20%	1.08	5.05%	5.36%	1.062	1.344
Osaka	9.02%	8.50%	0.94	8.08%	7.28%	0.901	1.167
Hyogo	2.73%	2.91%	1.07	2.72%	2.80%	1.028	1.040
Nara	0.59%	0.70%	1.18	0.98%	0.95%	0.965	0.737
Wakayama	0.18%	0.12%	0.67	0.43%	0.47%	1.092	0.265
Tottori	0.23%	0.21%	0.93	0.62%	0.66%	1.060	0.325
Shimane	0.25%	0.23%	0.91	0.53%	0.45%	0.851	0.508
Okayama	1.28%	1.20%	0.94	2.17%	2.13%	0.984	0.565
Hiroshima	1.95%	1.68%	0.86	2.03%	1.96%	0.968	0.857
Yamaguchi	0.73%	0.53%	0.72	0.90%	0.76%	0.840	0.696
Tokushima	0.67%	0.55%	0.83	0.99%	0.94%	0.946	0.585
Kagawa	0.19%	0.29%	1.51	0.63%	0.58%	0.915	0.504
Ehime	0.42%	0.38%	0.91	0.76%	0.84%	1.105	0.455
Kouchi	0.23%	0.26%	1.12	0.67%	0.65%	0.981	0.403
Fukuoka	3.72%	3.90%	1.05	4.90%	4.48%	0.913	0.871
Saga	0.58%	0.49%	0.86	0.43%	0.41%	0.952	1.199
Nagasaki	0.37%	0.36%	0.97	1.19%	1.21%	1.023	0.296
Kumamoto	0.57%	0.63%	1.11	1.15%	1.15%	0.996	0.550
Oita	0.17%	0.16%	0.95	0.59%	0.57%	0.969	0.277
Miyazaki	0.16%	0.16%	0.97	0.57%	0.52%	0.911	0.308
Kagoshima	0.32%	0.28%	0.89	0.93%	0.84%	0.900	0.336
Okinawa	0.19%	0.22%	1.16	0.56%	0.71%	1.256	0.311
Unknown	0.05%	0.07%	1.45	0.10%	0.15%	1.50	0.433
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 the field of Natural sciences and Engineering and the field of Life sciences were the same as in Table 3 and Table 4.
Source: Compiled by NISTEP based on Thomson Reuters Scientific "Web of Science"

6. The number of patent applications

Chart 6-1: The share of the number of the patent applications

The average value between and 2006–2008



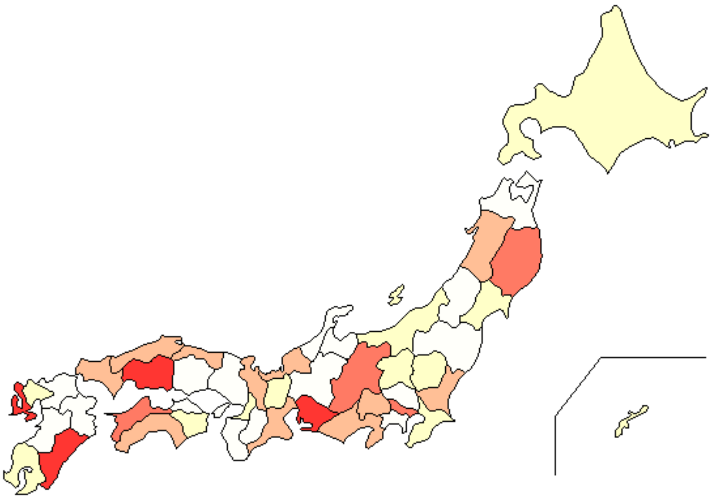
Legend	Classification			The number of prefectures
■	5.00% or over	～		4
🟩	2.00%	～	under 5.00%	1
▨	1.00%	～	2.00%	4
░	0.50%	～	1.00%	5
□		～	0.50%	33

Top 5	Share	Low rank 5	Share
Tokyo	50.96%	Tottori	0.04%
Osaka	16.19%	Aomori	0.05%
Aichi	8.87%	Oita	0.05%
Kanagawa	5.84%	Okinawa	0.05%
Kyoto	2.89%	Akita	0.05%

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 2001–2003 and 2006–2008



Legend	Classification			The number of prefectures
■	1.15 or over	～		4
▨	1.05	～	under 1.15	4
▧	0.95	～	1.05	11
░	0.85	～	0.95	12
□		～	0.85	16

Top 5	Growth rate	Low rank 5	Growth rate
Hiroshima	1.54	Yamagata	0.60
Miyazaki	1.33	Kumamoto	0.63
Aichi	1.28	Gifu	0.64
Nagasaki	1.21	Fukushima	0.71
Nagano	1.10	Aomori	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%. 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 2001–2003 to 2006–2008, the growing prefectures included Hiroshima and Miyazaki Prefectures. However, looking at the whole, there were 28 prefectures whose share increase rate was less than 0.95% and which represents over half of all prefectures (Chart 6-2).

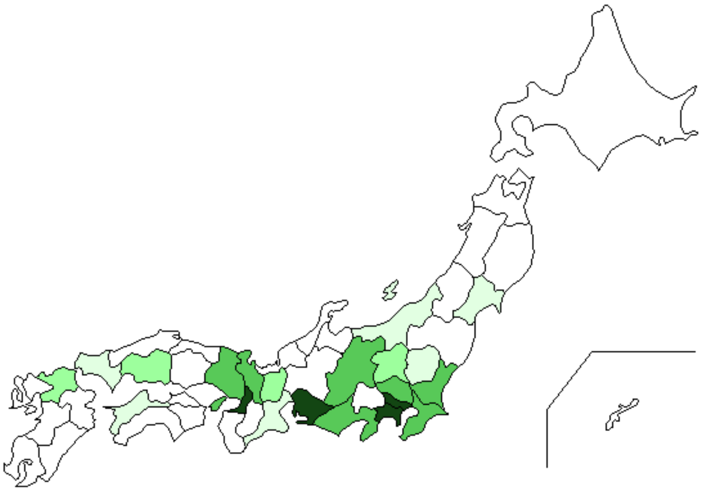
Table 6: The number of patent applications

Prefectures	3-year moving average				The growth rate of the share (B)/(A)
	2001-2003 Unit: case	2006-2008 Unit: case	2001-2003 Share (A)	2006-2008 Share (B)	
Hokkaido	1,150	974	0.31%	0.29%	0.938
Aomori	232	152	0.06%	0.05%	0.725
Iwate	299	284	0.08%	0.08%	1.050
Miyagi	1,347	1,135	0.36%	0.34%	0.933
Akita	203	184	0.05%	0.05%	1.002
Yamagata	506	272	0.14%	0.08%	0.596
Fukushima	421	270	0.11%	0.08%	0.709
Ibaraki	1,780	1,543	0.48%	0.46%	0.960
Tochigi	691	567	0.19%	0.17%	0.908
Gunma	2,910	2,310	0.78%	0.69%	0.879
Saitama	6,113	4,556	1.64%	1.35%	0.825
Chiba	3,520	2,829	0.94%	0.84%	0.890
Tokyo	180,683	171,682	48.44%	50.96%	1.052
Kanagawa	28,011	19,663	7.51%	5.84%	0.777
Niigata	1,347	1,122	0.36%	0.33%	0.922
Toyama	1,086	750	0.29%	0.22%	0.765
Ishikawa	1,018	691	0.27%	0.21%	0.752
Fukui	836	745	0.22%	0.22%	0.987
Yamanashi	820	753	0.22%	0.22%	1.016
Nagano	2,702	2,692	0.72%	0.80%	1.103
Gifu	1,778	1,024	0.48%	0.30%	0.637
Shizuoka	5,785	4,969	1.55%	1.48%	0.951
Aichi	25,782	29,869	6.91%	8.87%	1.283
Mie	1,407	1,240	0.38%	0.37%	0.976
Shiga	1,058	842	0.28%	0.25%	0.881
Kyoto	10,866	9,747	2.91%	2.89%	0.993
Osaka	64,084	54,535	17.18%	16.19%	0.942
Hyogo	8,949	6,464	2.40%	1.92%	0.800
Nara	628	478	0.17%	0.14%	0.843
Wakayama	779	564	0.21%	0.17%	0.801
Tottori	147	140	0.04%	0.04%	1.050
Shimane	448	388	0.12%	0.12%	0.959
Okayama	1,724	1,159	0.46%	0.34%	0.744
Hiroshima	2,553	3,547	0.68%	1.05%	1.538
Yamaguchi	1,615	1,454	0.43%	0.43%	0.997
Tokushima	627	483	0.17%	0.14%	0.852
Kagawa	619	443	0.17%	0.13%	0.793
Ehime	1,792	1,700	0.48%	0.50%	1.050
Kouchi	207	191	0.06%	0.06%	1.023
Fukuoka	3,700	2,654	0.99%	0.79%	0.794
Saga	248	203	0.07%	0.06%	0.909
Nagasaki	229	250	0.06%	0.07%	1.210
Kumamoto	482	273	0.13%	0.08%	0.627
Oita	214	162	0.06%	0.05%	0.839
Miyazaki	248	299	0.07%	0.09%	1.332
Kagoshima	300	247	0.08%	0.07%	0.912
Okinawa	213	181	0.06%	0.05%	0.943
Unknown	822	212	0.22%	0.06%	0.285
Whole	372,979	336,889	100.00%	100.00%	

Note:1) By Japanese people.
2) The column for others indicates that the prefecture cannot be determined.
3) The address of the first listed applicant is counted
Source: Japan Patent Office, "Japan Patent Office Annual Report"

7. The number of inventors

Chart 7-1: The share of the number of inventors in 2008

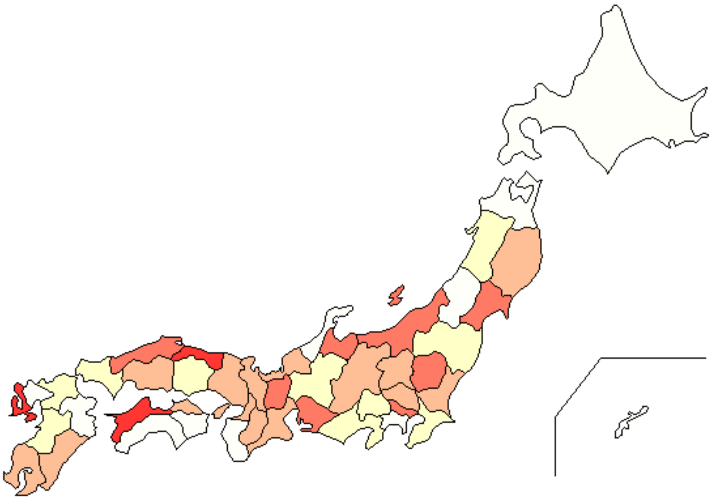


Legend	Classification			The number of of prefectures
🟩	5.00% or over	～		4
🟩	2.00%	～	under 5.00%	7
🟩	1.00%	～	2.00%	4
🟩	0.50%	～	1.00%	6
⬜		～	0.50%	26

Top 5	Share	Low rank 5	Share
Tokyo	33.08%	Okinawa	0.04%
Osaka	13.31%	Kouchi	0.05%
Kanagawa	10.47%	Aomori	0.06%
Aichi	9.51%	Saga	0.07%
Saitama	3.39%	Oita	0.08%

Source: Japan Patent Office, "Japan Patent Office Annual Report"

Chart 7-2: The share increase rate of the number of inventors
A comparison of the values for 2005 and those for 2008



Legend	Classification			The number of prefectures
🟥	1.15 or over	～		3
🟥	1.05	～	under 1.15	8
🟧	0.95	～	1.05	15
🟨	0.85	～	0.95	10
⬜		～	0.85	11

Top 5	Growth rate	Low rank 5	Growth rate
Nagawaki	1.34	Okinawa	0.55
Tottori	1.28	Oita	0.64
Ehime	1.25	Tokushima	0.68
Toyama	1.15	Yamagata	0.71
Aichi	1.14	Saga	0.75

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. When comparing the status of the patent applications which are the results of intellectual production activities with the distribution of the share of the number of applications (Chart 6-1) and the distribution of the share of actual inventors, it shows that the prefectures which have high shares for inventors are widely located around the prefectures which have the largest shares of patent applications.
- The prefecture with a relatively large share of inventors in 2005 and 2008 as well as a large rate of increase was Aichi Prefecture. It was also in the top five prefectures in terms of number of patents, share of patents, and share increase rate for patents. There were 21 prefectures whose shares decreased and whose share increase rate was less than 0.95% in 2008 (Chart 7-2).

Table 7: The number of inventors

Prefectures	The number of inventors (Unit: people)		Share		
	2005	2008	2005 (A)	2008 (B)	The growth rate (B)/(A)
Hokkaido	3,503	2,405	0.44%	0.34%	0.759
Aomori	629	437	0.08%	0.06%	0.768
Iwate	774	684	0.10%	0.10%	0.977
Miyagi	4,348	4,375	0.55%	0.61%	1.113
Akita	816	653	0.10%	0.09%	0.885
Yamagata	1,518	979	0.19%	0.14%	0.713
Fukushima	2,175	1,806	0.27%	0.25%	0.918
Ibaraki	26,312	23,692	3.31%	3.30%	0.996
Tochigi	7,154	7,153	0.90%	1.00%	1.106
Gunma	8,514	7,512	1.07%	1.05%	0.976
Saitama	28,292	24,341	3.56%	3.39%	0.951
Chiba	19,699	15,649	2.48%	2.18%	0.878
Tokyo	247,803	237,453	31.22%	33.08%	1.060
Kanagawa	98,900	75,167	12.46%	10.47%	0.840
Niigata	4,101	3,921	0.52%	0.55%	1.057
Toyama	2,572	2,669	0.32%	0.37%	1.148
Ishikawa	2,319	1,697	0.29%	0.24%	0.809
Fukui	1,938	1,747	0.24%	0.24%	0.997
Yamanashi	2,452	2,006	0.31%	0.28%	0.905
Nagano	20,098	18,360	2.53%	2.56%	1.010
Gifu	3,326	2,656	0.42%	0.37%	0.883
Shizuoka	23,255	19,971	2.93%	2.78%	0.950
Aichi	66,501	68,267	8.38%	9.51%	1.135
Mie	6,072	5,732	0.76%	0.80%	1.044
Shiga	10,906	10,407	1.37%	1.45%	1.055
Kyoto	15,537	14,685	1.96%	2.05%	1.045
Osaka	109,008	95,568	13.73%	13.31%	0.969
Hyogo	21,727	20,095	2.74%	2.80%	1.023
Nara	2,121	1,950	0.27%	0.27%	1.017
Wakayama	3,089	2,321	0.39%	0.32%	0.831
Tottori	979	1,130	0.12%	0.16%	1.276
Shimane	984	947	0.12%	0.13%	1.064
Okayama	3,408	2,904	0.43%	0.40%	0.942
Hiroshima	11,228	10,366	1.41%	1.44%	1.021
Yamaguchi	4,652	3,872	0.59%	0.54%	0.920
Tokushima	1,690	1,032	0.21%	0.14%	0.675
Kagawa	1,624	1,525	0.20%	0.21%	1.038
Ehime	5,620	6,346	0.71%	0.88%	1.249
Kouchi	527	386	0.07%	0.05%	0.810
Fukuoka	10,295	8,767	1.30%	1.22%	0.942
Saga	758	515	0.10%	0.07%	0.751
Nagasaki	1,469	1,777	0.19%	0.25%	1.338
Kumamoto	1,148	918	0.14%	0.13%	0.884
Oita	936	544	0.12%	0.08%	0.643
Miyazaki	763	658	0.10%	0.09%	0.954
Kagoshima	1,779	1,577	0.22%	0.22%	0.980
Okinawa	534	266	0.07%	0.04%	0.551
Whole	793,853	717,888	100.00%	100.00%	

Note: 1) The number of people is the total numbers of people who are abstracted from “Applicants” who were written on one application.
2) Excluding international applications (PCT applications)
Source: Japan Patent Office, “Patent Administration Annual Report”

Statistical Reference A Population of the main countries

(Unit: thousand people)

Year	Japan	U.S.	Germany	France	U.K.	China	Korea	EU-15	EU-27
1981	117,902	229,966	61,682	55,419	56,357	1,000,720	38,723	341,070	-
1982	118,728	232,188	61,638	55,751	56,291	1,016,540	39,326	341,786	-
1983	119,536	234,307	61,423	56,049	56,316	1,030,080	39,910	342,292	-
1984	120,305	236,348	61,175	56,321	56,409	1,043,570	40,406	342,773	-
1985	121,049	238,466	61,024	56,600	56,554	1,058,510	40,806	343,382	-
1986	121,660	240,651	61,066	56,886	56,684	1,075,070	41,214	344,125	-
1987	122,239	242,804	61,077	57,192	56,804	1,093,000	41,622	344,843	-
1988	122,745	245,021	61,450	57,519	56,916	1,110,260	42,031	345,962	-
1989	123,205	247,342	62,063	57,859	57,076	1,127,040	42,449	347,427	-
1990	123,611	250,132	63,254	58,171	57,237	1,143,330	42,869	349,511	-
1991	124,101	253,493	79,984 a	58,459	57,439	1,158,230	43,296	367,264 a	-
1992	124,567	256,894	80,594	58,745	57,585	1,171,710	43,748	368,865	-
1993	124,938	260,255	81,179	58,995	57,714	1,185,170	44,195	370,342	-
1994	125,265	263,436	81,422	59,210	57,862	1,198,500	44,642	371,367	-
1995	125,570	266,557	81,661	59,419	58,025	1,211,210	45,093	372,313	477,893
1996	125,859	269,667	81,896	59,624	58,164	1,223,890	45,525	373,285	478,680
1997	126,157	272,912	82,052	59,831	58,314	1,236,260	45,954	374,225	479,425
1998	126,472	276,115	82,029	60,047	58,475	1,247,610	46,287	375,044	480,050
1999	126,667	279,295	82,087	60,315	58,684	1,257,860	46,617	376,103	480,932
2000	126,926	282,407	82,188	60,725	58,886	1,267,430	47,008	377,952	482,631
2001	127,291	285,339	82,340	61,163	59,113	1,276,270	47,357	379,665	483,754
2002	127,435	288,189	82,482	61,605	59,323	1,284,530	47,622	381,671	485,579
2003	127,619	290,941	82,520	62,038	59,557	1,292,270	47,859	383,906	487,628
2004	127,687	293,609	82,501	62,491	59,846	1,299,880	48,039	386,273	489,851
2005	127,768	296,329	82,464	62,958	60,238	1,307,560	48,138	388,643	492,110
2006	127,770	299,157	82,366	63,382	60,587	1,314,480	48,297	390,740	494,099
2007	127,771	302,045	82,263	63,758	60,975	1,321,290	48,456	393,080	496,375
2008	127,692	304,906	82,120	64,120	61,350	1,337,410	48,607	395,372	498,690

Note: a: Break in series with previous year for which data is available.
<Germany> Until 1990, data is for the former West Germany. After 1991, data is for the unified Germany.
Source :<Japan> Ministry of Internal Affairs and Communications, Statistics Bureau "Population Estimates" Annual Report (Web site).
<U.S.>The Executive Office of the President, "Economic Report of the President 2009" (Web site).
<Germany, France, the U.K., Korea, EU>OECD, "Main Science and Technology Indicators 2009/2".
<China>National Bureau of Statistics of China, China Statistical Yearbook 2001, 2008 (Web site); for 2008, OECD, "Main Science and Technology Indicators 2009/2"

Statistical Reference B Labor force population of the main countries

(Unit: thousand people)

Year	Japan	U.S.	Germany	France	U.K.	China	Korea	EU-15	EU-27
1981	56,610	108,670	28,305	23,466	26,740	-	14,683	146,760	-
1982	57,770	110,204	28,558	23,672	26,678	-	15,032	147,829	-
1983	58,070	111,550	28,605	23,725	26,610	-	15,118	148,714	-
1984	58,650	113,544	28,298	23,846	27,235	-	14,997	149,616	-
1985	58,710	115,461	28,434	23,910	27,486	-	15,592	150,411	-
1986	59,550	117,834 a	28,768	24,042	27,491	-	16,116	151,483	-
1987	60,610	119,865	29,036	24,159	27,943	-	16,873	153,788	-
1988	61,360	121,669	29,220	24,291	28,345	-	17,305	155,474	-
1989	62,630	123,869	29,624	24,460	28,764	-	18,023	156,888	-
1990	63,680	125,840 a	30,771	24,632	28,909	651,322	18,539	159,458	-
1991	65,040	126,346	39,577 a	24,714	28,545	658,432	19,109	168,241 a	-
1992	65,660	128,105	39,490	24,823	28,306	665,159	19,499	167,946	-
1993	66,070	129,200	39,557	24,811	28,103	672,281	19,806	166,619 a	-
1994	65,870	131,056 a	39,492	25,398	28,052	679,314	20,353	167,430	-
1995	66,100	132,304	39,376	25,451	28,024	685,846	20,845	167,891	217,685
1996	66,630	133,943	39,550	25,705	28,134	695,028	21,288	169,103	218,253
1997	67,260	136,297 a	39,804	25,901	28,252	703,968	21,782	170,333	219,320
1998	67,170	137,673 a	40,131	26,239	28,223	712,080	21,428	172,186	220,987
1999	67,150	139,368 a	39,614	26,680	28,508	719,690	21,666	173,357	222,183
2000	67,380	142,583 a	39,533	26,931	28,740	726,800	22,134	175,246	224,094
2001	66,990	143,734	39,686	27,213	28,774	737,060	22,471	176,191	225,016
2002	66,220	144,863	39,641	27,466	29,030	745,100	22,921	177,931	225,784
2003	66,070	146,510 a	39,507	27,656	29,235	752,320	22,957	179,355	226,351
2004	65,760	147,401 a	39,948	27,812	29,369	760,270	23,417	181,250	228,414
2005	65,800	149,320 a	41,040	28,005	30,062	766,640	23,743	184,554	231,876
2006	65,980	151,428 a	41,521	28,278	30,575	772,470	23,978	187,216	234,745
2007	66,270	153,124 a	41,685	28,423	30,721	778,200	24,216	189,013	236,570
2008	66,010	154,287 a	41,777	28,415	31,118	794,221 b	24,216	190,957	238,786
2009	65,390	-	41,866 b	28,622 b	31,466 b	-	24,347 b	-	-

Note: a: Break in series with previous year for which data is available.
b: Calculated estimates of OECD based on the materials of each country.
Source: <Japan>Ministry of Internal Affairs and Communications, Labour Force Survey, Labor Force Population, The value as of December of each year (Web site)
<U.S.>Bureau of Labor Statistics, U.S. Department of Labor, Current Population Survey (Web site)
<Germany, France, U.K., China, EU, Korea>OECD, "Main Science and Technology Indicators 2009/2

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

(A) National Currencies

Year	Japan (Billion yen)	U.S. (Billion dollar)	Germany (Billion euro)	France (Billion euro)	U.K. (Billion pound)	China (Billion yuan)	Korea (Billion won)	EU-15 (Billion dollar)	EU-27 (Billion dollar)
1981	264,641.7	3,126.8	825.8	500.8	256.3	489.2	50,739.4	3,445.8	-
1982	276,162.8	3,253.2	860.2	574.4	281.0	532.3	58,087.8	3,690.3	-
1983	288,772.7	3,534.6	898.3	636.6	307.2	596.3	68,342.8	3,901.5	-
1984	308,238.4	3,930.9	942.0	693.1	329.9	720.8	78,316.3	4,149.7	-
1985	330,396.8	4,217.5	984.4	743.9	361.8	901.6	87,630.5	4,384.7	-
1986	342,266.4	4,460.1	1,037.1	802.4	389.1	1,027.5	102,276.1	4,608.9	-
1987	362,296.7	4,736.4	1,065.1	845.2	428.7	1,205.9	120,054.5	4,871.5	-
1988	387,685.6	5,100.4	1,123.3	911.2	478.5	1,504.3	142,933.6	5,254.4	-
1989	415,885.2	5,482.1	1,200.7	980.5	525.3	1,699.2	161,324.6	5,653.9	-
1990	451,683.0	5,800.5	1,306.7	1,033.0	570.3	1,866.8	194,618.2	6,045.3	-
1991	473,607.6	5,992.1	1,534.6 [a]	1,070.0	598.7	2,178.1	235,604.4	6,496.7	-
1992	483,255.6	6,342.3	1,646.6	1,107.8	622.1	2,692.3	268,460.5	6,723.9	-
1993	482,607.6	6,667.4	1,694.4	1,114.7	654.2	3,533.4	303,018.4	6,855.5	-
1994	489,378.8	7,085.2	1,780.8	1,154.7	693.0	4,819.8	354,654.3	7,196.9	-
1995	497,740.0	7,414.7	1,848.5	1,194.6	733.3	6,079.4	415,773.3	7,535.6	8,342.9
1996	509,095.8	7,838.5	1,876.2	1,227.3	781.7	7,117.7	467,644.9	7,832.6	8,689.8
1997	513,612.9	8,332.4	1,915.6	1,267.4	830.1	7,897.3	511,989.6	8,197.2	9,095.1
1998	503,324.1	8,793.5	1,965.4	1,323.7	879.1	8,440.2	504,659.0	8,571.6	9,508.5
1999	499,544.2	9,353.5	2,012.0	1,368.0	928.7	8,967.7	551,983.5	8,921.9	9,893.1
2000	504,118.8	9,951.5	2,062.5	1,441.4	976.5	9,921.5	603,236.0	9,530.2	10,558.8
2001	493,644.7	10,286.2	2,113.2	1,497.2	1,021.8	10,965.5	651,415.3	10,045.3	11,149.5
2002	489,875.2	10,642.3	2,143.2	1,548.6	1,075.6	12,033.3	720,539.0	10,448.3	11,631.9
2003	493,747.5	11,142.1	2,163.8	1,594.8	1,139.7	13,582.3	767,113.7	10,711.8	11,960.3
2004	498,490.6	11,867.8	2,210.9	1,660.2	1,200.6	15,987.8	826,892.7	11,236.8	12,593.6
2005	503,186.7	12,638.4	2,242.2	1,726.1	1,252.5	18,321.7	865,240.9	11,762.6	13,204.4
2006	510,899.0	13,398.9	2,325.1	1,806.4	1,321.9	21,192.4	908,743.8	12,441.3	14,017.7
2007	515,822.8	14,077.6	2,428.2	1,894.6	1,400.5	24,953.0	975,013.0	13,153.1	14,885.7
2008	497,678.7	14,441.4	2,495.8	1,950.1	1,442.9	-	1,023,937.7	13,439.4	15,298.7
2009	-	-	2,417.7 [b]	1,944.2 [b]	1,406.8 [b]	-	1,084,089.2	13,183.1 [b]	15,014.7 [b]

(B) OECD Purchasing Power Parity Equivalent

Year	Japan (Billion yen)	U.S. (Billion yen)	Germany (Billion yen)	France (Billion yen)	U.K. (Billion yen)	China (Billion yen)	Korea (Billion yen)	EU-15 (Billion yen)	EU-27 (Billion yen)
1981	264,641.7	682,971.5	170,397.5	126,768.2	111,738.1	62,403.8	26,648.4	752,653.1	-
1982	276,162.8	684,109.6	173,354.7	132,628.9	116,516.6	69,498.1	29,212.1	776,023.0	-
1983	288,772.7	731,917.7	180,244.4	137,387.6	123,594.9	78,843.7	33,124.9	807,884.8	-
1984	308,238.4	809,586.1	191,253.8	143,881.7	130,950.2	93,769.2	36,952.9	854,657.2	-
1985	330,396.8	862,211.3	200,227.1	149,720.9	138,797.5	108,950.9	40,378.3	896,383.3	-
1986	342,266.4	906,811.9	208,225.6	155,952.3	146,776.1	120,684.1	45,411.6	937,055.5	-
1987	362,296.7	939,788.7	211,747.9	160,284.1	153,910.6	135,186.1	50,598.1	966,599.5	-
1988	387,685.6	985,918.6	221,273.8	168,933.7	162,889.1	151,555.9	56,409.7	1,015,684.4	-
1989	415,885.2	1,044,531.1	235,203.2	180,030.0	170,451.5	160,970.4	61,604.3	1,077,262.0	-
1990	451,683.0	1,089,642.3	253,519.3	189,235.0	175,912.5	169,268.0	68,862.1	1,135,620.8	-
1991	473,607.6	1,119,562.0	297,313.9 [a]	196,772.0	178,558.7	190,270.3	77,543.4	1,213,842.0	-
1992	483,255.6	1,177,201.3	308,886.0	202,712.5	181,735.5	220,830.3	83,437.8	1,248,025.6	-
1993	482,607.6	1,216,159.3	308,031.4	201,924.4	186,758.2	253,081.1	89,024.9	1,250,464.4	-
1994	489,378.8	1,266,841.3	316,507.6	206,588.3	194,931.4	286,498.1	96,713.6	1,286,818.0	-
1995	497,740.0	1,292,711.3	320,866.0	209,898.3	199,850.3	316,125.1	105,049.0	1,313,783.4	1,454,533.4
1996	509,095.8	1,333,450.8	321,801.0	211,430.1	207,560.7	345,762.7	111,762.6	1,332,443.8	1,478,269.2
1997	513,612.9	1,402,533.7	325,847.3	219,140.2	220,214.7	380,182.4	117,661.1	1,379,774.3	1,530,908.0
1998	503,324.1	1,464,326.9	331,335.7	227,984.0	226,989.1	409,962.1	109,629.3	1,427,378.2	1,583,384.4
1999	499,544.2	1,515,601.3	334,409.9	230,926.0	230,581.2	435,431.3	118,481.8	1,445,668.3	1,603,036.3
2000	504,118.8	1,541,916.3	330,063.9	237,510.2	237,598.2	461,183.2	124,818.9	1,476,632.7	1,636,017.5
2001	493,644.7	1,537,147.1	330,525.4	243,595.1	243,678.2	493,321.5	128,581.4	1,501,140.3	1,666,150.1
2002	489,875.2	1,530,088.2	327,150.3	246,021.7	246,385.8	526,877.0	134,578.7	1,502,203.0	1,672,368.2
2003	493,747.5	1,556,342.8	329,419.8	237,535.4	248,419.6	575,064.9	134,668.2	1,496,235.8	1,670,634.4
2004	498,490.6	1,594,080.7	331,469.3	237,411.9	255,146.7	626,335.1	139,836.0	1,509,324.8	1,691,563.6
2005	503,186.7	1,637,329.4	335,090.3	242,182.7	255,063.4	688,486.0	142,084.9	1,523,872.2	1,710,661.1
2006	510,899.0	1,665,911.3	336,774.9	243,866.1	257,147.9	760,631.2	148,535.0	1,546,854.1	1,742,848.2
2007	515,822.8	1,691,230.0	340,618.8	249,954.9	260,366.7	826,803.9	156,203.3	1,580,164.8	1,788,312.3
2008	497,678.7	1,682,811.8	341,157.5	246,456.0	256,321.8	-	158,247.8	1,566,048.3	1,782,711.8
2009	-	-	327,422.2 [b]	243,218.1 [b]	247,107.7 [b]	-	162,902.4	1,516,730.8 [b]	1,727,449.4 [b]

Note: <Japan>Fiscal year.
<Germany>Until 1990, data is for the former West Germany. After 1991, data is for the unified Germany.
<China>FY data.
a: Continuity of these data with the previous fiscal year is impaired.
b: Estimate/calculation by OECD Secretariat based on national source materials

Source :<Japan>Cabinet Office, Economic and Social Research Institute " System of National Accounts (93SNA)" (Web site).
<U.S.>Bureau of Economic Analysis, "National Economic Accounts" (Web site).
<Germany, France, U.K., Korea, EU>OECD, "Main Science and Technology Indicators 2009/2".
<China>State Statistical Bureau of the People's Republic of China, China Statistical Yearbook 2008 (Web site).

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

Year	Japan	U.S.	Germany	France	U.K.	China	Korea
1981	82.8	58.9	66.9	53.1	44.7	-	33.0
1982	84.6	62.4	70.0	59.5	48.0	-	35.2
1983	86.6	64.9	71.9	65.1	50.6	-	37.4
1984	89.3	67.4	73.4	69.8	52.9	-	39.6
1985	91.4	69.4	74.9	73.7	56.0	-	41.5
1986	92.9	71.0	77.2	77.6	57.9	-	43.8
1987	93.2	73.0	78.2	79.8	61.0	-	46.3
1988	93.9	75.6	79.5	82.2	64.9	-	49.8
1989	96.1	78.4	81.8	84.9	69.6	-	52.7
1990	98.4	81.5	84.6	87.2	75.0	52.8	58.2
1991	101.3	84.4	87.2 [a]	89.4	79.8	56.4	64.4
1992	102.9	86.4	91.5	91.3	82.8	60.3	69.3
1993	103.5	88.3	94.9	92.7	85.2	70.9	73.7
1994	103.6	90.1	97.2	94.0	86.6	85.3	79.5
1995	103.0	92.0	99.0	95.2	88.9	96.8	85.4
1996	102.4	93.7	99.5	96.7	92.1	103.2	89.8
1997	103.1	95.4	99.8	97.7	94.7	104.0	93.9
1998	103.1	96.5	100.3	98.6	96.8	102.2	99.4
1999	101.8	97.9	100.7	98.6	98.8	99.9	99.3
2000	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2001	98.8	102.3	101.2	102.0	102.1	101.9	103.9
2002	97.2	103.9	102.6	104.4	105.3	103.1	107.2
2003	95.7	106.2	103.9	106.4	108.5	106.3	111.0
2004	94.7	109.2	104.8	108.1	111.2	113.4	114.4
2005	93.5	112.8	105.5	110.3	113.7	121.2	115.2
2006	92.7	116.5	106.1	112.9	116.7	128.3	115.0
2007	92.0	119.8	108.1	115.7	120.0	127.8	117.4
2008	91.2	122.4	109.7	118.6	122.8	137.0 [b]	120.6
2009	91.2 [b]	123.9 [b]	110.8 [b]	119.8 [b]	124.1 [b]	132.7 [b]	124.0 [b]

Note: <Germany>Until 1990, data is for the former West Germany.　After 1991, data is for the unified Germany.
a: This data has impaired continuity with the data for the previous fiscal year.
b: Calculated estimates of OECD Secretariat based on the materials of each country.
Source: OECD, “Main Science and Technology Indicators 2009/2”

Statistical Reference E　Purchasing Power Parity of the main countries

Year	Japan	U.S.	Germany	France	U.K.	China	Korea
	[yen／yen]	[yen／dollar]	[yen／euro]	[yen／euro]	[yen／pound]	[yen／yuan]	[yen／wan]
1981	1.0000	218.4251	206.3448	253.1537	436.0017	127.5744	0.5252
1982	1.0000	210.2882	201.5260	230.8817	414.6142	130.5533	0.5029
1983	1.0000	207.0723	200.6573	215.8073	402.3180	132.2292	0.4847
1984	1.0000	205.9544	203.0295	207.5952	396.9233	130.0896	0.4718
1985	1.0000	204.4366	203.3980	201.2676	383.6749	120.8412	0.4608
1986	1.0000	203.3165	200.7709	194.3660	377.1721	117.4521	0.4440
1987	1.0000	198.4184	198.8001	189.6486	359.0464	112.1075	0.4215
1988	1.0000	193.3022	196.9872	185.3981	340.4089	100.7496	0.3947
1989	1.0000	190.5349	195.8949	183.6042	324.5002	94.7313	0.3819
1990	1.0000	187.8532	194.0179	183.1852	308.4652	90.6737	0.3538
1991	1.0000	186.8397	193.7403	183.8951	298.2620	87.3541	0.3291
1992	1.0000	185.6111	187.5879	182.9847	292.1418	82.0215	0.3108
1993	1.0000	182.4038	181.7970	181.1470	285.4775	71.6255	0.2938
1994	1.0000	178.8011	177.7354	178.9057	281.2916	59.4421	0.2727
1995	1.0000	174.3444	173.5865	175.7059	272.5481	51.9996	0.2527
1996	1.0000	170.1156	171.5193	172.2794	265.5160	48.5781	0.2390
1997	1.0000	168.3229	170.1037	172.9019	265.2889	48.1408	0.2298
1998	1.0000	166.5238	168.5861	172.2383	258.2056	48.5724	0.2172
1999	1.0000	162.0357	166.2077	168.8097	248.2758	48.5555	0.2146
2000	1.0000	154.9431	160.0310	164.7807	243.3079	46.4834	0.2069
2001	1.0000	149.4378	156.4129	162.7021	238.4728	44.9884	0.1974
2002	1.0000	143.7742	152.6471	158.8718	229.0759	43.7850	0.1868
2003	1.0000	139.6813	152.2413	148.9424	217.9605	42.3394	0.1756
2004	1.0000	134.3198	149.9251	143.0030	212.5169	39.1757	0.1691
2005	1.0000	129.5520	149.4471	140.3089	203.6426	37.5775	0.1642
2006	1.0000	124.3319	144.8432	134.9989	194.5349	35.8918	0.1635
2007	1.0000	120.1362	140.2763	131.9270	185.9064	33.1345	0.1602
2008	1.0000	116.5269	136.6926	126.3822	177.6409	30.6296	0.1545
2009	1.0000	115.0507	135.4286	125.1025	175.6579	31.6171	0.1503

Note: The value for 2009 is calculated estimates of OECD Secretariat based on the materials of each country..
Source: OECD, “Main Science and Technology Indicators 2009/2”

A List of Science and Technology Indicators

1991	First edition	The Japanese Science and Technology Indicator System: Analysis of Science and Technology Activities	NISTEP REPORT No. 19
1995	Second edition	Science and Technology Indicators: 1994 *- 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

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