The leading advanced nations are reacting to economic globalization, to the attendant intensification of competition in the global economy, and to the increased importance of energy, food, global environmental problems, and other global and pan-human issues by aggressively promoting science and technology policies toward the assurance of competitive strengths and employment, and toward the resolution of global and pan-human issues.

In Japan, Gross Domestic Product (GDP) growth was limited to 1.0% for fiscal 2005, but R&D expenditure for the year witnessed an increase of 5.4%, a rise for the sixth consecutive year, due to big spending increases by private-sector enterprises, raising the R&D expenditure to GDP ratio by 0.15 points to 3.55%. In addition, the number of researchers in fiscal 2006 increased for the fifth year in a row, with overall R&D-related personnel, including research support staff and technicians, witnessing an increase for the third consecutive year.

R&D expenditures in Japan are therefore clearly rising. This upward trend is a step in the right direction for a Japan that aims to become "an advanced science- and technology-oriented nation." However, nations around the world are placing an emphasis on science and technology policy and are moving to expand R&D expenditures. If Japan is to continue in the future to enhance its international competitiveness, improve the quality of its people's lives, as well as respond to global issues, Japan must make continued efforts to strengthen research and development activities, while giving due consideration to its severe fiscal conditions.

Part 2 will compare Japan and major countries[1] in the areas pertaining to science and technology, such as research expenditures and number of researchers, so as to highlight the special characteristics of Japan's science and technology activities. This information will then be used for a more in-depth analysis of the trends in Japan's research activities.[2]

●International Comparisons of Science and Technology Indicators

A prerequisite for making international comparisons of statistical data is to examine the subject statistical data from each country based on unified standards. The Organisation for Economic Cooperation and Development (OECD) has prepared the Frascati Manual[3] as a guideline for the collection and analysis of data related to scientific and technological activities, and has asked member countries to base their science and technology indicators on that manual.

In the Frascati Manual, the method for calculating the number of researchers is derived from two types of data-a simple head count of the number of researchers, and a full-time equivalent (FTE) value[4], which takes into consideration the proportion of time actually devoted to research activities. The latter is touted in the Manual as being a proper quantitative method for measuring research personnel resources, and all OECD member countries are called upon to support the FTE value.

In Japan, a conversion of various elements has been used to arrive at a number representing the number of full-time researchers, using the "fulltime equivalent ratio" estimated from the results of a survey targeting instructors at universities and colleges taken in 1992 by the Ministry of Education, Culture, Sports, Science and Technology, and the number of researchers and amount of research expenses at universities and colleges from a 2006 survey of research and development (Table 2-1-1). The FTE differs from the simple head count, especially in the case of researchers at universities and colleges, who are also engaged in teaching activities, and thus, this also changes the corresponding amount of research expenses used at universities and colleges.

In Part 2, we shall use both the simple head count and the FTE value when we make international comparisons of researcher numbers and R&D expenditures for recent years.

[1] In Part 2, the major countries refers to the United States, Germany, France, the United Kingdom and Japan, unless otherwise noted.

[2] Part 2 describes research activities including the humanities and social sciences. Descriptions of the natural sciences alone are annotated. Furthermore, the classification of the humanities and social sciences as distinct from the natural sciences is based on the research content, not on the individual research institute or university and college department concerned.

[3] Frascati Manual: A manual for proper international comparisons of R&D statistics. The original proposal for the first edition of this manual was made at a meeting in Frascati, Italy, in 1963, and the manual was completed after discussions and revisions by experts of OECD member countries. Operations to revise the manual are currently underway. The sixth edition was published in December 2002.

[4] FTE value: FTE is an abbreviation for Full Time Equivalent, and is a converted value showing the actual time engaged in research. If a researcher has an average of 30% of his/her working hours allocated to research and development operations, and is engaged in other activities (teaching, university administration, student counseling, etc.), he/she is said to have a 0.3 FTE. In the same way, a full-time researcher employed for only six months in research and development work is said to have a 0.5 FTE.

* For the data on each country's R&D expenditure in Chapter 1, both the data each country publicized individually and the data each government reported to OECD were cited in the past. From this time, however, only the data reported to OECD are used (excluding the data on the European Union (the EU)), for the reason that they are surveyed on a unified standard and, therefore, are more appropriate for international comparison.

●Research and Development in the European Union

The Treaty on the European Union (commonly known as the Maastricht Treaty) was signed in 1992, and the European Union (hereinafter referred to as the EU) was established. The next step in this development was the introduction of a common currency in January 1999, which was followed three years later, in January 2002, with the circulation of Euro-denominated coins and bills in member states. In May 2004, ten central and eastern European countries were granted membership, increasing the number of EU member nations from 15 (EU-15)[5] to 25 (EU-25)[6]. Furthermore, two eastern European countries joined on January 1, 2007, as members, increasing the number to the current 27 nations (EU-27)[7]. The EU has demonstrated its important presence in recent years in many arenas on the international stage, rapidly establishing its position as a global player. In terms of science and technology indicators, the EU is second only to the United States. In the future, Japan should not fail to ensure a good relationship with the EU so that Japan can enhance its international competitive strength (Table 2-1-2).

The basic objectives of the EU science and technology policy are "strengthening the scientific and technological basis of Community industry and encouraging it to become more competitive at an international level, while promoting all the research activities deemed necessary by virtue of other Chapters of this Treaty" (Treaty Establishing the European Community). Based on these

Table 2-1-1 Comparison of FTE value and simple head count (FY2005)

(Persons, Million yen)

Item	Simple head count (A)	FTE value (B)	Change (B/A)%
Number of university researchers	295,476	180,494	61.1
Total number of researchers	819,931	704,949	86.0
University R&D expenditure	3,407,410	2,234,817	65.6
Total R&D expenditure	17,845,224	16,672,631	93.4

Notes: 1. The number of researchers is as of March 31, 2006.
2. Values for "Total number of researchers" and "Total R&D expenditure" in the "Simple head count" column are calculated based on the head count at universities.
Source: Ministry of Internal Affairs and Communications, Statistics Bureau (Statistics Bureau).
"Report on the Survey of Research and Development"
FTE value: Statistics Bureau data

Table 2-1-2 Comparison of the tripolar world

Category	Japan	United States	EU-25	EU-15
Population	130,000,000	300,.000,000	460,000,000	390,000,000
GDP	503 trillion yen	1,366 trillion yen	1,487 trillion yen	1,410 trillion yen
R&D expenditure	17.8(16.7) trillion yen	33.8 trillion yen	26.1 trillion yen	25.6 trillion yen
Number of researchers	820,000(700,000)	1,330,000	1,210,000	1,090,000

Notes: 1. Japan population and GDP is for 2006, R&D expenditure is for FY2005, researchers figure is for 2006.
2. For R&D expenditure and number of researchers in Japan, head count is used for universities. The numbers in ( ) are FTE values.
3. U.S. population is for 2005, GDP is for 2005, R&D expenditure is for 2004, researchers figure is for 2002.
4. For EU-25 or EU-15, population and GDP is for 2005, R&D expenditure is for 2004, researchers figure is for 2004.
5. The IMF exchange rate is used to convert U.S., EU-25 and EU-15 currency to Japanese yen.

[5] The EU-15 consists of Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, the United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden.
[6] The EU-25 consists of the EU-15 and the following 10 countries: Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia.
[7] The EU-27 consists of the EU-25 and the following 2 countries: Bulgaria, Romania.

objectives, the Framework Programme (Seventh Framework Programme (FP7), from 2007 to 2013, now in progress) showing the basic framework for research and development activities in the EU was adopted.

While the EU is not included in the international comparisons in this part of this publication, because it is not a nation but rather a community of nation states, indicators for the EU have been included in these comparisons in Part 2 wherever possible, as totals of science and technology indicators[8] for EU countries.

[8] EU science and technology indicators: The EU science and technology indicators used in Part 2 utilize research expenses drawn from data reported by Eurostat (European Commission Statistics Bureau), numbers of researchers from data reported by the OECD, and numbers of patent applications and registrations from WIPO (World Intellectual Property Organization) data.

2.1 R&D Expenditures

2.1.1 Total R&D Expenditures

2.1.1.1 Trends in R&D Expenditures in Selected Countries

As the quantitative international comparison of R&D expenditure[9], comparing the expenditure that each country surveyed along the Frascati Manual of OECD, the Unite States registered the highest total, at 33.8 trillion yen at the IMF currency conversion rate (41.8 trillion yen at the OECD purchasing power parity conversion rate), followed by the EU-25 at 26.1 trillion yen at the IMF exchange rate conversion rate (29.6 trillion yen in OECD purchasing power parity), and Japan at 17.8 trillion yen (or 16.7 trillion yen at the FTE value) (Figure 2-1-3).

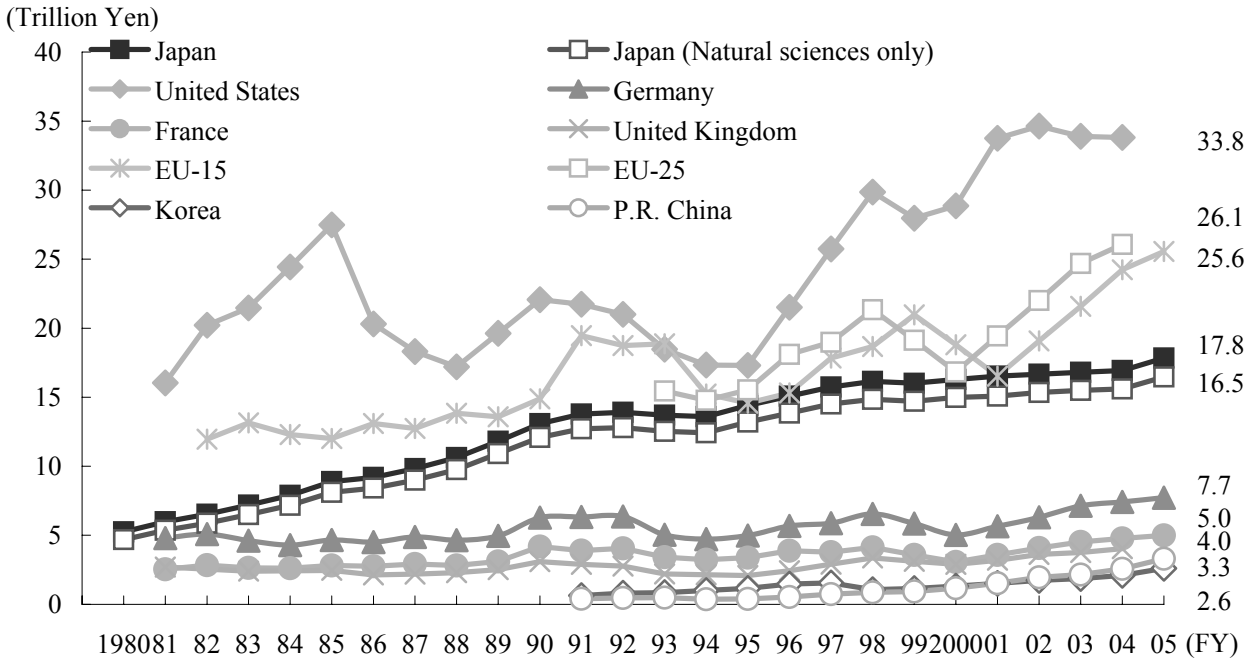

Figure 2-1-3 (1) Trends in R&D expenditures of selected countries - IMF exchange rate conversion

[9] Definition of R&D expenditures: In the "Report on the Survey of Research and Development" by the Statistics Bureau of the Ministry of Internal Affairs and Communications, "research" is defined as "creative efforts and investigations conducted to obtain new knowledge about things, functions, and phenomena, or to open paths toward new applications of existing knowledge." All outlays incurred for these activities (labor costs, materials, expenditures on tangible fixed assets, etc.) are treated as research expenditures.

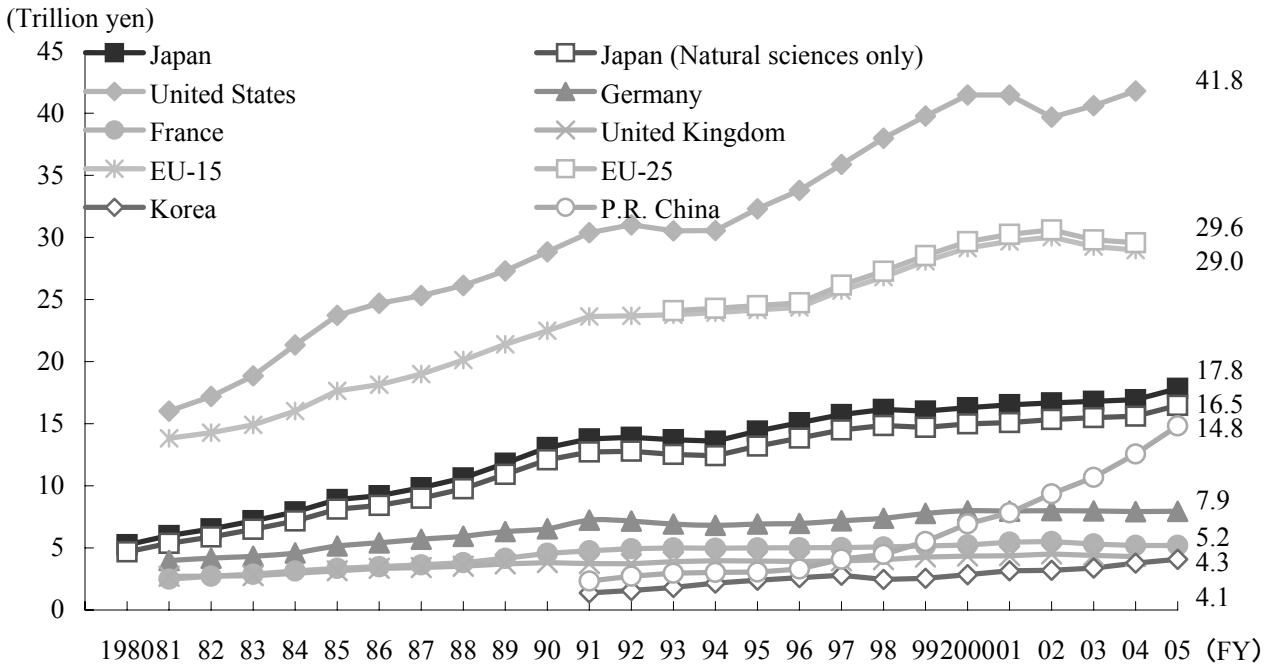

Figure 2-1-3 (2) Trends in R&D expenditures of selected countries - OECD purchasing power parity

Notes: 1. For comparison purposes, statistics for all countries include research in social sciences and humanities. The figure for Japan shows also the amount for natural sciences only.
2. Japan added industries as new survey targets in FY1996 and FY2001.
3. U.S. figures for 2003 and later are provisional.
4. French figure for FY2005 is provisional.
5. German figures for 2005 are estimates.
6. The EU figures converted at the IMF currency conversion rate are estimates by Eurostat, while the figures based on the purchasing power parity conversion are OECD estimates.
7. EU-15 consists of 15 countries: Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden.
8. The EU-25 consists of the EU-15 and the following 10 countries: Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia.

Source: Japan: Japan-Statistics Bureau. "Report on the Survey of Research and Development"
U.S., Germany, France, U.K., China, South Korea: OECD "Main Science and Technology Indicators"
EU: Database on website of Eurostat (Statistical Office of the European Communities, hereinafter abbreviated) and OECD "Main Science and Technology Indicators"

2.1.1.2 Increase of R&D Expenditures in Real Terms

R&D expenditures in real terms for selected countries are calculated in order to compare national growth rates. The trend in the past decade shows the United States, Germany[10] and Japan registering high growth, and China and South Korea registering phenomenal growth. Japan reflects expansion in private-sector companies' research and development investment, which registered eleven straight years of growth beginning in fiscal 1995 (Figure 2-1-4).

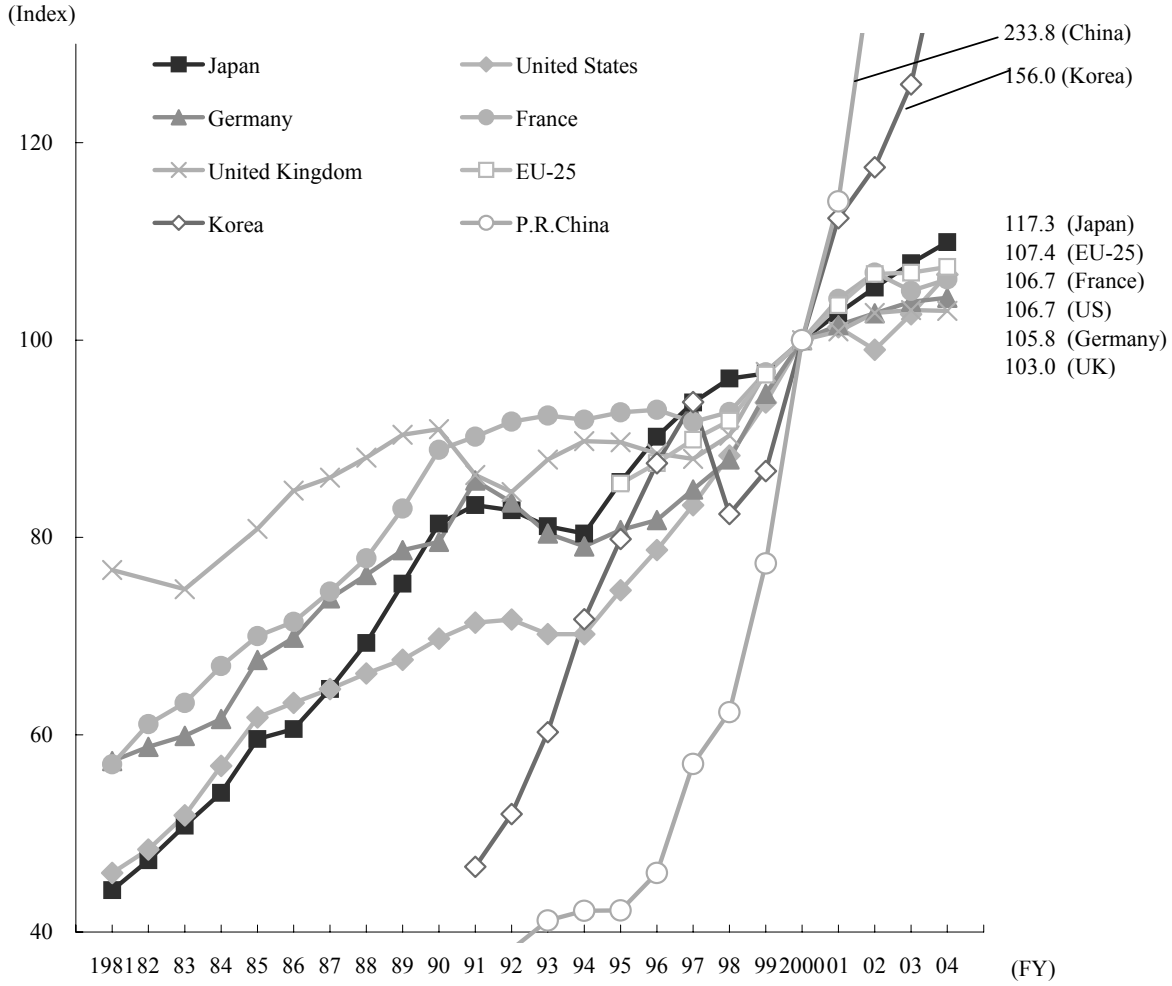

Figure 2-1-4 Growth of R&D expenditures (in real terms) in selected countries, with FY2000 as 100

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities.
2. Japan added industries as new survey targets in FY1996 and FY2001.
3. U.S. figure since 2003 is provisional.
4. France figure for 2005 is provisional.
5. German figures for 2005 are estimates.
6. EU figures are Eurostat estimates.

Source: GDP deflator-OECD. "Main Science and Technology Indicators" Others-Same as in Figure 2-1-3.

[10] Germany: The data for Germany in Chapter 2.1 and 2.2 cover Western Germany only until 1990, and Unified Germany from 1991. In Chapter 2.3, Germany before fiscal 1990 refers to a combination of the figures of West and East Germany.

2.1.1.3 R&D Expenditures as a Percentage of Gross Domestic Product (GDP)

Taking a look at the ratio of research expenditure to GDP as an indicator of nationwide R&D investment level, although decreases were observed in all countries in the early 1990s, the ratio started to increase in Japan and the United States in fiscal 1995 and in European countries a little later. Japan continues to maintain the highest standard among the major advanced nations, at 3.55% of GDP in fiscal 2005 (3.31%, using the FTE) (Figure 2-1-5).

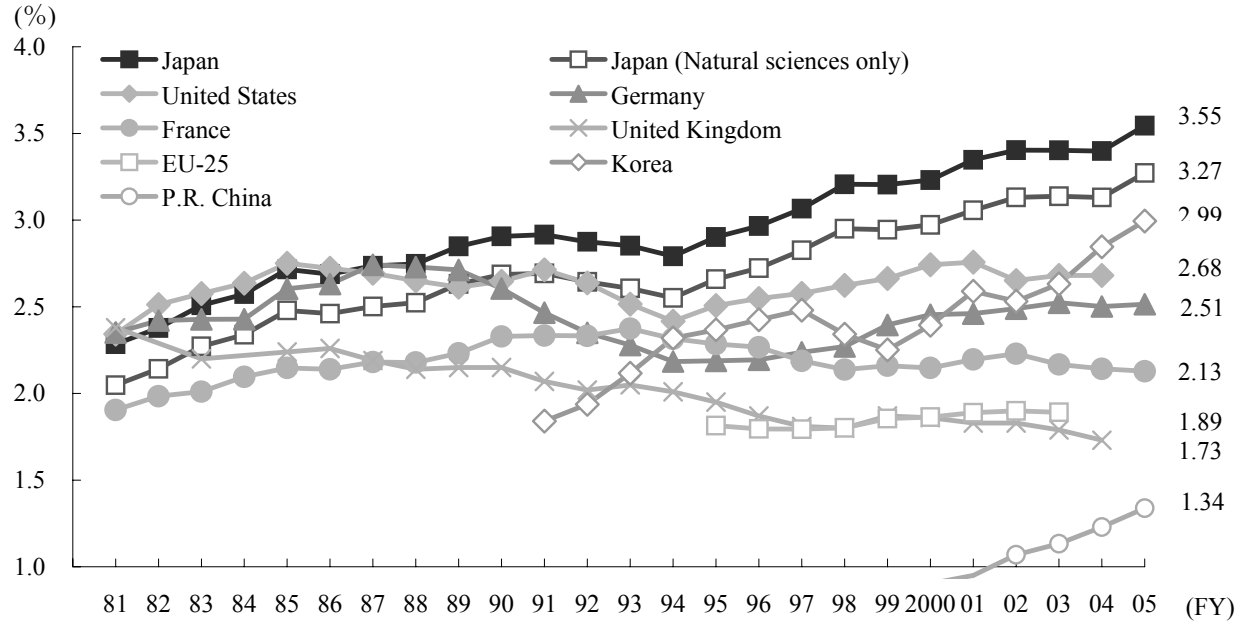

Figure 2-1-5 R&D expenditures as a percentage of GDP in selected countries

Notes: 1. For comparison, statistics for all countries (excluding South Korea) include research in social sciences and humanities.
The figures for Japan show also the amount for natural sciences only.
2. Japan added industries as new survey targets in FY1996 and FY2001.ssss
3. US figures since 2003 is provisional.
4. French figure for FY2005 is provisional.
5. German figures for 2005 are estimates.
6. EU-25 figures are Eurostat estimates.

Source: Same as in Figure 2-1-3.

2.1.2 R&D Expenditures by Financing and Performance

R&D expenditures can be characterized by the financing and performance aspects of categorized sectors. The statistics compiled by the OECD categorize sectors into government[11], industry, universities and colleges, private research institutions, and overseas. Shares of R&D expenditures by financing and performance in selected countries are compared by OECD-categorized sectors.

2.1.2.1 Share of R&D Expenditures

A look at the share of total research expenditures held by governments shows France with the highest percentage, at about 40% of expenditures. Japan's share shows the lowest level among selected countries, a figure that is probably affected by such factors as the extremely low share held by defense research and by the large amount of activity in the private sector (Figure 2-1-6). The large share of R&D expenditures carried by the private sector means that the figures tend to be easily swayed by fluctuations in the business environment (Figure 2-1-7).

The decline in defense-related R&D expenditures since the end of the Cold War structure has resulted in a gradual, continuous decline in the share of R&D expenditures financed by governments in other countries, although it has been on the rise in the United States and France in recent years. The share of R&D expenditures financed by the Japanese government has declined slightly for the sixth straight year (Figure 2-1-8).

For the government share of expenditures in relation to gross domestic product (GDP), France had the highest percentage, followed in order by the United States, Germany, Japan, and the United Kingdom. The shares for the United States, Germany and France have been increasing, while that for Japan has remained flat (Figure 2-1-9).

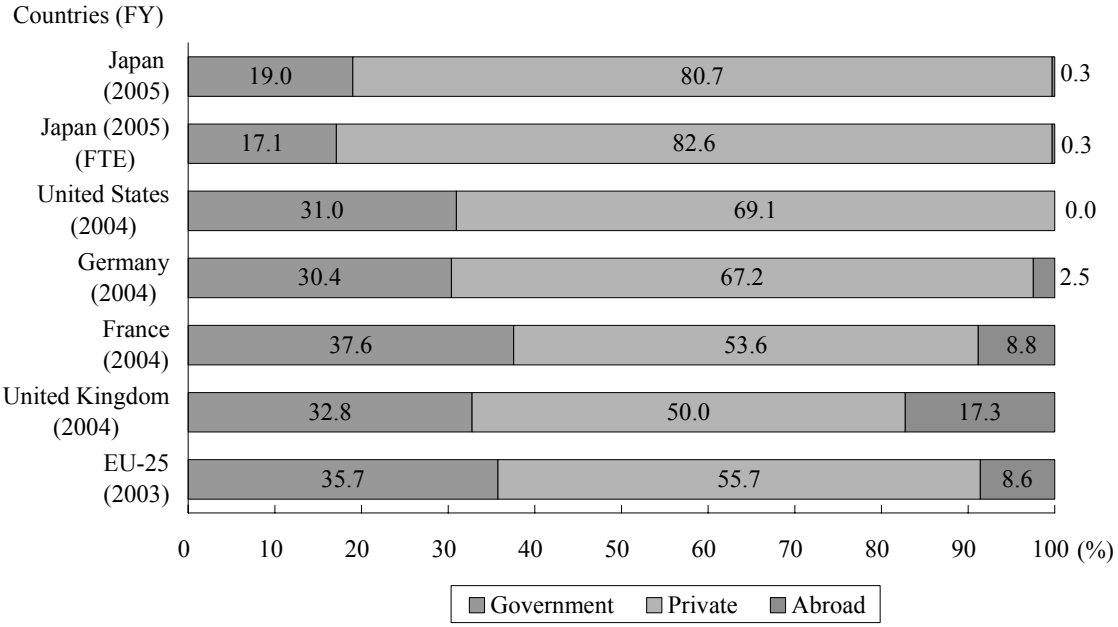

Figure 2-1-6 Share of R&D expenditures by financing sector in selected countries

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities. The figure for Japan includes the FTE value.
2. Japan's FTE value is calculated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) based on the Statistics Bureau data.
3. U.S. figures are provisional.
4. Everything other than government and abroad is classified as private sector.
5. EU figures are OECD estimates.

Source: EU- OECD. "Main Science and Technology Indicators" Others - Same as in Figure 2-1-3.

[11] Government: In Chapters 2.1 and 2.2, when research expenses and numbers of researchers are expressed, "governments" means central governments, local government (in the case of Japan, local public bodies), and its agencies concerned.

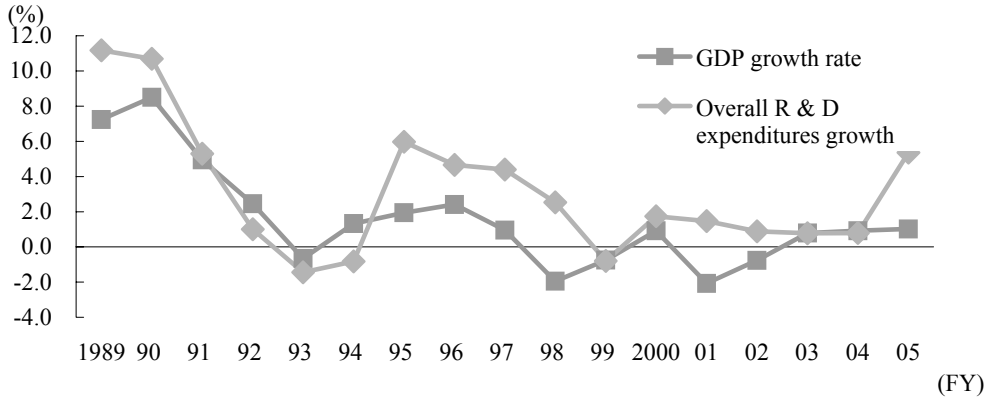

Figure 2-1-7 Trends in overall growth in R&D expenditures, and gross domestic product (GDP) growth rates

Source: Cabinet Office, Economic and Social Research Institute. "Annual Report on National Accounts", "Quarterly Estimates of GDP (preliminary Report)"
Statistics Bureau. "Report on the Survey of Research and Development"

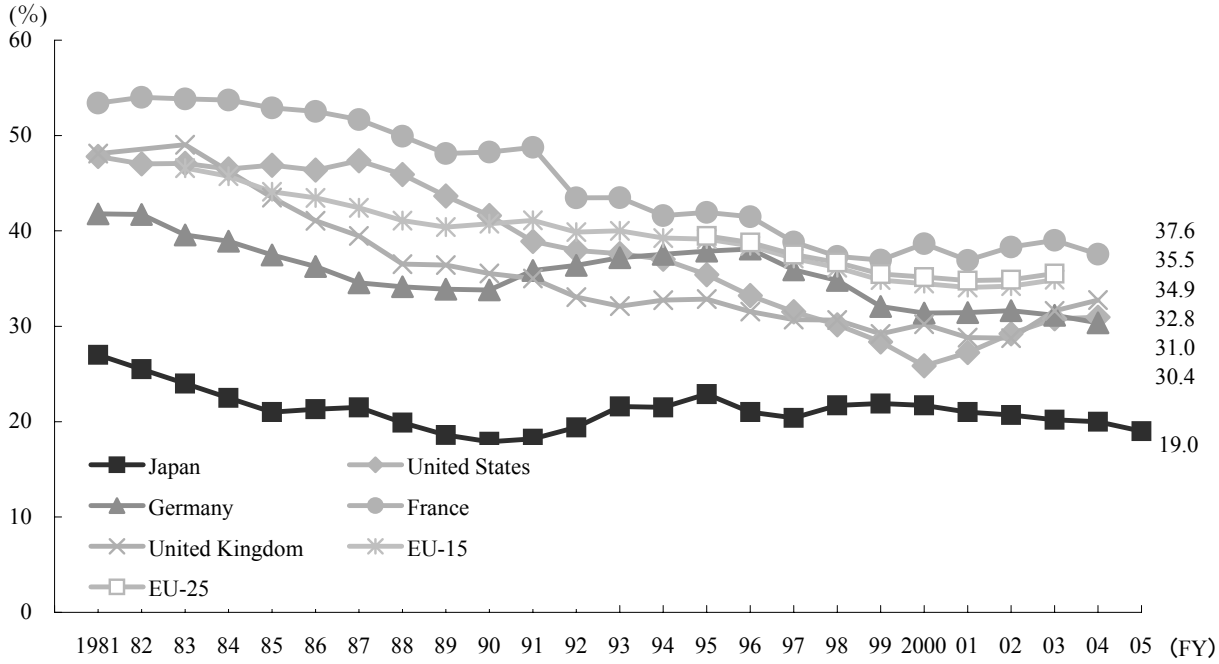

Figure 2-1-8 (1) Trends in government-financed R&D expenditures - Share of R&D expenditures financed by government

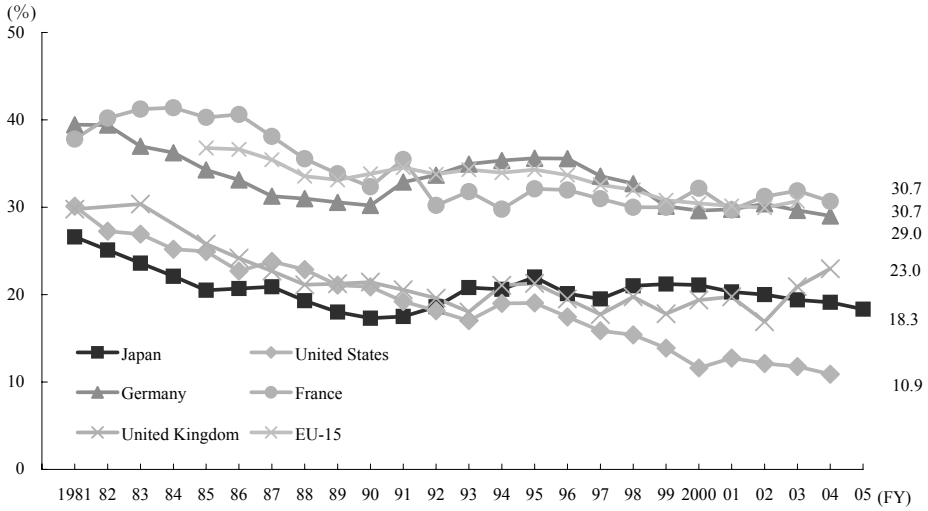

Figure2-1-8 (2) Trends in government-financed R&D expenditures - Share of R&D expenditures exclusive of defense-related R&D expenditures

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities.
2. Government percentages exclusive of defense-related research expenditures are calculated by the following equation.

$$\frac{\text{(Government - financed R \& D expenditures)} - \text{(Defense - related R \& D expenditures)}}{\text{(R \& D expenditures)} - \text{(Defense - related R \& D expenditures)}} \times 100\%$$

The national budget for defense-related R&D was used to derive the defense-related R&D expenditure. Therefore, this indicator should only be treated as a reference. It should be noted that the results of defense-related R&D often not only affect defense but also contribute to the development of science and technology for the civil welfare.
3. Japan added industries as new survey targets in FY1996 and FY2001.
4. U.S. figures for FY 2003 and later are provisional.

Source: Defense-related R&D expenditures in Japan-MEXT. "Budget for Science and Technology".
Others -Same as in Figure 2-1-3

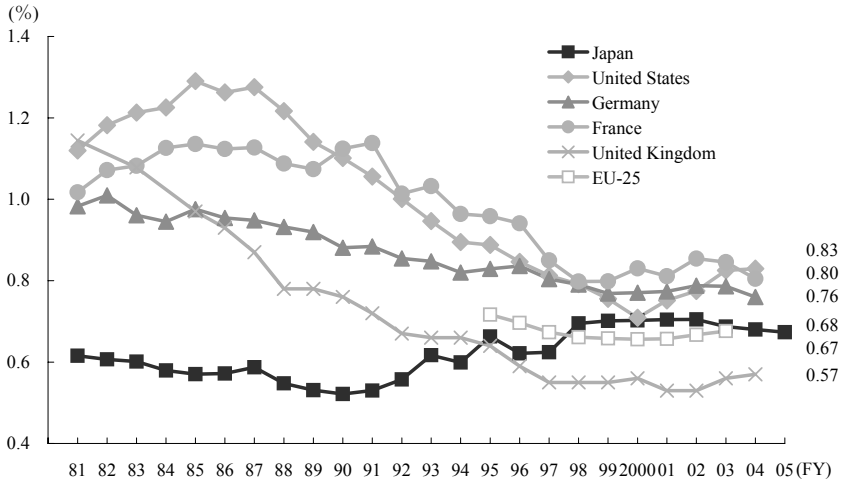

Figure 2-1-9 Trends in the proportion of government-financed R&D expenditures to gross domestic product (GDP) in selected countries

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities.
2. Japan added industries as new survey targets in FY1996 and FY2001.
3. U.S. figures since 2003 is provisional.

Source: Same as in Figure 2-1-3.

2.1.2.2 Share of R&D Expenditures by Performance

Industry spends approximately two-thirds of total R&D expenditures in all selected countries, demonstrating just how large a role private-sector companies play in research and development. Among the selected countries, government research institutions' share of R&D expenditures was highest in France (Figure 2-1-10).

In the selected countries, the trends in real R&D expenditures by type of organization reveals that industry has contributed the most greatly in all countries to growth in R&D expenditures (Figure 2-1-11).

In Japan, a look at the contribution by type of organization to year-on-year growth of R&D expenditures (in real terms) shows that R&D expenses at private companies have a large effect on trends in Japan's R&D expenses. For the degree of contribution, private companies made a positive contribution from fiscal 1995 to fiscal 1998, but then fell into a negative contribution for fiscal 1999. Private companies returned to a positive contribution in fiscal 2000 (Figure 2-1-12).

2.1.2.3 R&D Expense Flows

Japan's R&D expense flows between sources of funding and sectors of performance reveal that about 51% of government funding goes to universities, about 40% to government research institutions, and about 9% to the private sector. In private-sector funding, by contrast, about 98.9% goes to the private sector, with about 1.0% to universities and about 0.1% to government research institutions.

Comparing flows of R&D expenditures between the financing and performance sectors shows that in Japan there is a lesser flow of R&D expenditures between sectors (government, industry, universities and colleges) than exists in other countries. The ratio of private sector R&D expenditures funded by government is high in the United States and in the United Kingdom. The United Kingdom is characterized by a large proportion of R&D expenditures being borne from abroad (Figure 2-1-13).

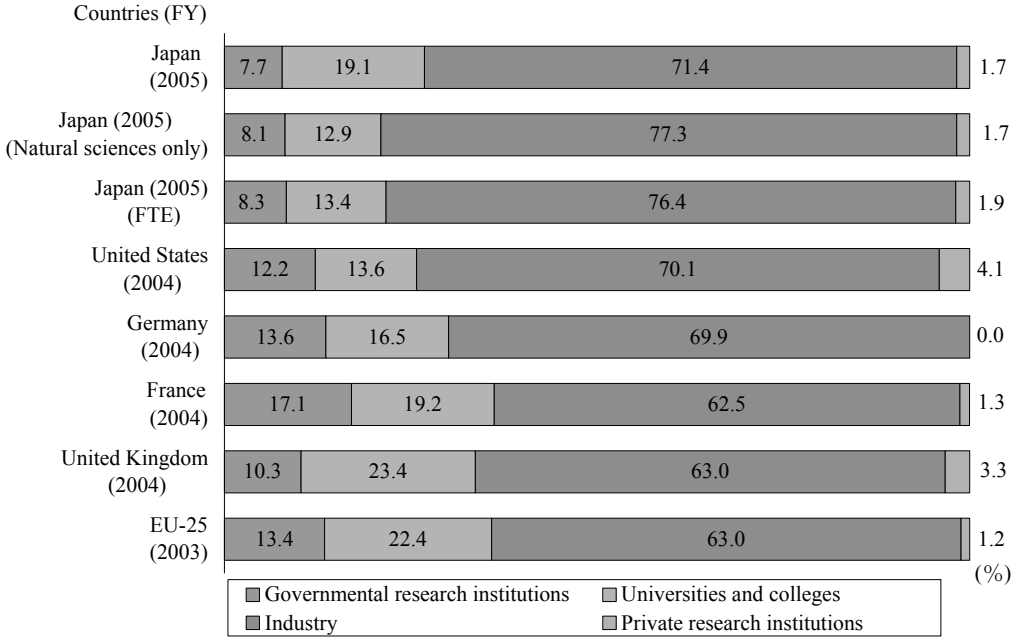

Figure 2-1-10 Share of R&D expenditures by performance sector in selected countries

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities. The figures for Japan also show the amount for natural sciences only and FTE value.
2. Japanese figures for natural science only and for FTE are the figures the MEXT estimated based on the data of the Statistics Bureau of the Ministry of Internal Affairs and Communications.
3. U.S. figures are provisional. In addition, Germany's research expenditures at "private research institutions" are included in "government research institutions."

Source: Same as in Figure 2-1-3.

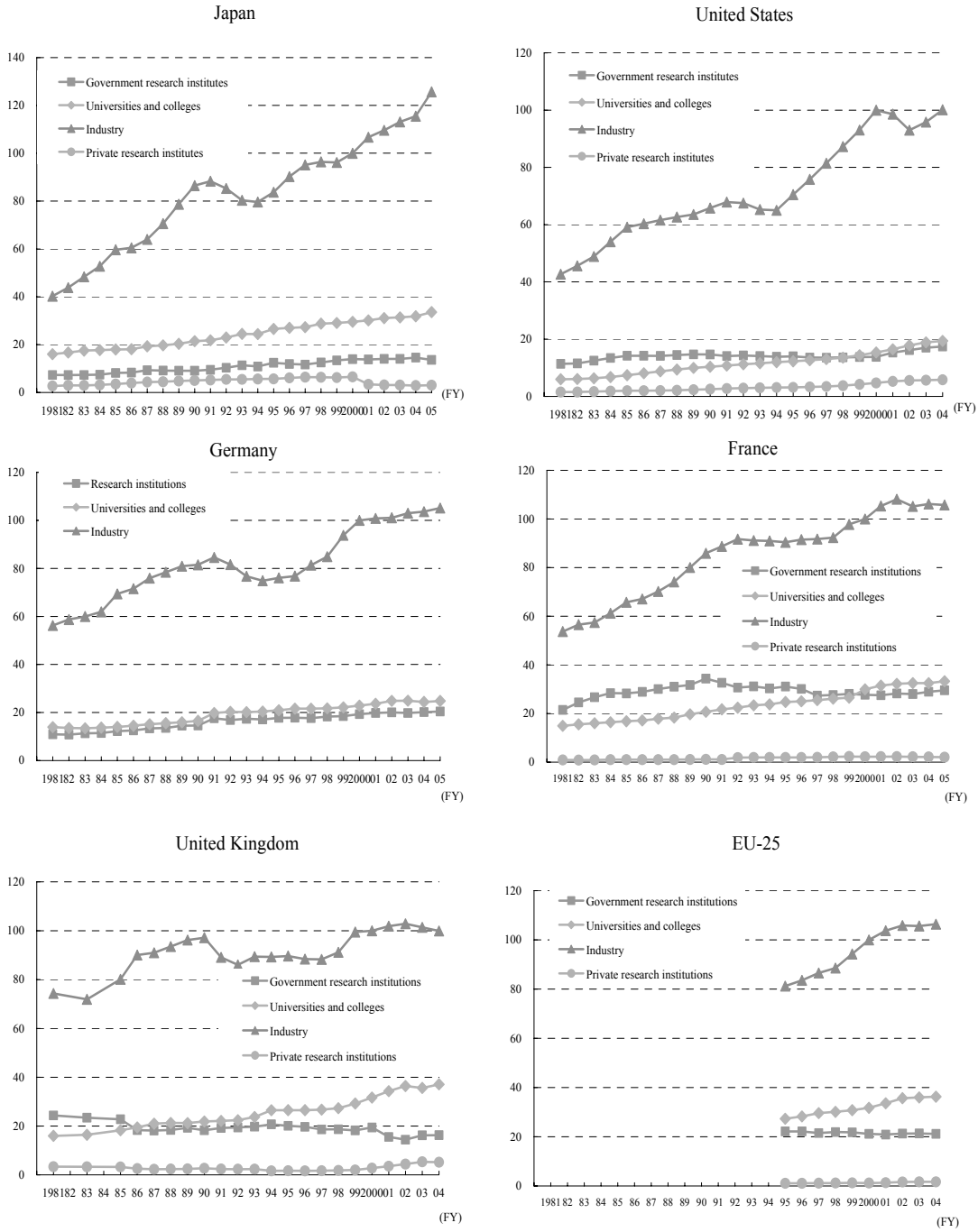

Figure 2-1-11 R&D expenditures growth (in real terms) by sector in selected countries

Notes: 1. All countries include social sciences and humanities for purposes of international comparison. In addition, industry's real research expenditures for FY2000 are set at 100.
2. U.S. data for FY2003 and later are provisional.
3. Since no differentiation has been made between "government research institutions" and "private research institutions" in Germany, they are listed simply as "research institutions."
4. Japan added some industries as new survey targets in FY1996 and FY2001.
5. EU figures are Eurostat estimates.

Source: Same as in Figure 2-1-3.

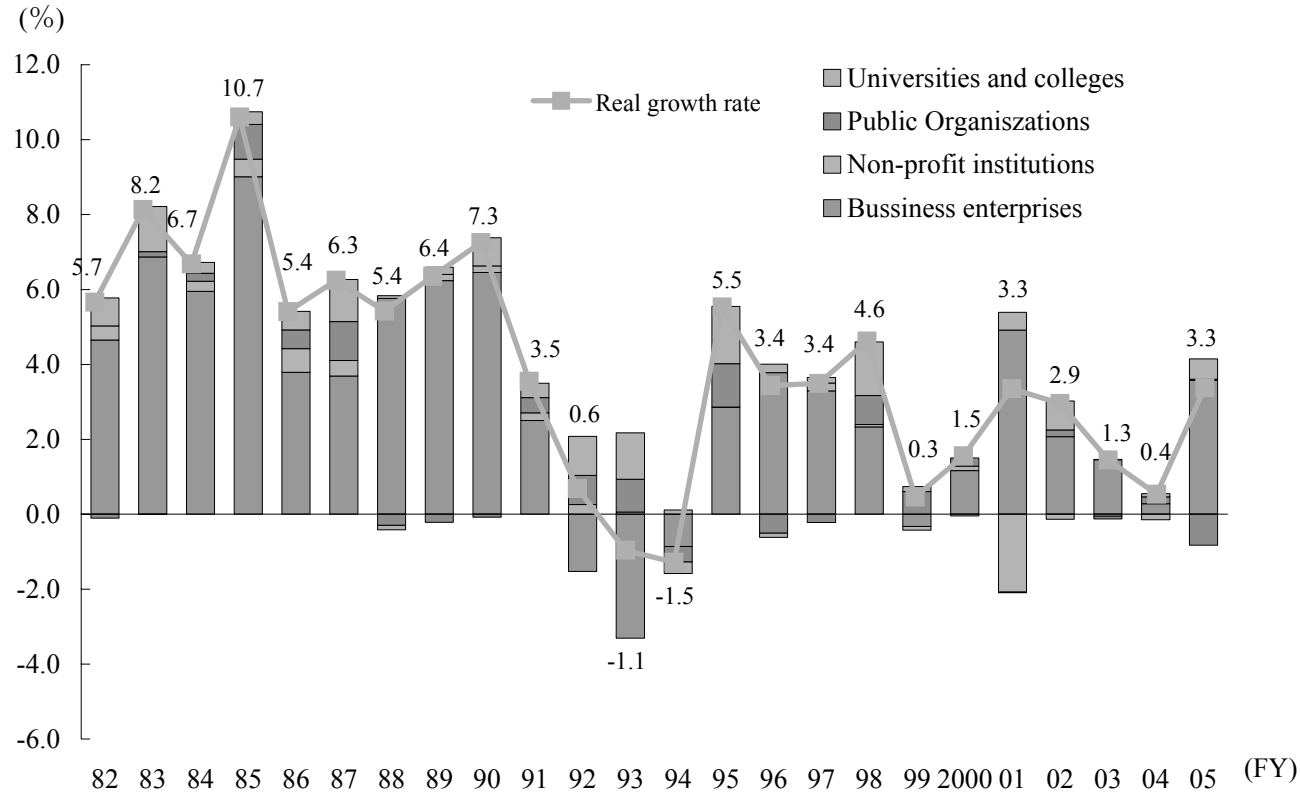

Figure 2-1-12 The contribution by organization to the year-on-year growth rate in Japan's real R&D expenditures

Notes: 1. The deflation referring for each sector is based on FY2000.
2. Japan added some industries as new survey targets in FY1996 and FY2001.
3. Survey coverage categories were changed in FY2001; figures up to FY2000 are for the following categories:

FY2001	Up to FY2000
Companies	Business Enterprises
Private research	Non-profit institutions
Government research institutions	Government research institutions

Source: Statistics Bureau. "Report on the Survey of Research and Development", data of Statistics Bureau

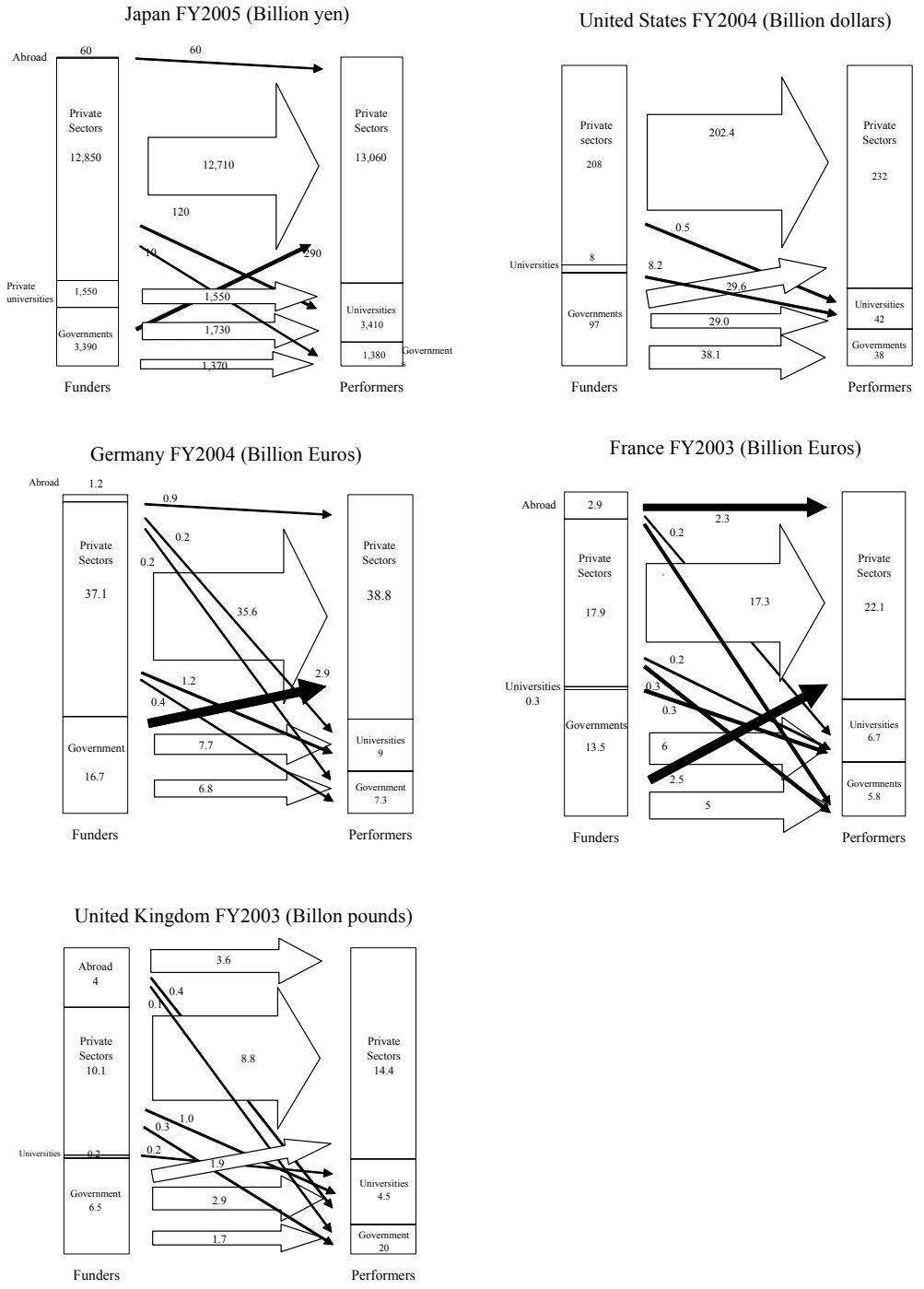

Figure 2-1-13 R&D expense flows in selected countries

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities.
2. U.S. figures are for calendar years and provisional.
3. In Germany, data from private research institutions are included in the government figures, and in the other countries are included in the private sector.

Source: Japan: "Report of the Survey of Research and Development" by the Statistics Bureau of the Ministry of Internal Affairs and Communications
Others: OECD "Research and Development Statistics".

On the reason why R&D expenses flow from government to the private sector, and from the private sector to universities, are so low in Japan, it can be pointed out that research and development in Japan often relies more on private-sector activities than it does in other countries. The large flows from government to the private sector in the United States, the United Kingdom, and elsewhere are due to the large flows of aerospace research and defense research funds. Moreover, a major reason for the large flow of research funds from foreign countries into the United Kingdom is likely the existence in that country of many foreign-capitalized corporations with research and development centers in operation, which would therefore be sending R&D funds to the United Kingdom from their own home countries.

2.1.3 R&D Expenditures per Researcher

Comparing R&D expenditures per researcher in major countries, Japan ranked fourth when the yen was converted to the IMF exchange rate, and ranked last when the OECD's purchasing power parity conversion rate was used (Figure 2-1-14).

Japan's R&D expenditures per researcher have been hovering around 22 million yen in recent years.

For R&D expenditures per researcher by type of organization in fiscal 2005, public organizations and non-profit institutions with high ratios of non-personnel R&D expenditures also registered high R&D expenditures per researcher, while universities and colleges, where the ratio of non-personnel R&D expenditures were low, registered lower expenditures per researcher (Figure 2-1-15).

If we limit the R&D expenditures per researcher at universities and colleges to those invested in those teachers, then the national universities with particularly high non-personnel R&D expenditures have the highest expenditures per researcher, followed by private universities and other public universities. By specialty (academic field), the rankings were, in order, physical science, engineering, agricultural sciences, and health sciences (Figure 2-1-16).

2.1.3.1 R&D Expenditures per Researcher by Type of Industry

For R&D expenditures per researcher by type of industry, the top five industrial categories were led by the telecommunications industry, with its high purchase rate for large machinery, equipment, facilities, and other tangible fixed assets, followed by the pharmaceutical industry, academic research institutions, the automobile industry, and the transportation industry (Figure 2-1-17).

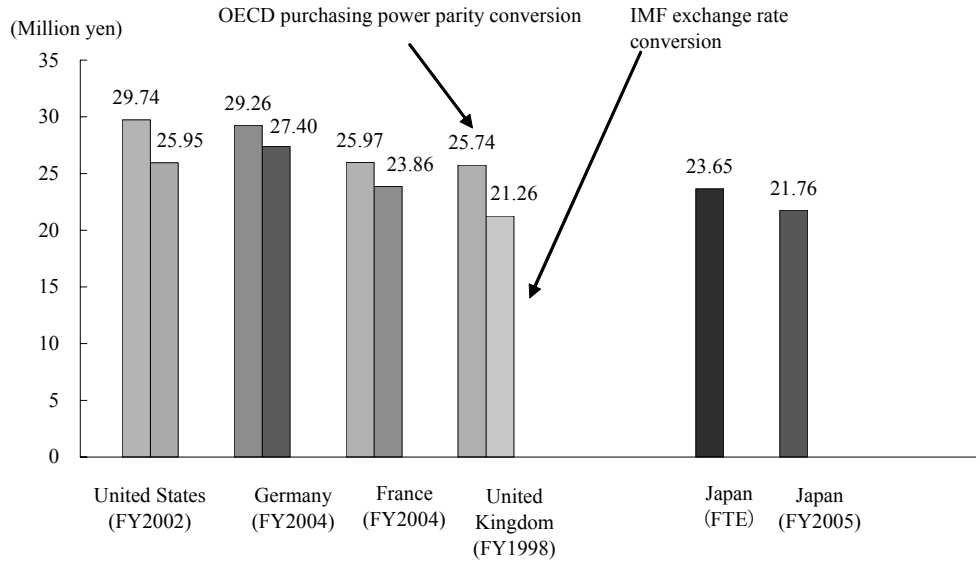

Figure 2-1-14 R&D expenditures per researcher

Notes: 1. For comparison, figures for all countries include social sciences and humanities. The figure for Japan includes the FTE value.
2. The FTE values for Japan were estimated by the Ministry of Education, Culture, Sports, Science and Technology based on data issued by the Statistics Bureau of the Ministry of Internal Affairs and Communications.

Source: Same as in Figure 2-1-3.

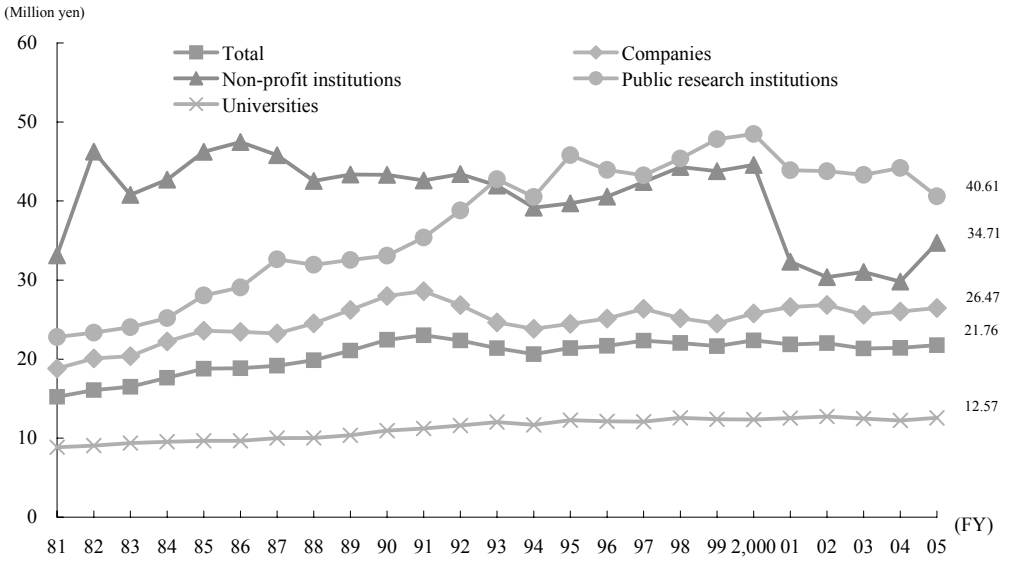

Figure 2-1-15 (1) Trends in R&D expenditures per researcher (in nominal terms)

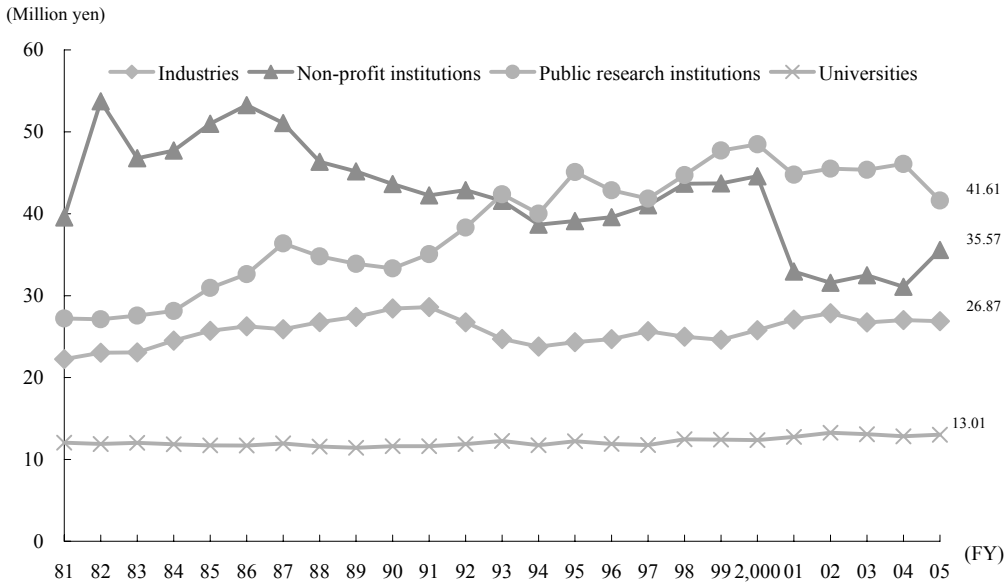

Figure 2-1-15 (2) Trends in R&D expenditures per researcher (in real terms)

Notes: 1. Survey coverage categories were changed in FY2001; figures up to FY2000 are for the following categories:

FY2001	Up to FY2000
Companies	Business Enterprises
Private research	Non-profit institutions
Government research institutions	Government research institutions

2. Figures for universities, the total, business enterprises (companies), private non-profit institutions (private research institutions), and public organizations (government research institutions) up to fiscal 2000 are based on the number of regular researchers.
3. Real values are calculated using the R&D expenditure deflator with fiscal 2000 as the base year.

Source: Statistics Bureau. "Report on the Survey of Research and Development", Data of the Statistics Bureau

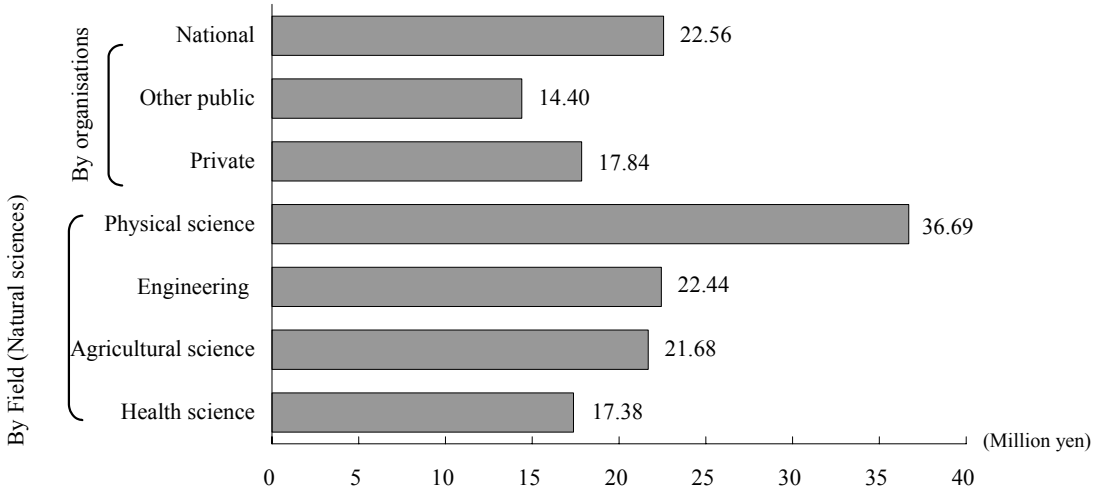

Figure 2-1-16 R&D expenditures per researcher at universities and colleges (FY2005)

Notes: 1. Figures by organization include the humanities and social sciences.
2. Figures are for faculty members only, out of all researchers.
3. The number of researchers is as of March 31, 2006.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

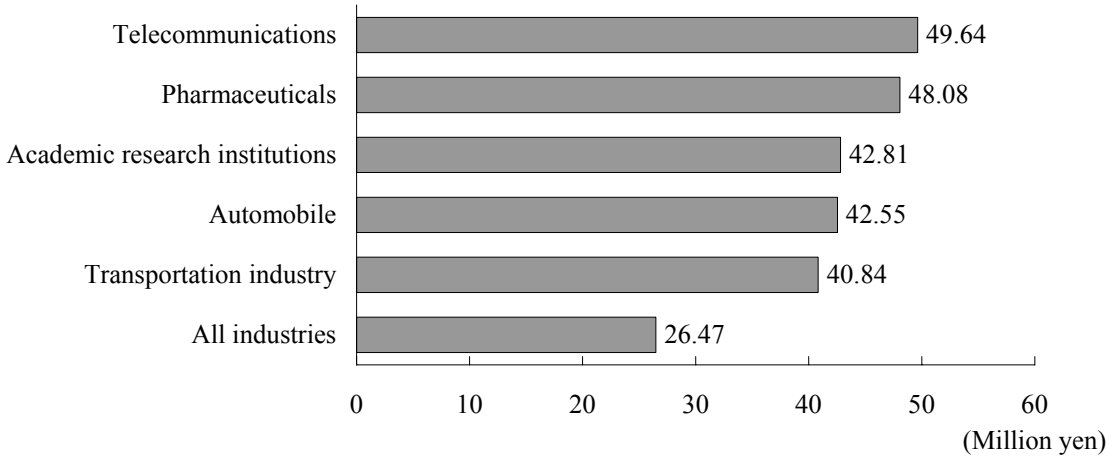

Figure 2-1-17 R&D expenditures per researcher by industry (Top five industrial categories) (FY2005)

Note: The number of researchers is as of March 31, 2006.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.4 R&D Expenditures by Character of Work

Statistical data of R&D expenditures by the classification into basic research, applied research, and development[12] generally reflects the R&D activity of each country.

Recent statistical data for Japan, the United States, Germany and France shows that France and Germany spend more on basic research, and that Japan spends less on basic research (Figure 2-1-18).

A look at the trend for the share held by basic research in selected countries shows that Japan's allotment for basic research slightly tended to rise in fiscal 1998, but then turned slightly downward in fiscal 2005. The United States, while showing some minor fluctuations, has generally increased its share of basic research since fiscal 1986 (Figure 2-1-19).

In Japan, research expenses in the different types of organizations, classified into companies, research institutions, and universities and colleges, are clearly differentiated in structure. For companies, proportion of development turned downward since fiscal 2004, but development plays an extremely important role due to their corporate business functions. On the other hand, universities and colleges place emphasis on basic research and applied research. Non-profit institutions and public organizations, meanwhile, both exhibit intermediate trends (Figures 2-1-20, 21).

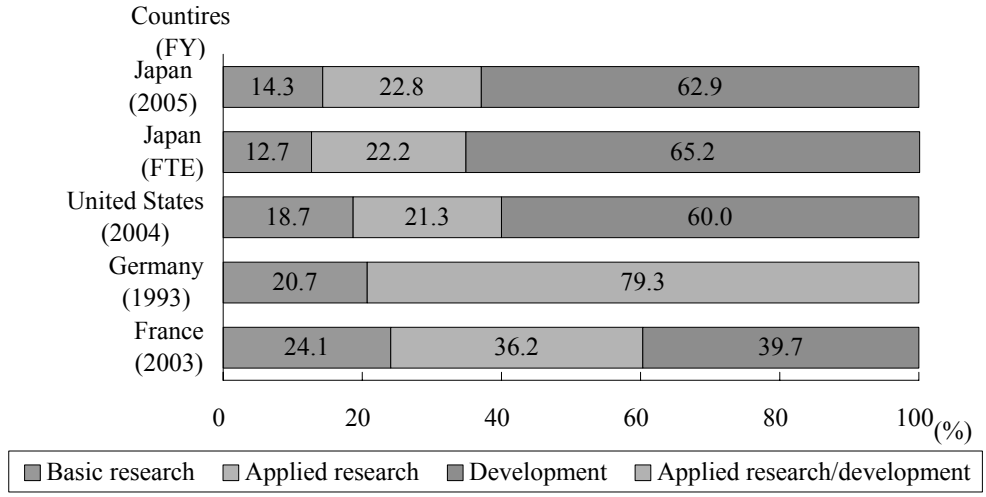

Figure 2-1-18 R&D expenditures by character of work in selected countries

Notes: 1. Figures for Japan's FTE value are prepared from Statistics Bureau data.
2. There is no distinction in Germany between applied research and development.
Source: Japan - Same as in Figure 2-1-3.
Others - OECD. "Research and Development Statistics"

[12] Research classification: "Report on the Survey of Research and Development" by the Statistics Bureau defines research by type of characteristics as follows:
- Basic research: Basic or experimental research conducted with no direct consideration for specific applications or uses, in order to form hypotheses or theories, or to obtain new knowledge about phenomena or observable reality.
- Applied research: Research that utilizes knowledge discovered through basic research to confirm the feasibility of commercialization for a specific objective, and research that searches for new applications for methods that have already been commercialized.
- Experimental development: Research that utilizes knowledge obtained from basic research, applied research, or actual experience for the objective of introducing new materials, devices, products, systems, processes, etc., or of making improvements to those already exist.

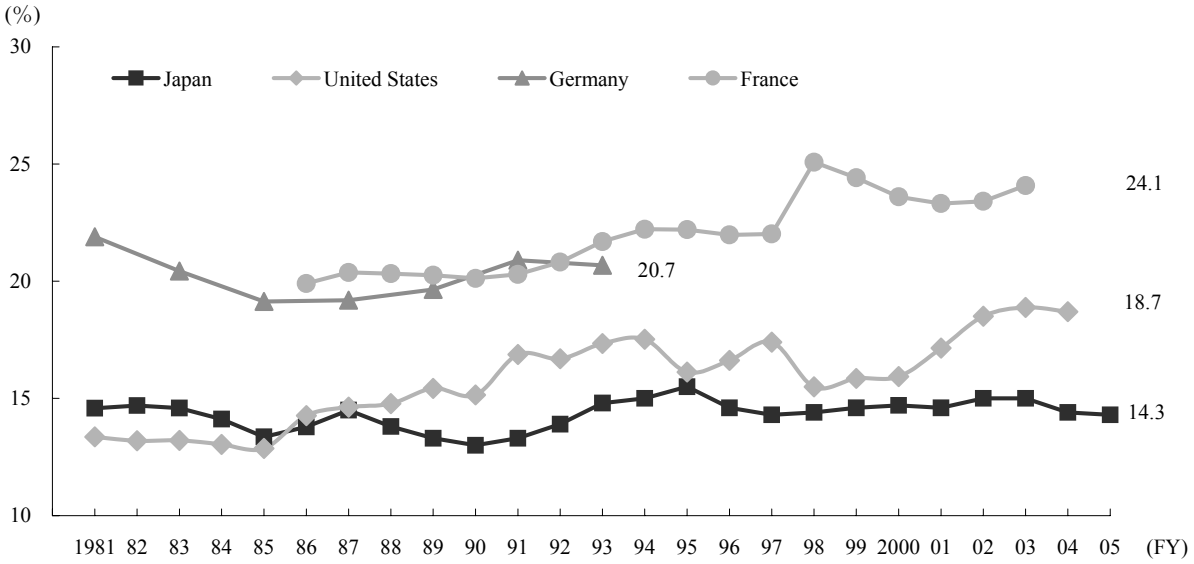

Figure 2-1-19 Trends in the proportion of basic research expenditures in selected countries

Source: Japan, United States-same as in Figure 2-1-3.
Germany, France-OECD. "Research and Development Statistics"

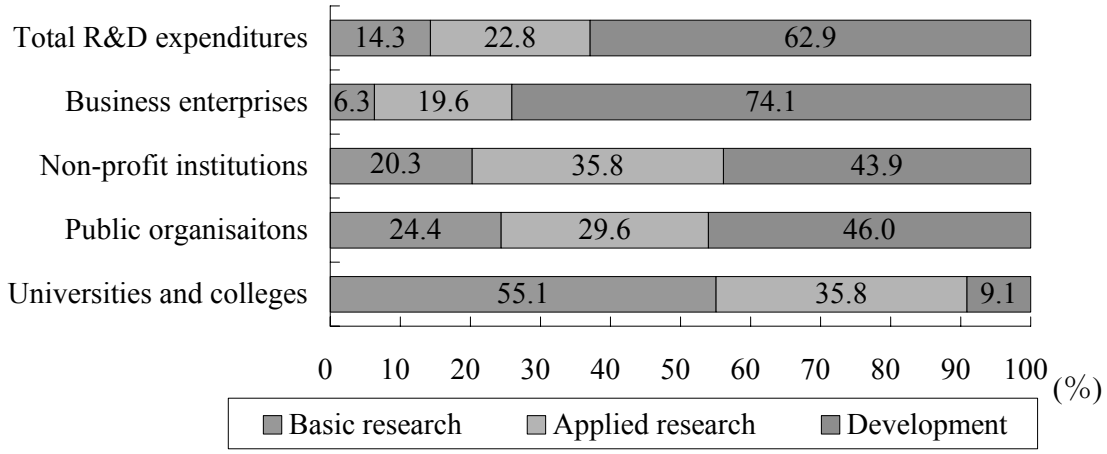

Figure 2-1-20 Composition of R&D expenditures by character of work by sector in Japan (FY2005)

Note: The figures are for the composition of R&D expenditures by character of work in the natural sciences (physical science, engineering, agricultural science, and health science).
Source: Statistics Bureau. "Report on the Survey of Research and Development"

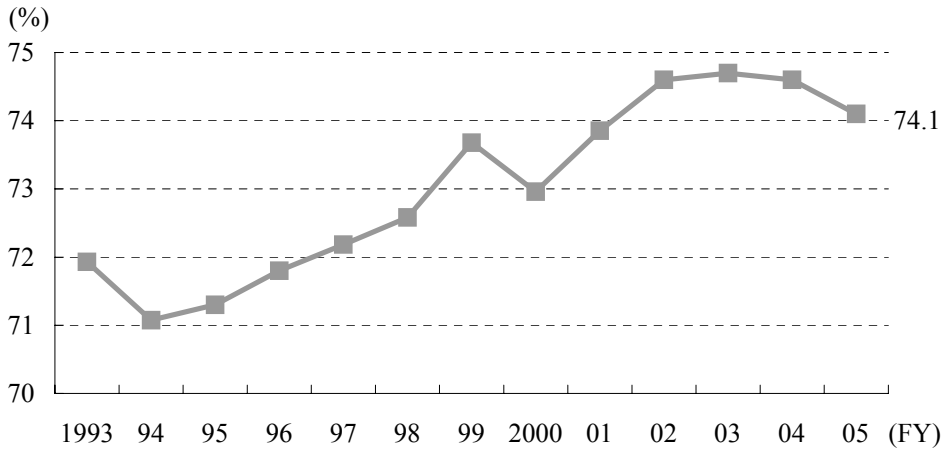

Figure 2-1-21 Trend in the share of development expenditures out of total research expenditures of companies

Note: The share of research expenditures in only for the natural sciences.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.5 R&D Expenditures by Industry

2.1.5.1 R&D Expenditures by Industry

While the statistical survey range varies from country to country, making simple comparisons difficult, it is plain that research expenses in the service industry have been increasing in all countries since the mid-1980s, in response to the shift of industrial structure from manufacturing to services in major countries. The figures for services are particularly high in the United States and the United Kingdom (Figure 2-1-22).

2.1.5.2 R&D Expenditures by Type of Manufacturing Industry

For the top six R&D expenditure manufacturing industry sectors in major countries, all countries showed high ratios for the electronics industry, the automobile industry, and the pharmaceuticals industry, which are all subject to severe competition internationally. For the total share of the top three industries, the automobile industry, the information and telecommunications machinery and equipment industry, and machinery industry accounted for 47.2% of the total in Japan; in the United States, the electronics industry, other transportation industry, and the chemical industry accounted for 54.3%; in Germany, the automobile industry, other machinery industries, and the electronics industry accounted for 56.4%; in France, the automobile industry, the electronics industry, and the pharmaceuticals industry accounted for 47.9%; and in the United Kingdom, the pharmaceuticals industry, the aerospace industry, and the automobile industry accounted for 57.6% of the total. In all major countries, therefore, R&D expenses are concentrated in the top-ranking industries (Figure 2-1-23).

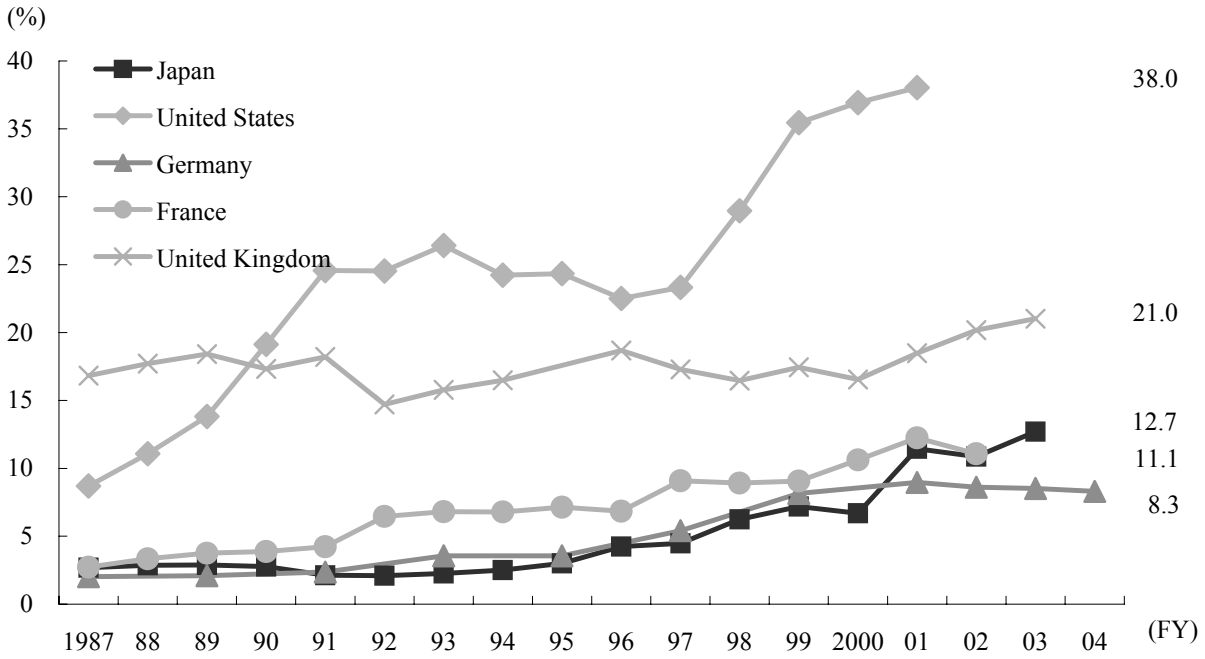

Figure 2-1-22 Share of services industry in total R&D expenditures

Notes: 1. For purposes of international comparison, the figures for each country include the humanities and social sciences.
2. Japan added some industries as new survey targets in FY1996 and FY2001.
Source: OECD. "Research and Development Statistics"

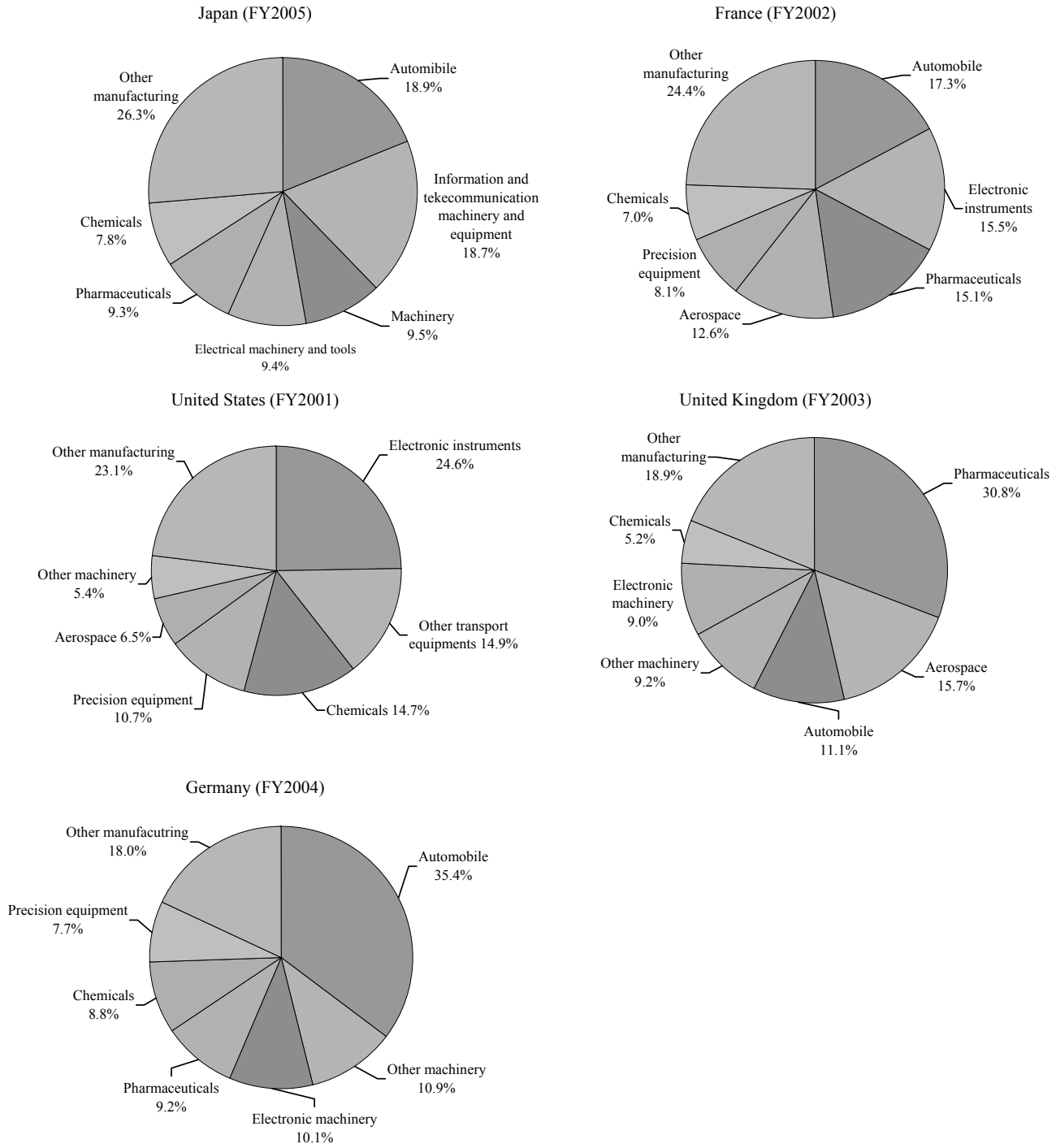

Figure 2-1-23 Manufacturing industry research expenditures in selected countries by Industry

Source: Japan-Statistics Bureau. "Report on the Survey of Research and Development"
Other countries-OECD. "Research and Development Statistics"

2.1.6 R&D Expenditures in Japan by Sector

The following section gives R&D expenditures in Japan by sector[13] on the basis of the Survey of Research and Development (2006) conducted by the Ministry of Internal Affairs and Communications.

2.1.6.1 Business Enterprises[14]

According to the survey, the business enterprises that engaged in research in fiscal 2005 numbered 18,000 companies, with the manufacturing industry accounting for the vast majority of these, at almost 75.7% of all industry types. Within the manufacturing sector, the fabricated metal products, machinery, and electrical machinery and tools industry held the largest shares.

Also, the total of R&D expenses incurred by companies in fiscal 2005 rose by 7.4% from the previous fiscal year to 12.7458 trillion yen, accounting for about 71.4% of Japan's total R&D expenditures.

By source of funding for R&D expenditures, companies accounted for almost all of the total, dwarfing the government funding of about 1.2% of the total.

Moreover, for R&D expenses incurred by companies excluding public corporations and incorporated administrative agencies, classified by company capitalization, those with a capitalization of 10 billion yen or more accounted for 71.5% of the total, a result that showed R&D expenditures were concentrated in larger corporations. Furthermore, the growth rates since fiscal year 2004 of the companies with a capitalization of 100 million yen or more and below 1 billion yen were 2.3% and those of other companies were 7% or more (Table 2-1-24).

Table 2-1-24 R&D expense growth rates and component ratio by size of company capitalization

Capitalization	R&D expenditures (Million yen)	Growth rate over previous year (%)	Component ratio (%)
10 million to 100 million yen	538,763	7.3	4.2
100 million to 1 billion	802,073	2.3	6.3
1 billion to 10 billion	2,282,678	8.6	17.9
10 billion or more	9,103,717	7.6	71.5
Total	12,727,231	7.4	100.0

Source: Statistics Bureau. "Report on the Survey of Research and Development"

[13] Research Performing Sector: Research activities in Japan in this paper are provided by business enterprises, public organizations, non-profit institutions, and universities and colleges. These classifications are based on the "Report on the Survey of Research and Development" compiled by the Statistics Bureau. The following defines some of these organizations.

[14] Business enterprises: Corporate companies (Capital: 1 million or more yen (fiscal 1974 or before), Capital: 300 million yen or more (between fiscal 1975 and fiscal 1978), Capital: 5 million yen or more (between fiscal 1979 and fiscal 1993), Capital: 10 million yen or more (fiscal 1994 and after)), profit-oriented public corporations and independent administrative institutions. The public corporations and independent administrative institutions specializing in research are excluded, and are included in the research institutions defined below.

2.1.6.2 Non-Profit Institutions[15]

In fiscal 2005, the government and the private sector were sources for nearly equal shares of funding for non-profit institutions. The total R&D expenditures at non-profit institutions increased by 3.7% over the previous fiscal year to 309.8 billion yen, representing 1.7% of Japan's total R&D expenditures (Figure 2-1-25).

2.1.6.3 Public Organizations[16]

The government was the source for nearly all R&D expenditures at public organizations in fiscal 2005, with private-sector funding accounting for only about 1.0%.

Total R&D expenditures at government research institutions decreased by 7.7% in the previous fiscal year to 1,382.2 billion yen, representing 7.7% of Japan's total R&D expenditures. When looking at expenditures by type of institution, non-profit institutions had slight year-on-year increases while all others witnessed declines (Figure 2-1-25).

2.1.6.4 Universities and Colleges[17]

By source of funding for R&D expenditures at universities and colleges in fiscal 2005, the government accounted for about 50% of the total. The total R&D expenditures at universities and colleges increased by

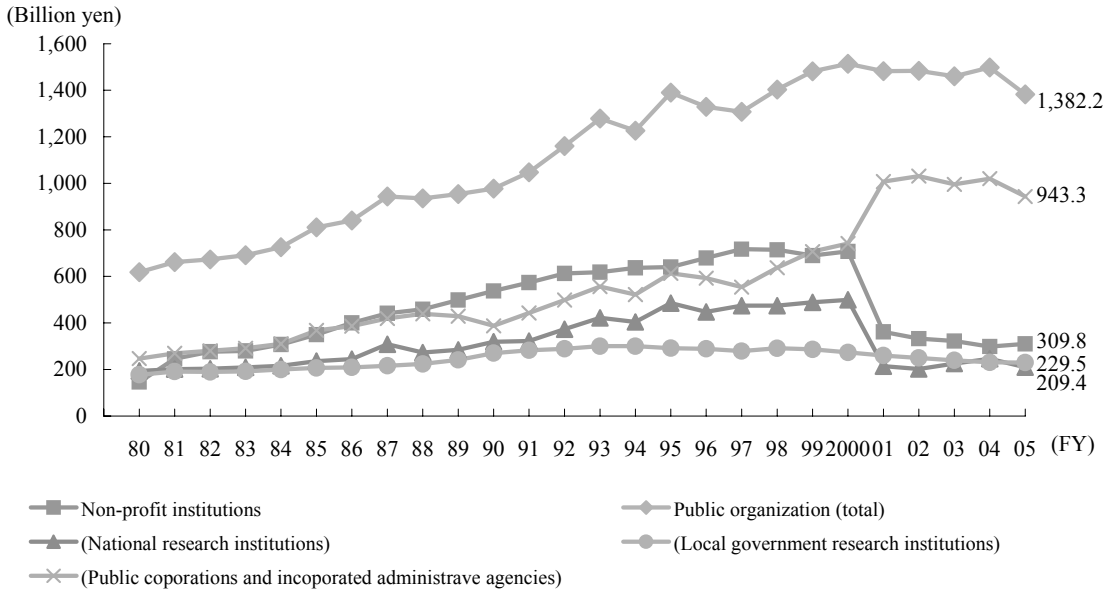

Figure 2-1-25 Trends in R&D expenditures for non-profit institutions and public organizations

Note: Survey coverage categories were changed in FY2001; figures up to FY2000 are for the following categories:

FY2001	Up to FY2000
Non-profit institutions	Private research institutions
Public organizations	Research institutions excluding private research institutions
National research institutions	National research institutions
Local government-owned research institutions	Local government-owned research institutions
Public corporations and incorporated administrative agencies	Public corporations

Source: Statistics Bureau. "Report on the Survey of Research and Development"

[15] Non-profit institutions: Corporations, groups, etc. such as incorporated foundations or incorporated bodies that carry out research and do not seek private profit.
[16] Public organizations: National and local government-owned research institutions and public corporations and independent administrative institutions whose primary business is research and development.
[17] Universities and colleges: Departments of universities and colleges (including graduate schools), junior colleges, colleges of technology, research institutions attached to the universities and colleges and inter-university research institutes, National Institution for Academic Degrees and University Evaluation, Center for National University Finance and Management, and National Institute of Multimedia Education.

4.1% over the previous fiscal year to 3,407.4 billion yen, accounting for 19.1% of Japan's total R&D expenditures.

For trends in R&D expenditures by type of university, public and private universities registered year-on-year increase again while national universities, which had had decline from 2003, started to increase. By type of field, all fields witnessed year-on-year increases, since both engineering, which had had decreases from 2003, and physical sciences, which started to decrease in the previous year, started to increase (Figure 2-1-26).

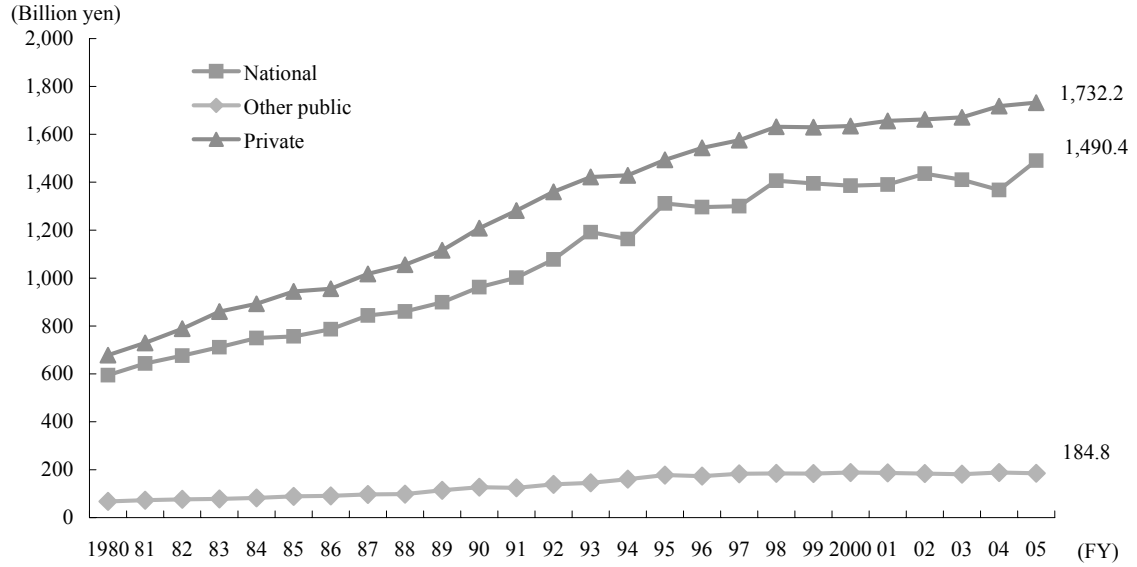

Figure 2-1-26 (1) Trends in R&D expenditures at universities and colleges by type of university

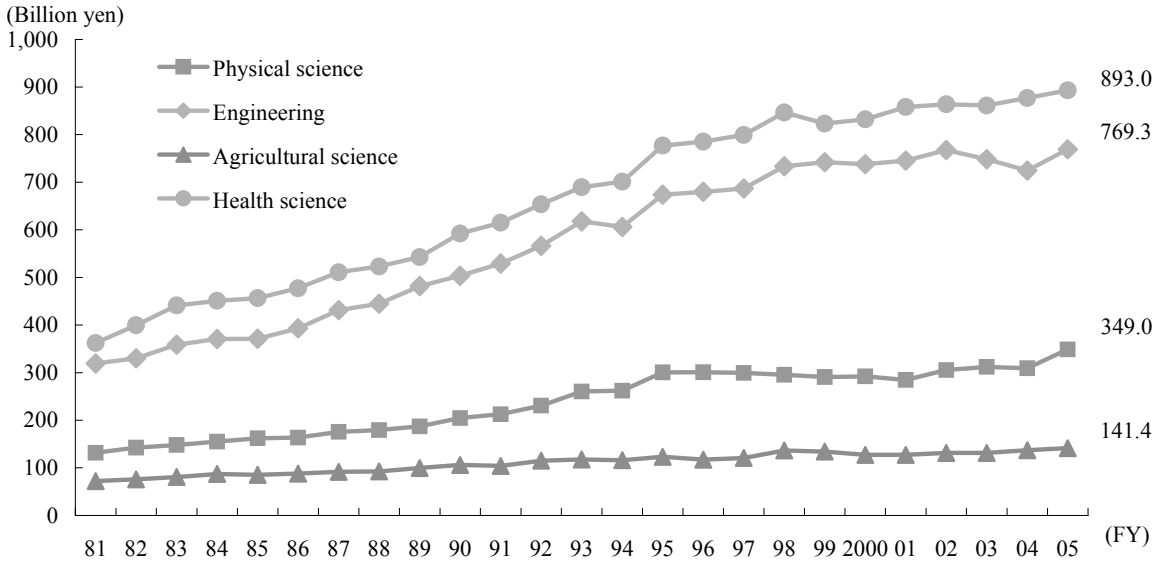

Figure 2-1-26 (2) Trends in R&D expenditures at universities and colleges by field

Note: The figures by type of university include the humanities and social sciences.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.7 R&D Expenditures in Japan by Type

R&D expenditures break down into labor costs, materials, expenditures on tangible fixed assets (land and buildings, machinery, instruments, equipment and others), and lease fees (separated from 'Other expenses' in fiscal 2001) and other expenses.

An examination of Japan's R&D expenditures by type reveals that total labor costs in fiscal 2005 increased by 4.2% over the previous fiscal year to 7.9325 trillion yen. The total expenditures for materials increased by 1.2% over the previous fiscal year to 2.8493 trillion yen. The total expenditures for tangible fixed asset purchases decreased, registering a 12.3% increase over the previous fiscal year to 1.7543 trillion yen. On the other hand, the total expenditures for lease fees decreased by 0.7% over the previous fiscal year to 179.7 billion yen. The share of other expenses required for research, such as books and journals, utilities, travel, and telecommunications, etc., increased by 7.6% over the previous fiscal year to 5.1294 trillion yen (Figure 2-1-27).

Moreover, the trends in the breakdown of expenditures reveal that while labor cost has long held the largest share of overall expenditures, that share has stayed flat in recent years. Material costs have also stayed flat. Tangible fixed asset purchase expenditures are declining. The shares of other expenditures are increasing (Figure 2-1-28).

By category in fiscal 2005, company R&D expenditures were characterized by increases in all categories except lease fees that remained almost the same with the previous year (Figure 2-1-29).

Non-profit institutions and public organizations had lower ratios than any other institutions on expenditures for labor costs, while their tangible fixed asset purchase expenditures showed higher ratios. When looking at expenditures by type of institution, local government-owned institutions were characterized by exceptionally high labor costs. On the other hand, public corporations and incorporated administrative agencies have higher ratios of expenditures for the purchase of tangible fixed assets, because they include those requiring large-scale facilities and equipment for nuclear and space R&D (Figure 2-1-30).

Universities and colleges had a higher share of labor costs than other institutions, accounting for 64.3% of expenditures, while raw material costs were the lowest in share. When looking at expenditures by the field of study within the natural sciences, the physical sciences in particular had lower than average shares of labor costs tended to require larger than average shares of total costs for tangible fixed assets (Figure 2-1-31).

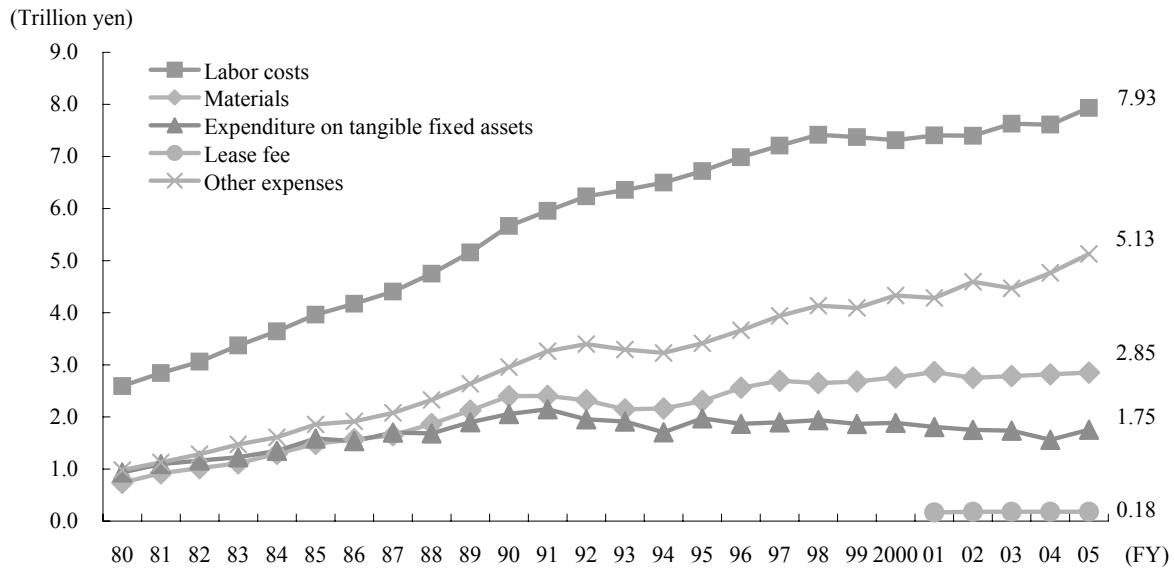

Figure 2-1-27 Trends in R&D expenditures by type

Notes: 1. The humanities and social sciences are included.
2. Lease fee was separated from 'Other expenses' in FY2001.
3. Some Industries were added as new survey targets in FY1996 and FY2001.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

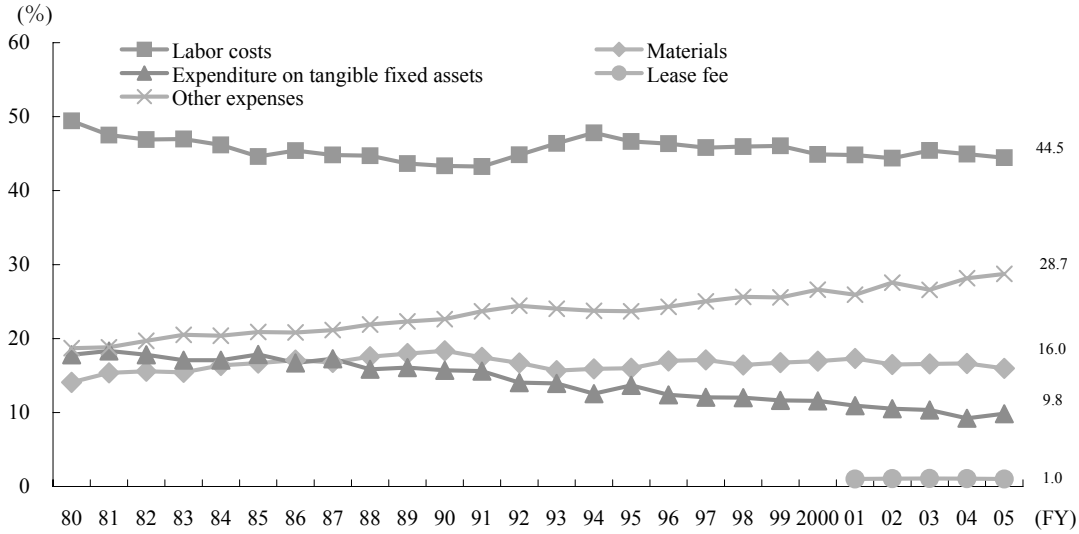

Figure 2-1-28 Trends in R&D expenditures by constituent elements

Notes: 1. The humanities and social sciences are included.
2. Lease fee was separated from 'Other expenses' in FY2001.
3. Some Industries were added as new survey targets in FY1996 and FY2001.

Source: Statistics Bureau. "Report on the Survey of Research and Development"

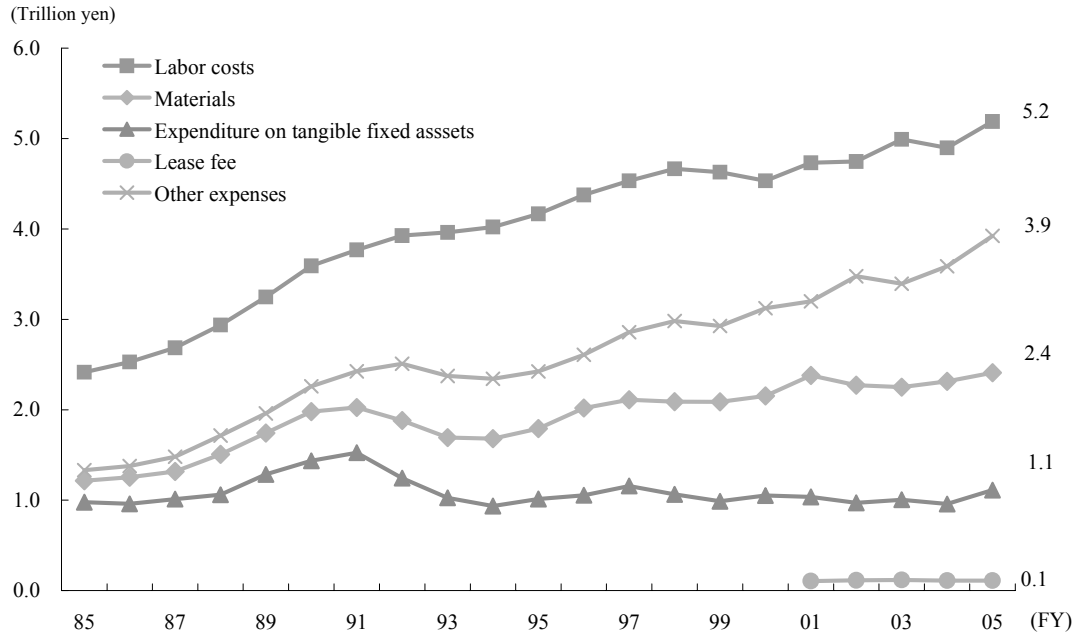

Figure 2-1-29 Trends in R&D expenditures at business enterprises by type

Notes: 1. Lease fee was separated from 'Other expenses' in FY2001.
2. The software industry and wholesale trade were newly added to the scope of the survey in 1996 and 2001, respectively.

Source: Statistics Bureau. "Report on the Survey of Research and Development"

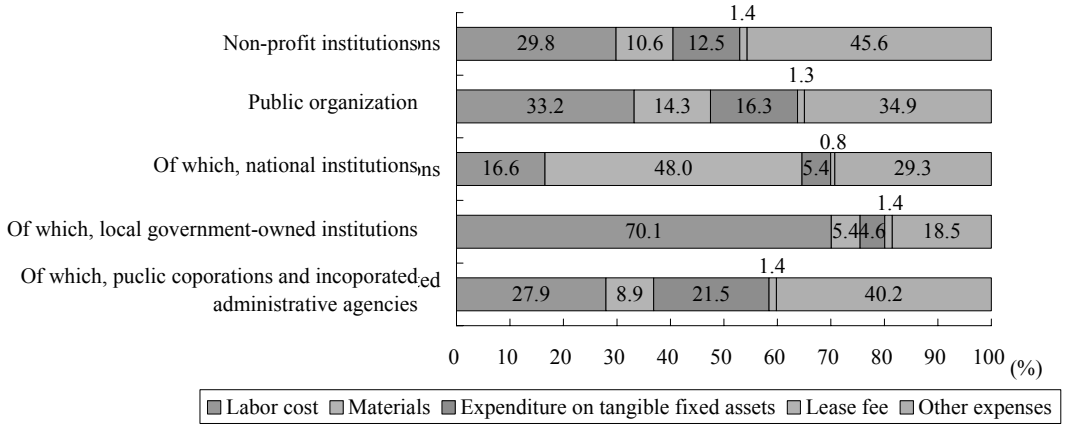

Figure 2-1-30 Composition of research expenditures at non-profit institutions and public organizations by type (FY2005)

Source: Statistics Bureau. "Report on the Survey of Research and Development"

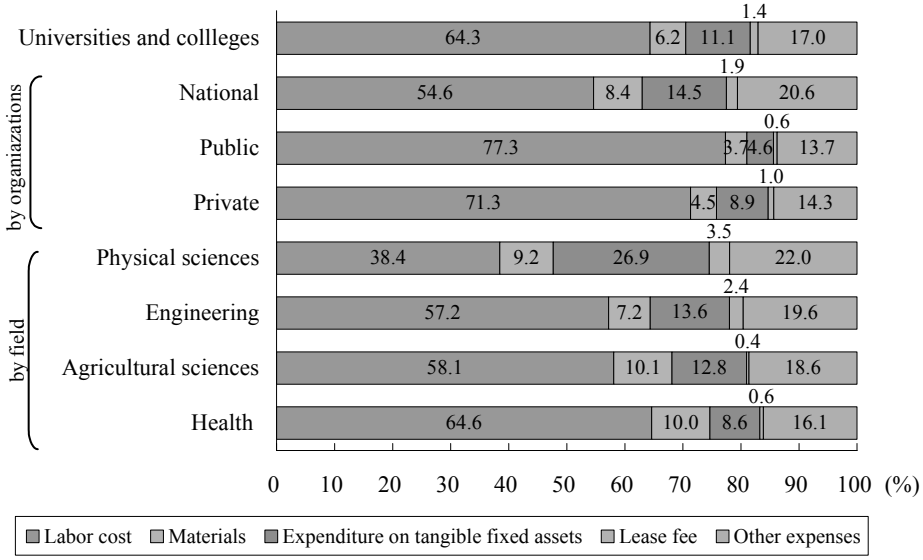

Figure 2-1-31 Composition of R&D expenditures at universities and colleges by type (FY2005)

Note: The figures for all universities and colleges and those by organization include the humanities and social sciences.
Source: Statistics Bureau. "Report on the Survey of Research and Development"