[Column 20]

Selection of "Key Technologies of National Importance"

The conditions surrounding Japan have drastically changed from the time the Second Science and Technology Basic Plan was made, including the decreasing and aging of the population, change in the international power balance by the rise of China and Korea in Asia and the growth of BRICs countries, restricted supplies of resources and energy, frequent natural disasters such as earthquakes and typhoons, the entry into force of the Kyoto Protocol with greenhouse gas reduction as an international agreement, and insecurity of health and food including new and reemerging infectious diseases and BSE. For continuously developing as a first-class nation in this knowledge competition era and leading the world, it is essential to carefully select and promote the important technologies ("Key Technologies of National Importance") that are to be the base for the nation's continuous development, and be worked out with a long-term national strategy.

Based on the recognition of these circumstances, the Third Basic Plan prescribes that "Key Technologies of National Importance," that require concentrated investment during the period of the Basic Plans, should be selected from large world-leading long-term projects implemented by a state-led consistent promotion system and that the target and long-term strategy of the state should be clarified and worked out. Below are the selected five "Key Technologies of National Importance":

- The world's highest level "next generation super computer" that carries science and technology forward
- "X-ray free electron laser" that has the characteristics of both radiation light and laser and that enables analysis that was impossible by conventional methods
- "Ocean and earth exploration system" that contributes to clarify phenomena and predict influences of global warming, to clarify mechanisms of generations of earthquakes and tsunamis, and to probe resources
- "Fast breeder reactor (FBR) cycle technology" that secures a long-term stable supply of energy
- "Space transport system" that is essential for Japan's total security and for keeping Japan's autonomy in international society

(2) Reforming the Science and technology system

●Developing, securing and activating human resources

To foster the human resources that will play the central role in the future of science and technology in Japan and the strengthening of international competitiveness, an environment will be developed where human resources with diverse talents, including the young, female, foreign and senior researchers can demonstrate their motivation and abilities to the fullest. In addition, through the drastic enhancement of graduate education, the human resources development function of universities will be enhanced, and the human resources that will lead the industry-academia-government collaboration and the returning of the results of research and development to society will be fostered, while consistent and comprehensive measures for human resources development will be taken, right from the elementary and lower secondary education stages through to the level of full-fledged researchers/engineers. In this way, the quality and quantity of human resources will be secured even as society ontinues to age.

●Creating scientific development and persistent innovation

In order to realize the social and economic value of the results of research and development through innovation and to find the intellectual and cultural value form scientific progress, there is an aim to effectively utilize resources for science and technology and promote science and technology that returns results to society and the people. To this end, a competitive environment will be developed and university competitiveness will be enhanced, while efforts to strengthen the system for generating innovation will be promoted along with other measures. In order to effectively and efficiently promote research and development, there will be measures to reform the assessment systems and thoroughly eliminate waste in the allocation of research funds, as well as measures to resolve the institutional and operational bottlenecks impeding smooth operation and regulation of science and technology activities and a return of results to society.

●Reinforcing the foundation for promoting science and technology

In order to develop and train talented personnel and promote creative, cutting-edge research and development, progress will be made on the preparation of equipment and facilities of universities and public research institutes that form the foundation for research and development activities. Besides, to achieve results of the highest level in the world, promotion of the preparation and shared use of large, state-of-the-art research facilities will be needed. Furthermore, in order to return the innovative, ground-breaking research and development results to society and the public, promotion of measures related to the creation, protection and use of intellectual property will be carried out.

●Strategically promoting international activities

For strategic promotion of international science and technology activities, science and technology alliances with other Asian nations will be strengthened, in addition to the promotion of collaborative research and formation of multi-layered networks within bilateral and multilateral frameworks. Besides, the environment to enhance international activities will continue to be developed in order to promote the welcoming of talented foreign researchers.

(3) Science and technology to be supported by society and the public

In order to further develop science and technology activities in the future, it is crucial to obtain the widespread support of society and the public. To achieve this, the following measures will be taken to assign the roles to each of the various levels, in the research community, research agencies and individual researchers, and obtain the confidence of society and the public.

Science and technology also has a large influence on social areas like law and ethics, including the ethical questions about clone technology with regard to humans, and the question of misconduct in research, such as falsification of experimental data, which damages the reputation of all those associated with science and technology, and destroys confidence in science and technology itself. In light of this, in addition to encouraging the establishment of rules to be followed by those associated with science and technology, there will also be support of measures to rationalize risk management for the return of science and technology results to society.

In addition to return the fruits of science and technology to the people, research institutes and researchers have a basic responsibility to publicize the research activities as much as possible and to explain the content and results in an understandable way to society. In order to enable researchers to understand peoples' needs, dialogue between researchers and the public will be promoted. In addition, to promote interest in science and technology among the public, there should be an improvement in education in math and science in primary and secondary education levels, and widespread distribution of easy-to-understand documents on knowledge, techniques, and viewpoints related to science and technology in order to increase the understanding and ability of adults regarding science and technology. Furthermore, there will also be efforts to develop museums and science centers to expand the opportunities for the public to have contact with science and technology from childhood through old age.

(4) Dealing with a declining population and an aging society with fewer children

The Third Basic Plan indicates that, while a declining population and an aging society with fewer children give rise to not only economic problems, but also various new social problems including health issues and the social security burden on citizens, science and technology is sought to make some contribution to the significantly changing society as the aging of society progresses and the number of children continues to decline, based on the need to continuously improve productivity in order to achieve stable economic growth and the spiritual well-being strongly desired by the public as well as a sense of security and stability in daily life.

It implies the importance to maintain and promote science and technology as a source of power for the country in order to sustain development and overcome population declines and an aging society with fewer children. The goals put forward in the plan are to overcome diseases afflicting the public, from children to the elderly, and to achieve a society in which everyone can stay healthy. By achieving this goal, science and technology will make a greater contribution to the people, society and the world.

1.3.2 Japan and Science and Technology in the Future

Summary

Although the economy in Japan shows signs of a sustained growth process, there are still many problems to be overcome, such as the worry of a shrinking work force due to declining population, and the progression of an aging society with fewer children, intensified international competition, and global problems such as the possibility of large-scale natural disasters, terrorism, and environmental problems.

Japan will be the first developed nation to pursue solutions to the problems from a declining population and an aging society with fewer children. Science and technology is expected to make a large contribution to the goal of becoming a problem-solving nation, through the realization of a vigorous, abundant society.

1.3.2.1 Science and Technology as a Source of Vitality

Although the Japanese economy has shown signs to shift to a sustainable growth process, there are many problems that Japan needs to handle, including the rapid aging of society and decline in the number of children, the fear of a shrinking labor force, intensifying international competition, large-scale natural disasters, terrorism and global problems like environmental problems. To solve these problems, there are greater and greater expectations placed on science and technology. Indeed, many of the issues that society faces are those that should be addressed by approaches other than science and technology, such as improving the social system, but there are also problems that can only be resolved by introducing new science and technology innovations that go beyond the level of the existing technology. The scope of such societal issues is widening further with the expanding needs of people and society. Science and technology is expected to contribute to realizing a society in which people can act freely and comfortably, bringing economic benefits through innovation, and building a social environment in which people can enjoy spiritual and material ease.

What will science and technology bring forth in the future? According to the survey "Comprehensive Analysis of Science and Technology Benchmarking and Foresight" (May 2005), regarding the development trends at science and technology by the National Institute of Science and Technology Policy, the importance of technology regarding safety and security is increasing, and the fusion of fields and interdisciplinary research should be promoted in many fields, starting with life sciences. This is expected to result in improvements in medicine and daily life through a safer and more convenient society.

To build a society desired by the people, it is not sufficient to simply improve safety and convenience through science and technology; there must also be social systems and mechanisms prepared to deal with the changes. Science and technology alone cannot provide the solutions to all problems, but through a shared understanding of the issues, and solutions to each of the problems that can be addressed, science and technology will be a force that provides enormous benefits to the society of man, and can be a source of social, economic and cultural vitality for the nation.

1.3.2.2 Becoming a Problem-solving Leader

As the historical products of the 20^{th} century, mankind now faces various global problems in the 21^{st} century. In the midst of this, Japan is also the first among developed nations to face a rapidly declining population and the progression of an aging society with fewer children. In order to become a country of significance in the world, Japan needs to become a nation that can contribute to the settlement of those problems and actively propose solutions to create a sustainable society.

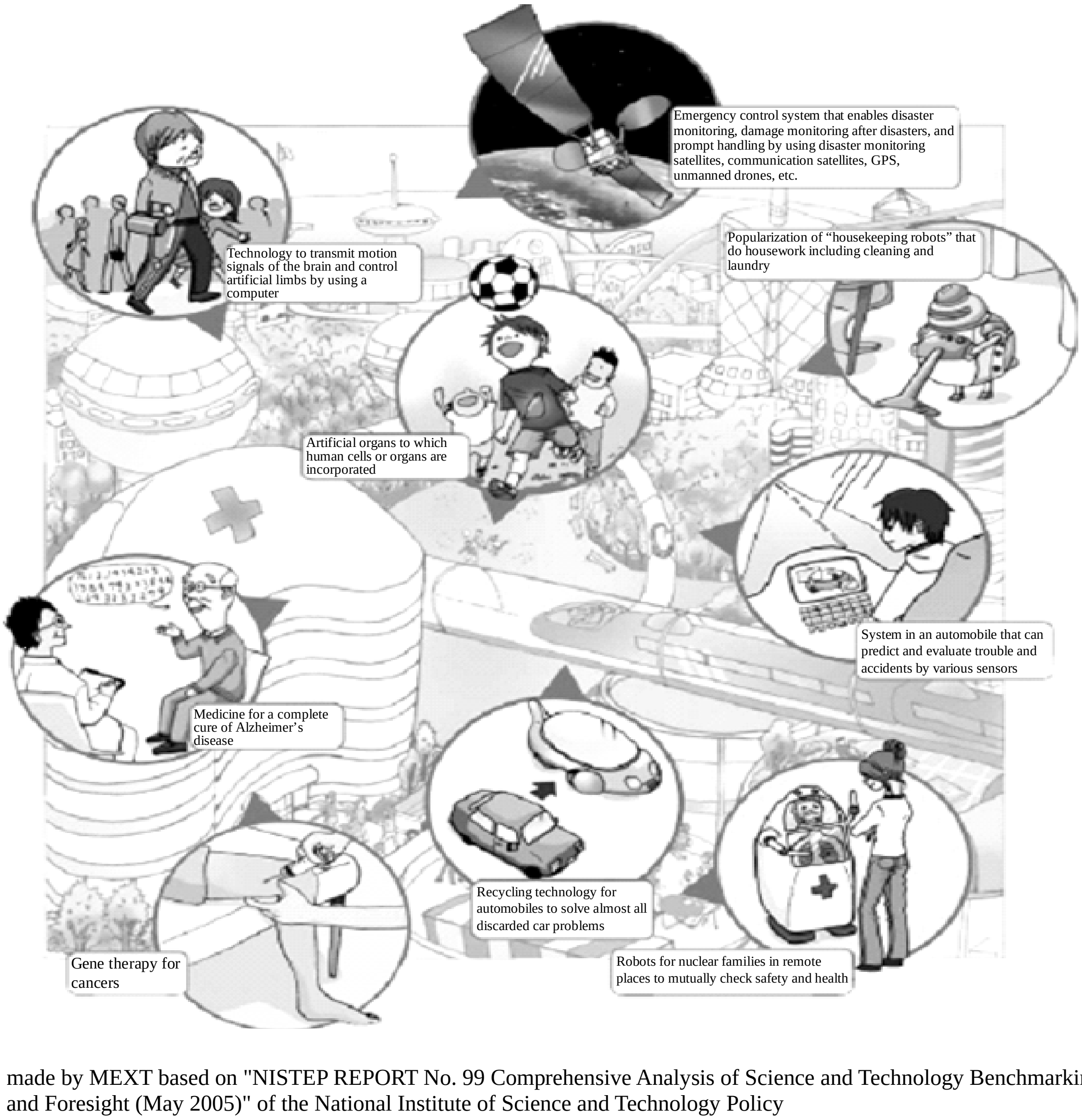
Science and technology is one of effective means for Japan to overcome these problems and to make a contribution to the rest of the world. Japan has become one of the earliest developed countries in the world to be forced to resolve the problems of a declining population and an aging society with fewer children.

By achieving an abundant and vigorous society even with an aging society with fewer children, Japan should show the world effective solutions and aim to be a leading problem-solver for the world, and in this area science and technology is expected to make a large contribution.

[Column 21]

Society in 2030

Based on the questionnaires asked to specialists in each field, the National Institute of Science and Technology Policy made, in May 2005, a report on the long-term prospect of the development of science and technology in Japan.
According to the report, by around 2030, the following technologies are supposed to be used in society and major advancement is expected in the effort to cope with society with its decreasing and aging population.



Source: made by MEXT based on "NISTEP REPORT No. 99 Comprehensive Analysis of Science and Technology Benchmarking and Foresight (May 2005)" of the National Institute of Science and Technology Policy

Conclusion

As described above, the progress of an aging society with fewer children is a problem that will affect a variety of aspects of Japan's society in the future. It is a big issue for us to cope with this problem in the midst of increasingly severe international competition. However, as we now face the big transition in the declining population, it could be said that we have the opportunity to be the pioneers of a new society by actively addressing the problems, regarding this to be a challenging opportunity to build the future society.

In order to realize such a challenge, it should be required to review the various social systems that have been established under the growing population, and to realize affluence under the aging society with fewer children, while giving consideration to global environmental problems and resource/energy constraints.

The challenge would be to design a society where we can maintain economic vitality and achieve happiness of the people through self-realization, with each individual working to enhance their skills and capabilities, and to conduct fulfilling activities in the community. In addition, it would be a society where the social burden could be minimized as much as possible with everyone working and supporting each other. It would also be a society where an individual could spend time throughout their life on family activities, personal interests and community activities, while maintaining a balance between work and daily life: in other words, a balanced society offering quality of life.

To realize such a society, it is necessary to make wide-ranging efforts throughout the entire society, since it involves a variety of elements, such as the various social systems and attitudes of people. As the population declines, science and technology becomes the wellspring of the power to maintain and improve the economic vigor that is the foundation of a wealthy society. Science and technology have a significant role to fulfill in this challenge, including the creation of new knowledge resulting from the progress in science and technology, and realization of innovation based on this. Science and technology are also required to address the needs of society in the fields of health, safety and security.

It is also anticipated that science and technology will provide an even greater impact on all facets of society in the future. In order for science and technology to properly meet the demands of society, there must be understanding, sympathy and support from a wide range of people toward science and technology. In such an environment, a wide range of science and technology related human resources can be developed, as well as the nurturing of an attractive research environment where highly qualified personnel from throughout the world can gather and develop under competitive conditions. Furthermore, it is also expected that this will give rise to knowledge and understanding that will contribute to solving common problems shared for all of humanity.

This is the first year of the Third Science and Technology Basic Plan that adopts the basic posture of "S&T to be supported by public and to benefit society," and "Emphasis on fostering human resources and competitive research environments." From now, Japan will aim to be a creative nation based on science and technology, and to steadily implement the Basic Plan while strategically prioritizing research and development investment through selection and concentration. Through this effort and the promotion of science and technology, it is required to establish an abundant and vital society, as well as to contribute to solving the common problems for all of humanity through the creation and utilization of knowledge.

Part 2
The Current Status of Science and Technology in Japan and Other Nations

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 0.5% for fiscal 2004, but R&D expenditure for the year witnessed an increase of 0.8%, a rise for the fifth consecutive year, due to big spending increases by private-sector enterprises, raising the R&D expenditure to GDP ratio by 0.01 points to 3.41%. In addition, the number of researchers in fiscal 2005 increased for the fourth year in a row, with overall R&D-related personnel, including research support staff and technicians, witnessing an increase for the second 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 propor- tion 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 2005 survey of research and development (Table 2-1-1).

[1] In Part 2, the major countries refers to the United States, Germany, France, 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. Further-more, the classification of the humanities and social sciences as distinct from the natural sciences is based on the research content, not on the individ-ual 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 re-searcher has an average of 30% of his/her working hours allocated to research and development operations, and is engaged in other activities (teaching, uni-ver-sity 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.

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.

Table 2-1-1 Comparison of FTE value and simple head count (FY2004)

(Persons, Million yen)

Item	Simple head count (A)	FTE value (B)	Change (B/A)%
Number of university researchers	291,147	177,421	60.9
Total number of researchers	790,932	677,206	85.6
University R&D expenditure	3,273,966	2,119,125	64.7
Total R&D expenditure	16,937,584	15,782,743	93.2

Note:1. The number of researchers is as of March 31, 2005.
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

●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]. 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 com- petitive 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 objectives, the Framework Programme (Sixth Framework Programme (FP6), from 2002 to 2006, 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[7] for EU countries.

[5] The EU-15 consists of Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, 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] 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.

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	505 trillion yen	1,269 trillion yen	1,398 trillion yen	1,333 trillion yen
R&D expenditure	16.9 (15.8) trillion yen	32.9 trillion yen	24.6 trillion yen	24.2 trillion yen
Number of researchers	790,000 (680,000)	1,260,000	1,170,000	1,050,000

Notes : 1. Japan population and GDP is for 2005, R&D expenditure is for FY2004, researchers figure is for 2005.
2. Figures in parentheses for R&D expenditure and number of researchers in Japan are FTE values.
3. U.S. population is for 2005, GDP is for 2004, R&D expenditure is for 2003, researchers figure is for 1999.
4. For EU-25 or EU-15, population and GDP is for 2004, R&D expenditure is for 2003, researchers figure is for 2003.
5. The IMF exchange rate is used to convert U.S., EU-25 and EU-15 currency to Japanese yen.

2.1 R&D Expenditures

2.1.1 Total R&D Expenditures

2.1.1.1 Trends in R&D Expenditures in Selected Countries

When a country examines its R&D expenditures[8], its statistical contents and approach may differ from other nations. As a result, a simple comparison of R&D expenditures among countries may not pre-sent comparable data, although it gives a general idea as to a country's attitude towards science and technology. In terms of R&D expenditures, the United States registered the highest total, at 32.9 trillion yen at the IMF currency conversion rate (39.5 trillion yen at the OECD purchasing power parity conversion rate), followed by the EU-25 at 24.6 trillion yen at an IMF exchange rate conversion (29.5 trillion yen in OECD purchasing power parity), and Japan at 16.9 trillion yen (or 15.8 trill- ion yen at the FTE value) (Figure 2-1-3).

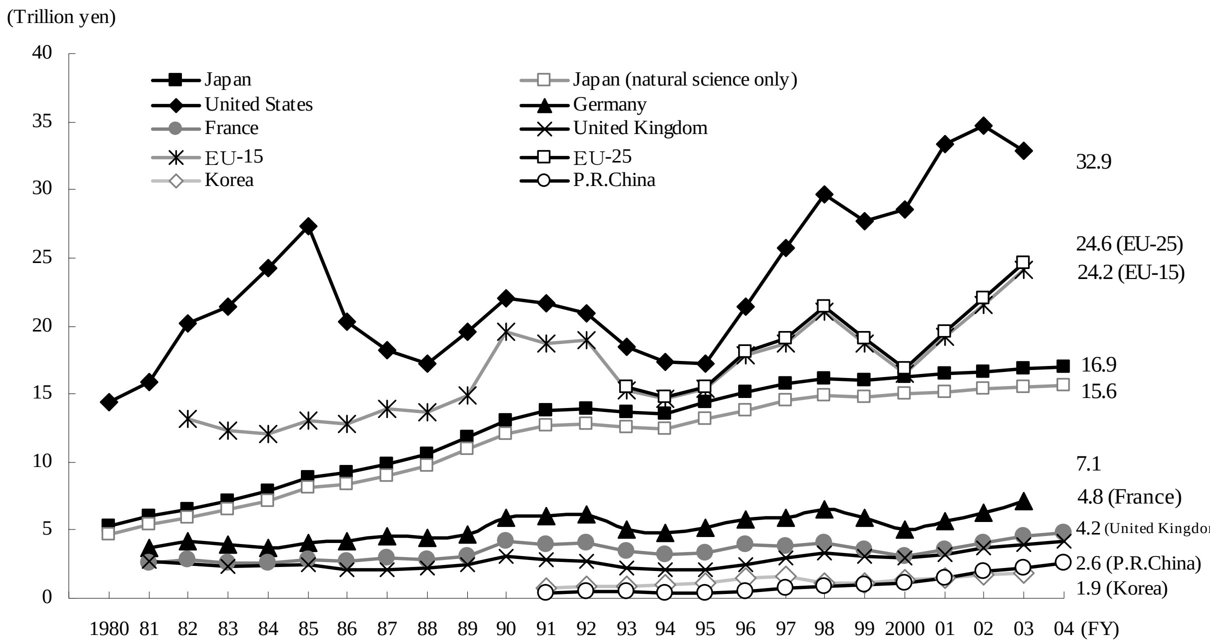


Figure 2-1-3 (1) Trends in R&D expenditures of selected countries －IMF exchange rate conversion

[8] 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.

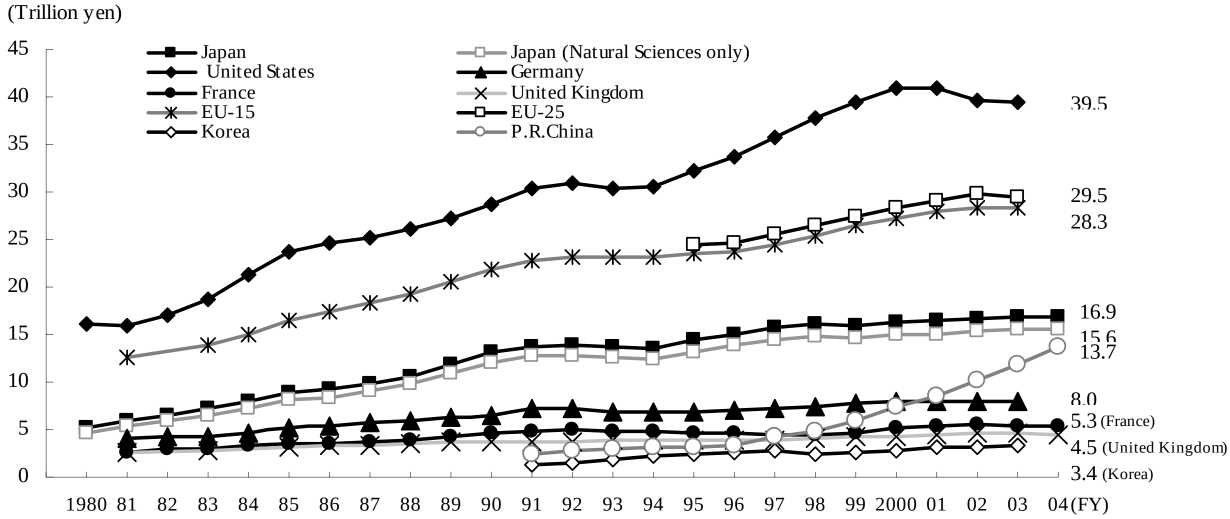


Figure 2-1-3 (2) Trends in R&D expenditures of selected countries －OECD purchasing power parity

Notes:1. For comparison purposes, statistics for all countries (excluding South Korea) 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 2002 and later are provisional.
4. French figure for FY2004 is provisional.
5. 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.
6. EU-15 consists of 15 countries: Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden.
7. 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-Statistics Bureau. "Report on the Survey of Research and Development"
United States-National Science Foundation. "National Patterns of R&D Resources"
Germany-Federal Ministry of Education and Research. "Bundesbericht Forschung"
France-"Project de Loi de Finance: Rapport annexe sur l' Etat de la Recherche et du Developpement Technologique"
United Kingdom-Office for National Statistics. "Gross Domestic Expenditure on Research and Development"
EU-Database on website of Eurostat (Statistical Office of the European Communities, hereinafter abbreviated)
China and South Korea-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[9] 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 ten straight years of growth beginning in fiscal 1995 (Figure 2-1-4).

[9] 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.

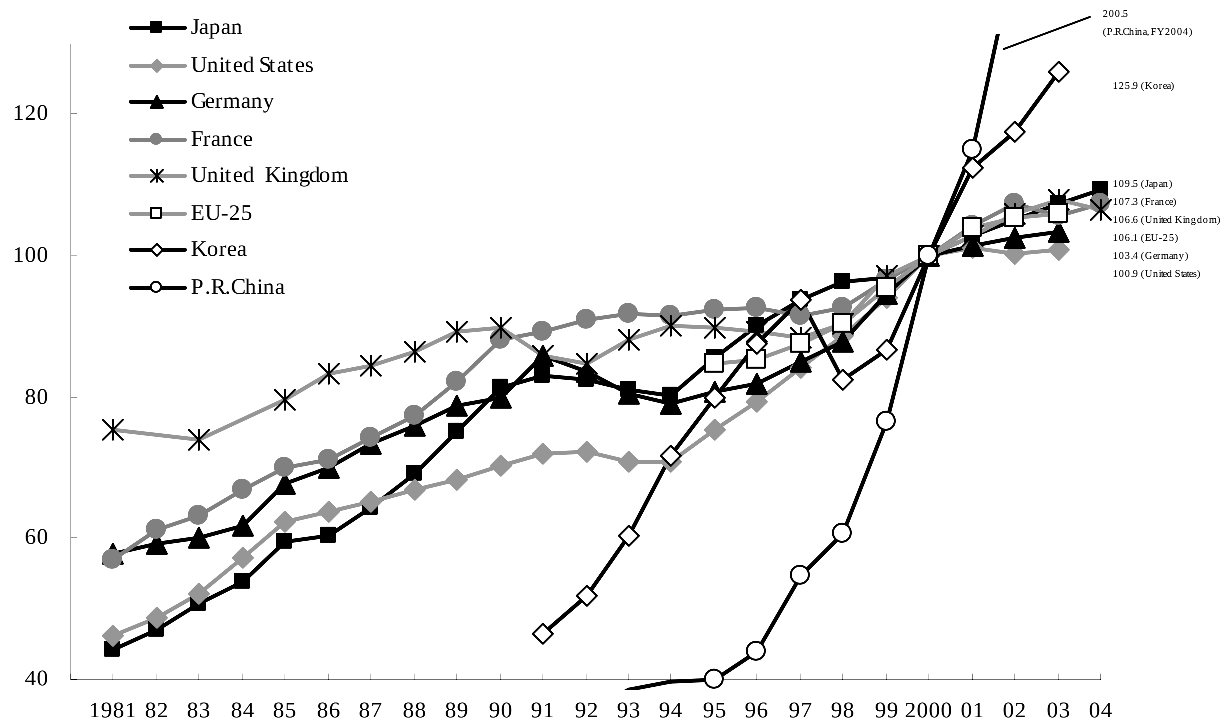


Figure 2-1-4 Growth of R&D expenditures (in real terms) in selected countries, with FY1995 as 100

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 for 2002 is provisional.
4. France figure for 2004 is provisional.
5. EU figures are Eurostat estimates.

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

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 3.35% of GDP in fiscal 2003 (3.13%, using the FTE) (Figure 2-1-5).

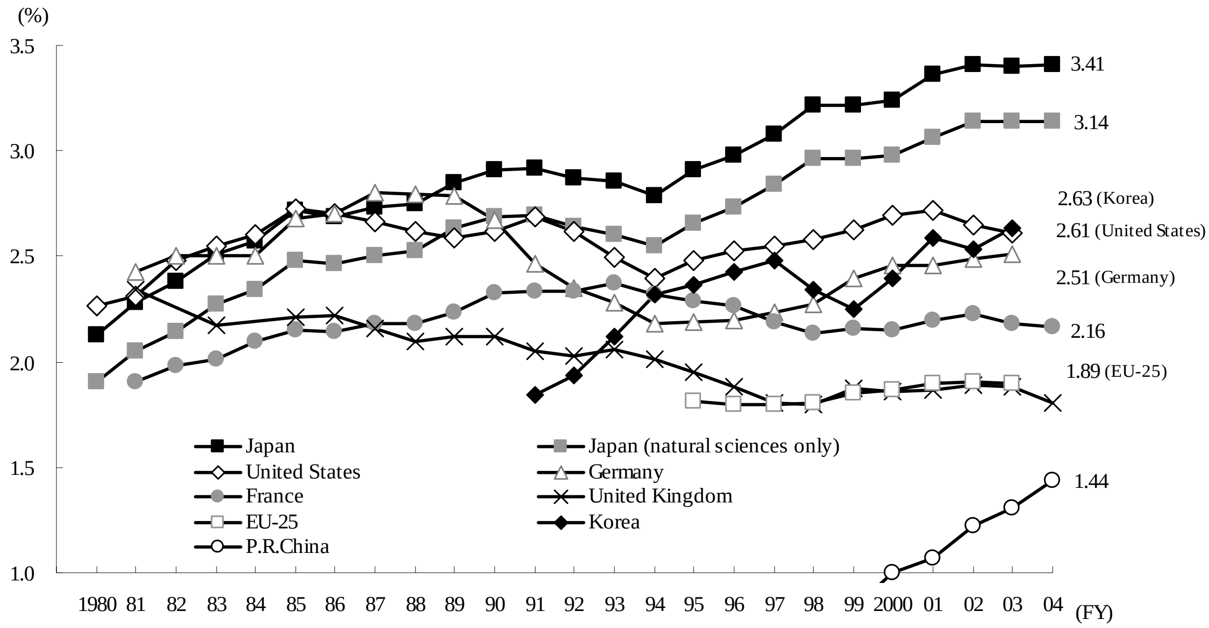


Figure 2-1-5 R&D expenditures as a percentage of GDP in selected countries

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.
3. U.S. figures for 2002 is provisional.
4. French figure for FY2004 is provisional.
5. EU 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[10], 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).

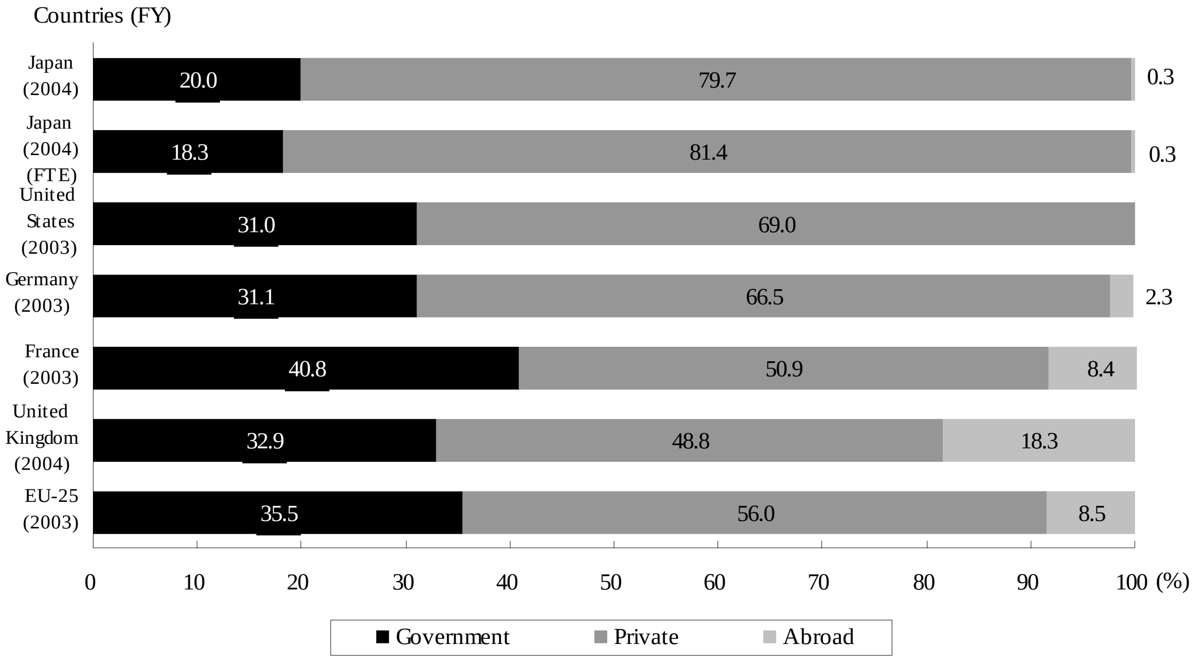


Figure 2-1-6 Share of R&D expenditures by financing sector in selected countries

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.

[10] 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.

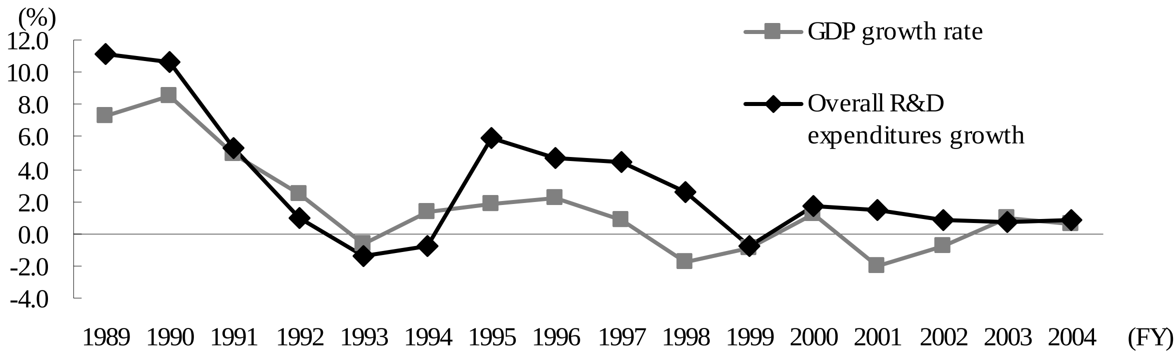


Figure 2-1-7 Trends in overall growth in R&D expenditures, and gross domestic product (GDP) growth rates

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"

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 fifth 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).

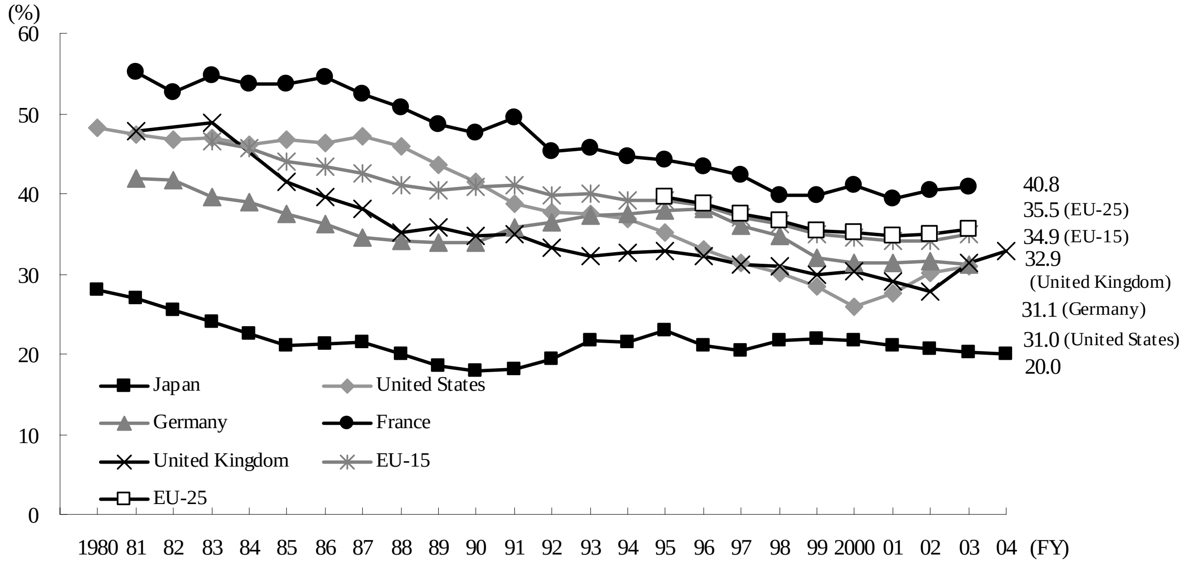


Figure 2-1-8 (1) Trends in government-financed R&D expenditures-Share of R&D expenditures financed by government

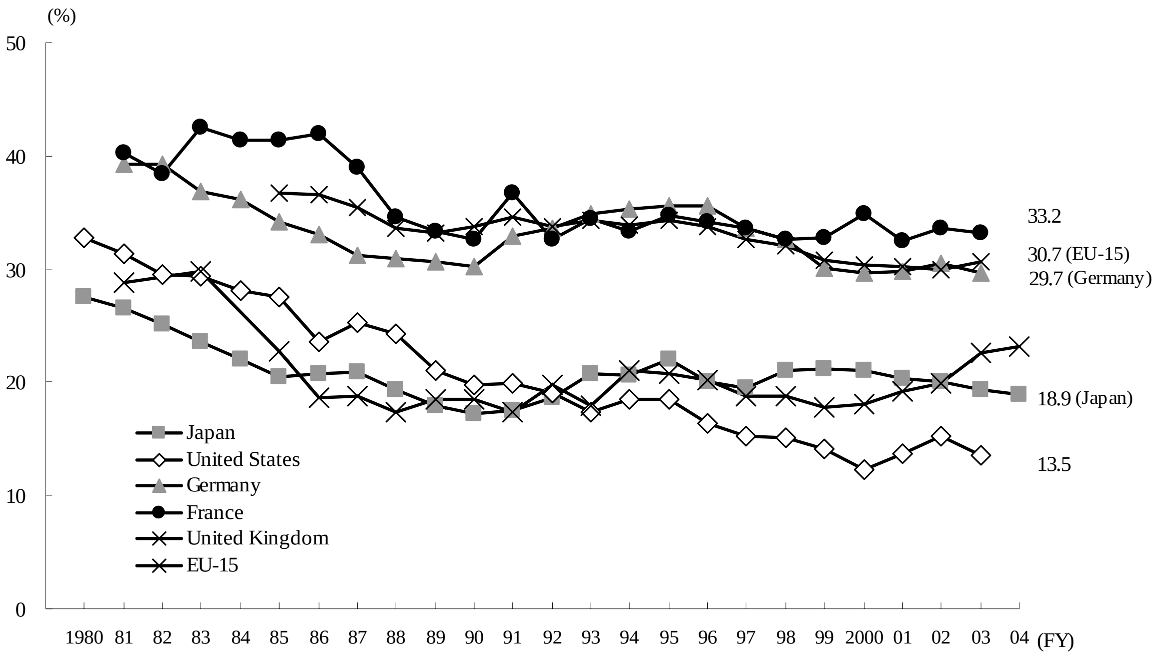


Figure2-1-8 (2) Trends in government-financed R&D expenditures -Share of R&D expenditures exclusive of defense-related R&D expenditures

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 FY2002 and later are provisional.

Source:Defense-related R&D expenditures in Japan-MEXT. "Budget for Science and Technology".
Defense-related R&D expenditures in the U.S.-The Budget of the U.S. Government
Defense-related R&D expenditures in the U.K.-"SET Statistics".
Others -Same as in Figure 2-1-3

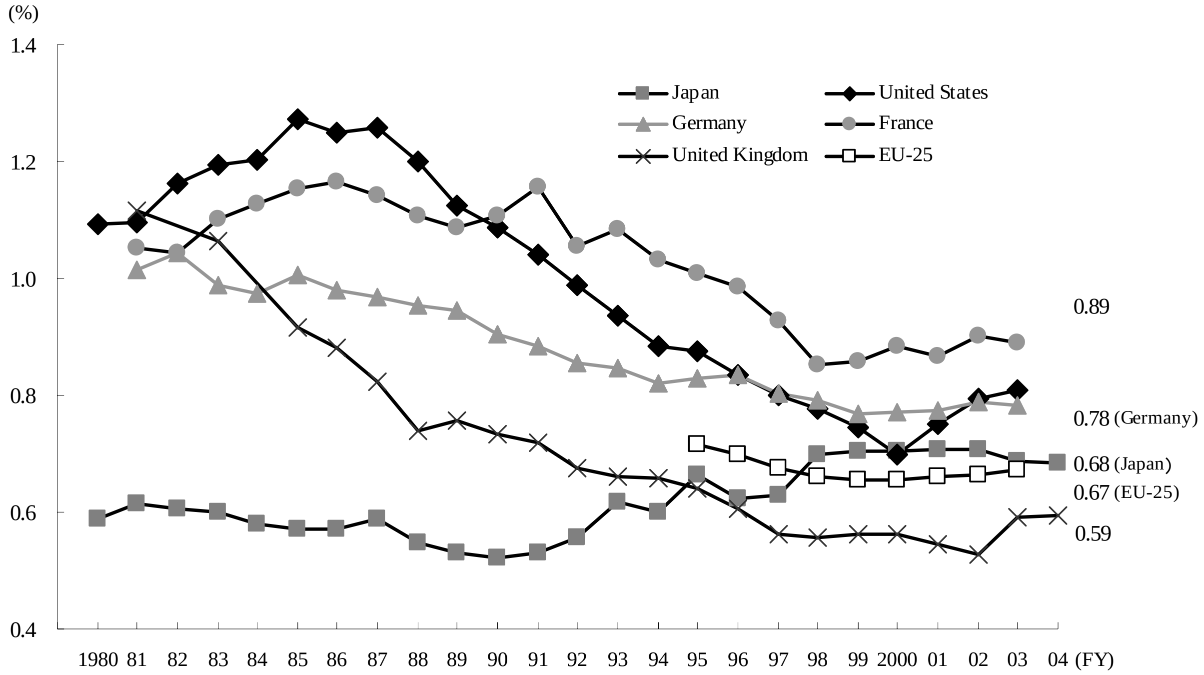


Figure 2-1-9 Trends in the proportion of government-financed R&D expenditures to gross domestic product (GDP) in selected countries

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 for 2002 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).

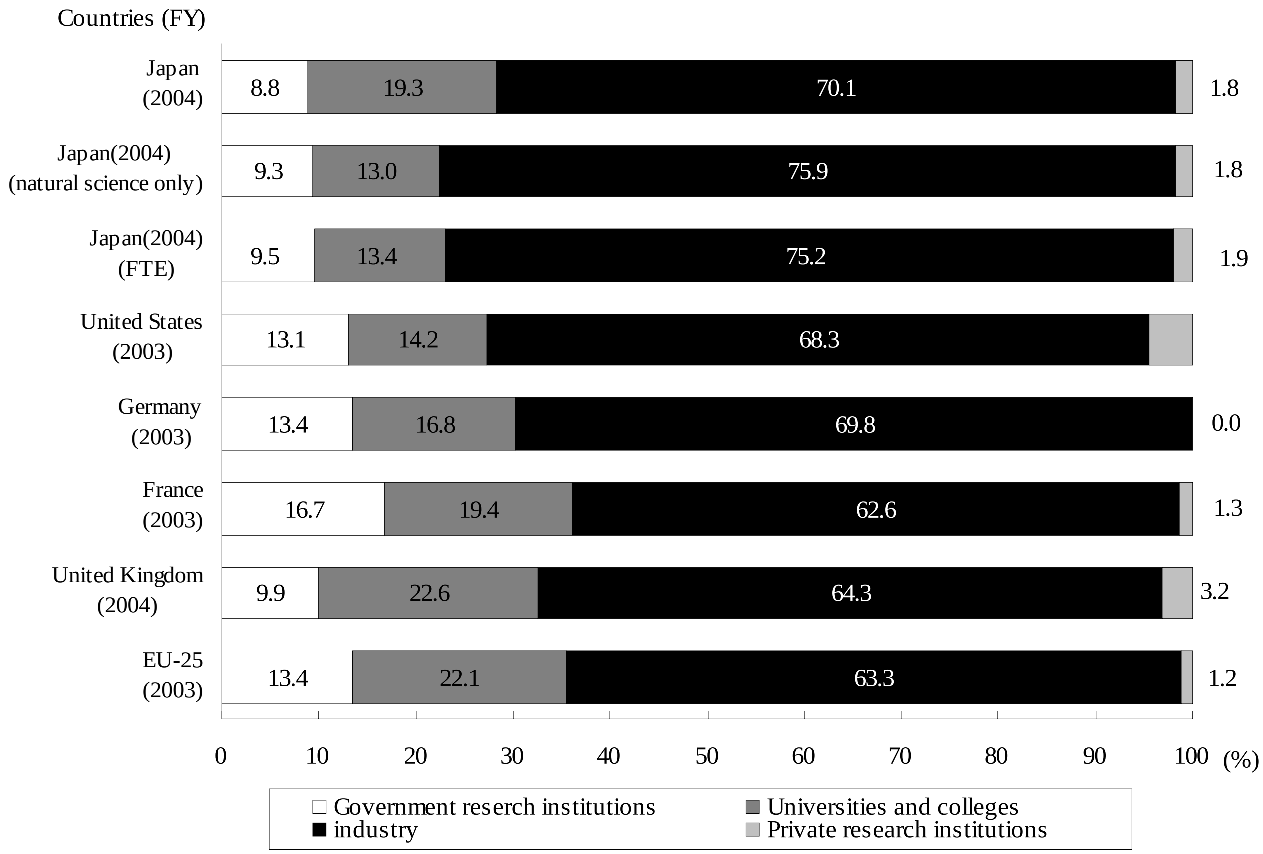


Figure 2-1-10 Share of R&D expenditures by performance sector in selected countries

Notes: 1. For comparison, statistics for all countries include research in social sciences and humanities. The figures for Japan show also the amount for natural sciences only and FTE value.
2. Figures for Japan's FTE value are prepared from the Statistics Bureau data.
3. U.S. figures are provisional. In addition, Germany's research expenditures at "private research institutions" are included in "government" research institutions.

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

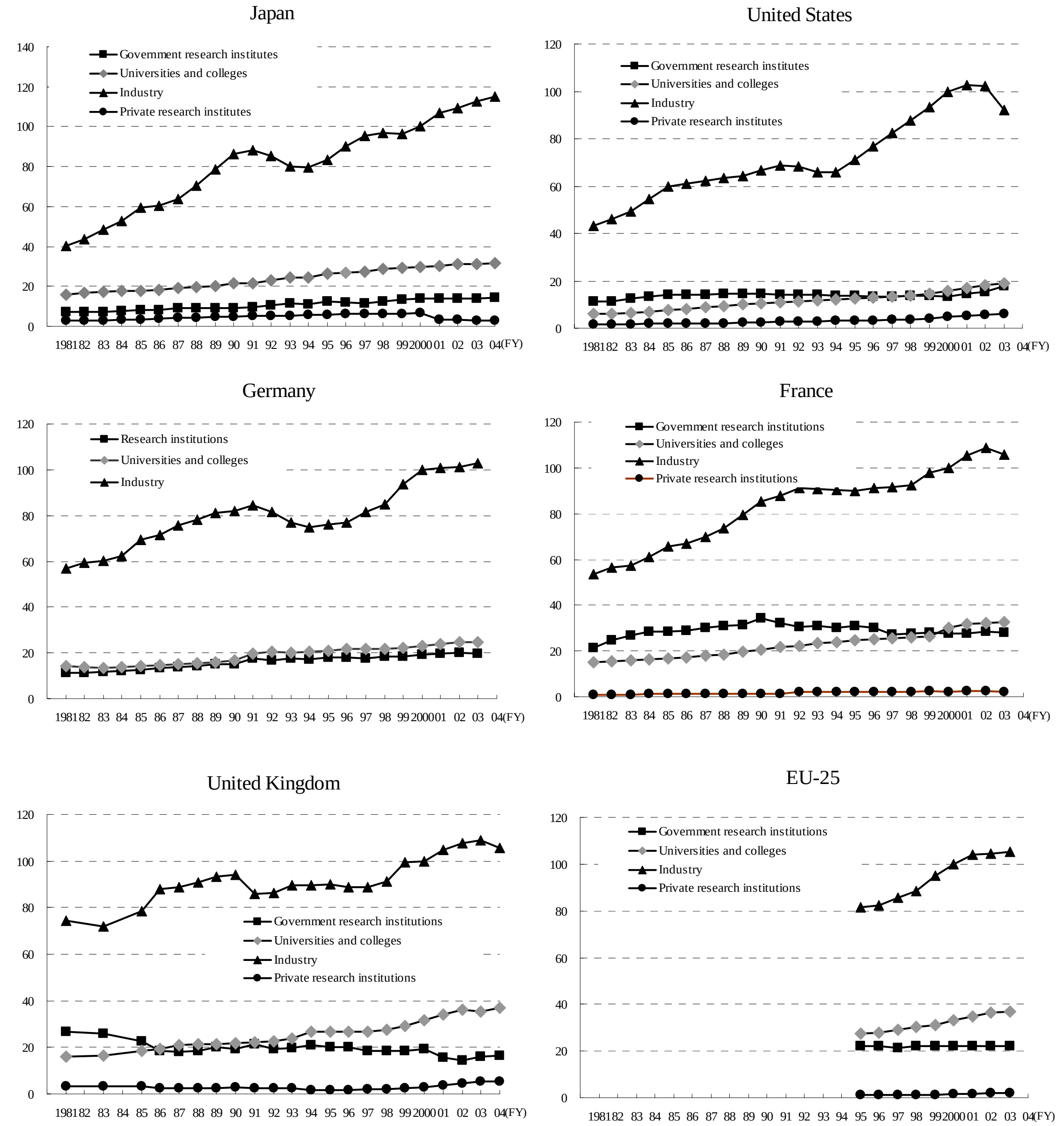


Figure 2-1-11 R&D expenditures growth (in real terms) by sector in selected countries

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 are for FY2003 is 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: France─OECD. "Main Science and Technology Indicators"
Others─Same as in Figure 2-1-3.

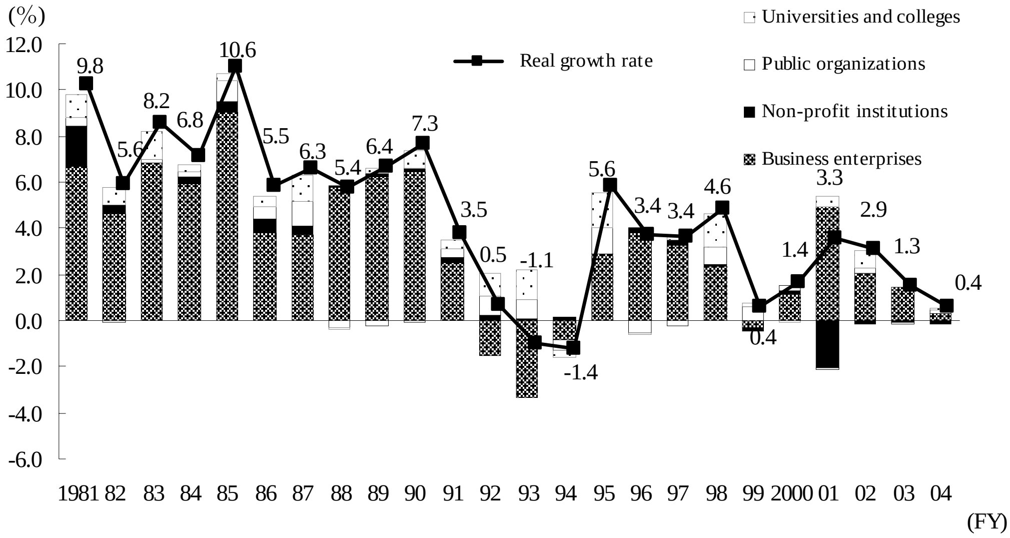


Figure 2-1-12 The contribution by organization to the year-on-year growth rate in Japan's real R&D expenditures

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

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 48% of government funding goes to universities, about 44% to government research institutions, and about 9% to the private sector. In private-sector funding, by contrast, about 98.8% goes to the private sector, with about 1.0% to universities and about 0.2% 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).

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.

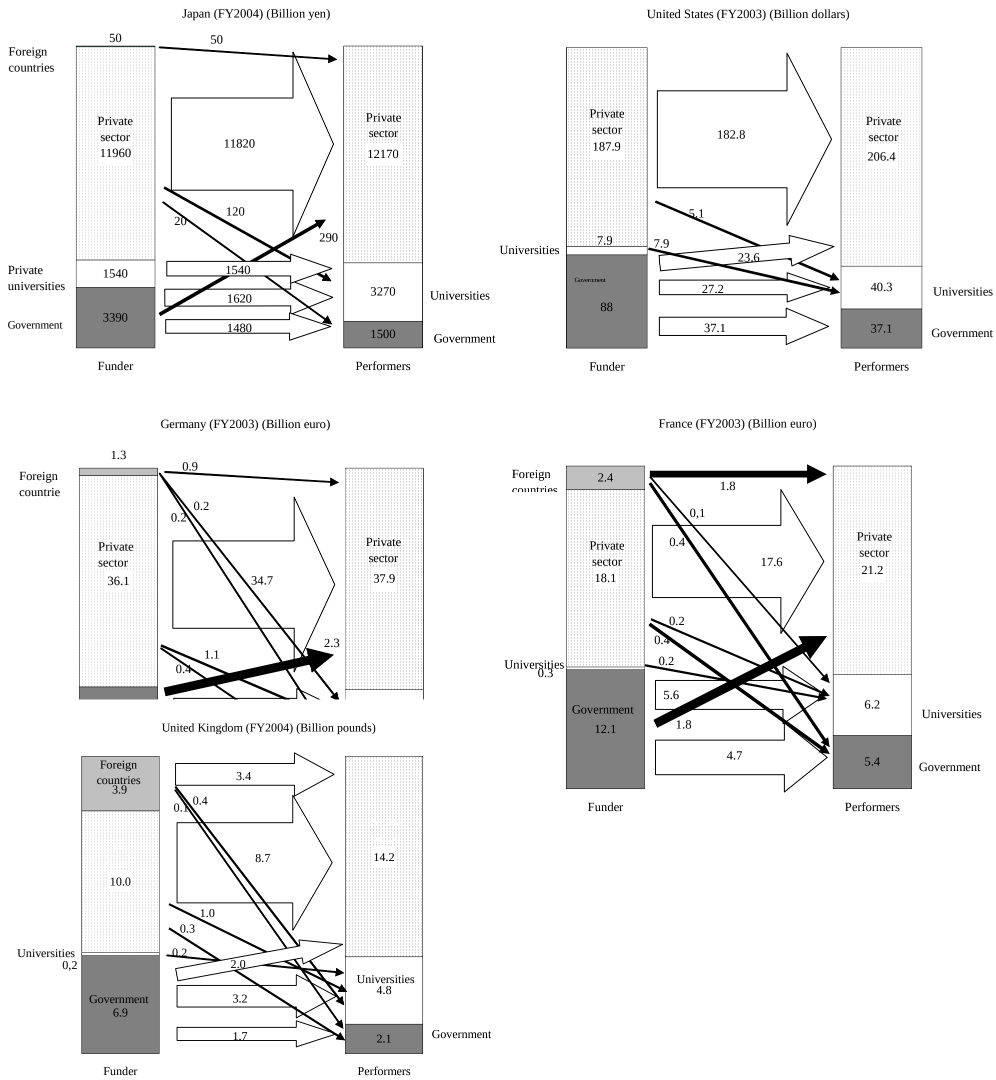


Figure 2-1-13 R&D expense flows in selected countries

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: France─OECD. "Research and Development Statistics" Other countries─Same as in Figure 2-1-3.

2.1.3 R&D Expenditures per Researcher

Because of differences in how researchers are targeted, in survey methods used, and in ex-change rates, simple comparisons between countries of R&D expenditures per researcher may not be precise. Nevertheless, a look at statistics for five major countries shows 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).

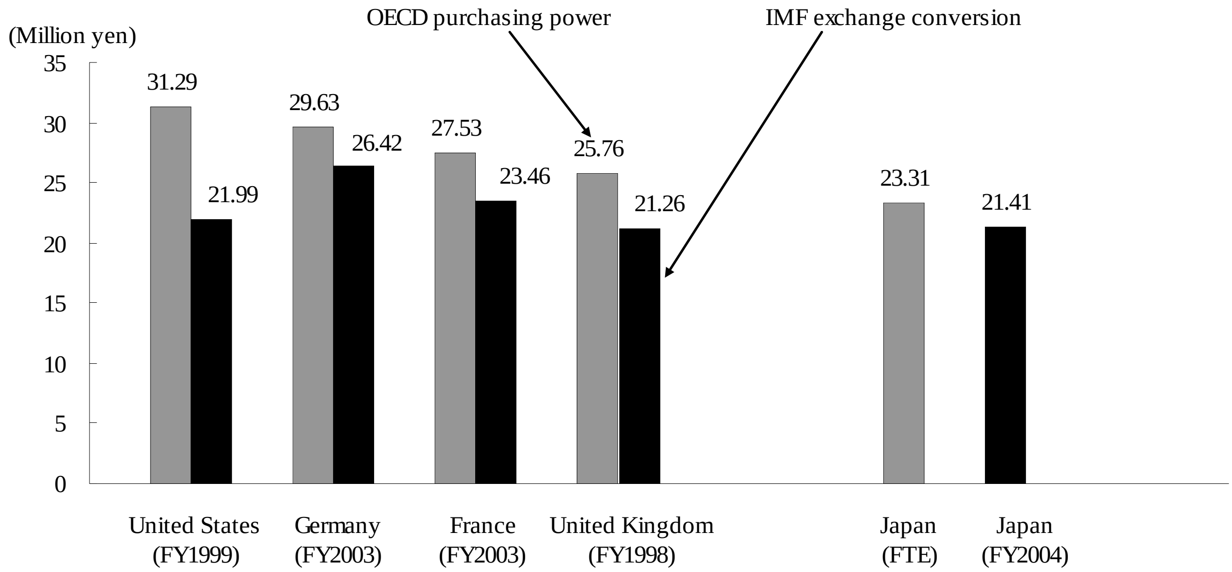


Figure 2-1-14 R&D expenditures per researcher

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.

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 2004, 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 re-searcher 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).

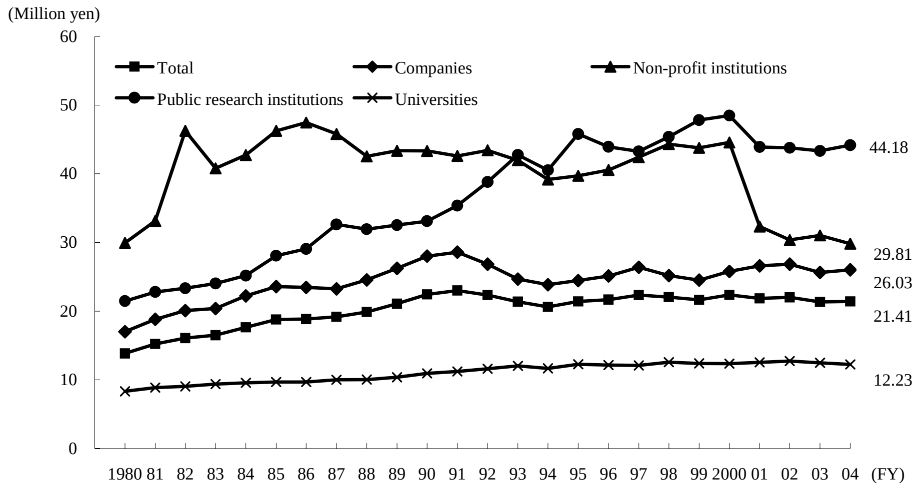


Figure 2-1-15 (1) Trends in R&D expenditures per researcher (in nominal terms)

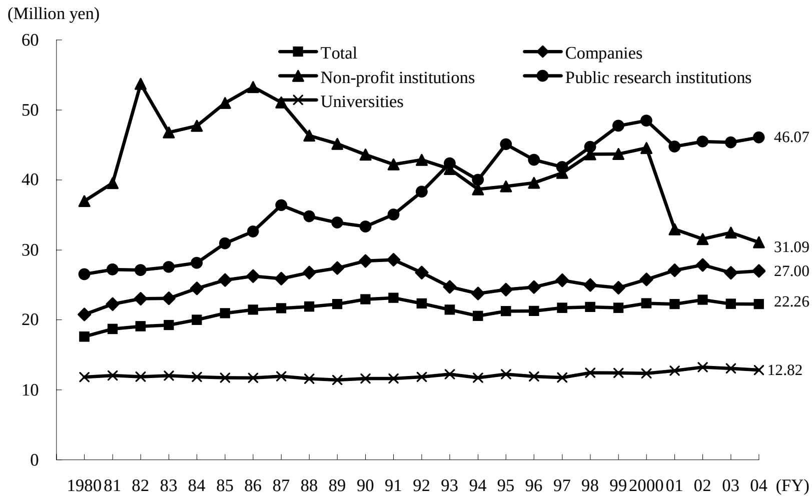


Figure 2-1-15 (2) Trends in R&D expenditures per researcher (in real terms)

Note: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

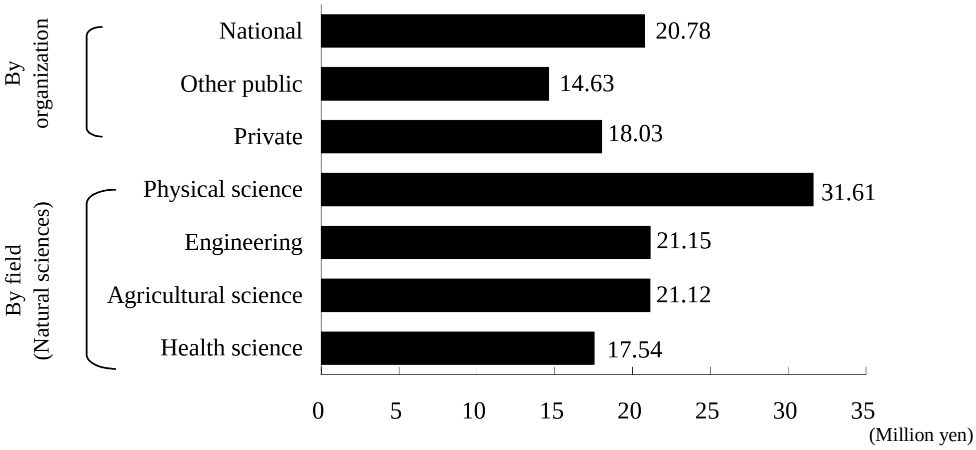


Figure 2-1-16 R&D expenditures per researcher at universities and colleges (FY2004)

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, 2005.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

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, the broadcasting industry, the transportation industry and the automobile industry (Figure 2-1-17).

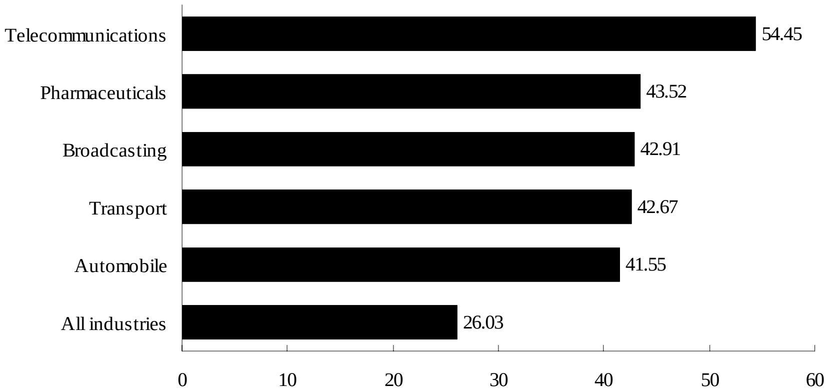


Figure 2-1-17 R&D expenditures per researcher, by industry (top five industrial categories) (FY2004)

Note: The number of researchers is as of March 31, 2005.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.1.4 R&D Expenditures by Character of Work

Classification into basic research, applied research, and development[11], may differ from country to country. Although it is difficult to make a comparison due to differences in distinctions between the three among the countries concerned, R&D expenditure data by character of work 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).

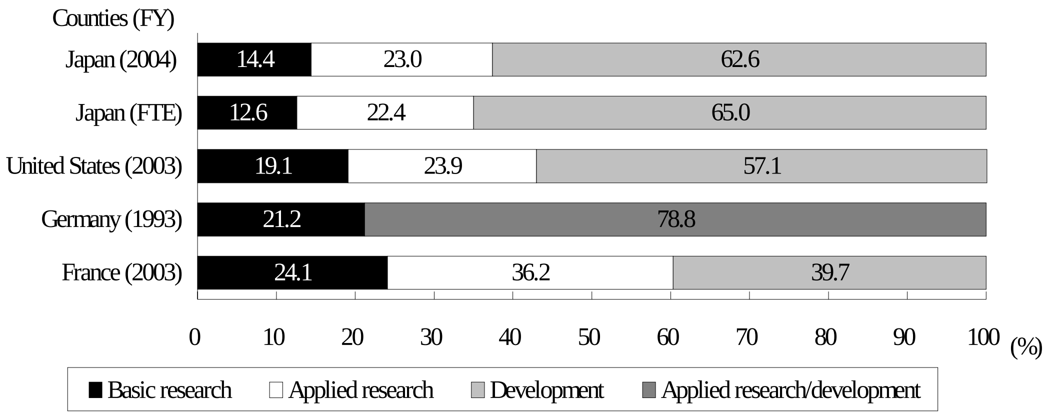


Figure 2-1-18 R&D expenditures by character of work in selected countries

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, U.S.—Same as in Figure 2-1-3.
Germany, France—OECD. " Research and Development Statistics "

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 downward in fiscal 2004. 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, development plays an extremely important role due to their corporate business functions, and this trend has become even more intensified in recent years. 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).

[11] 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 existing.

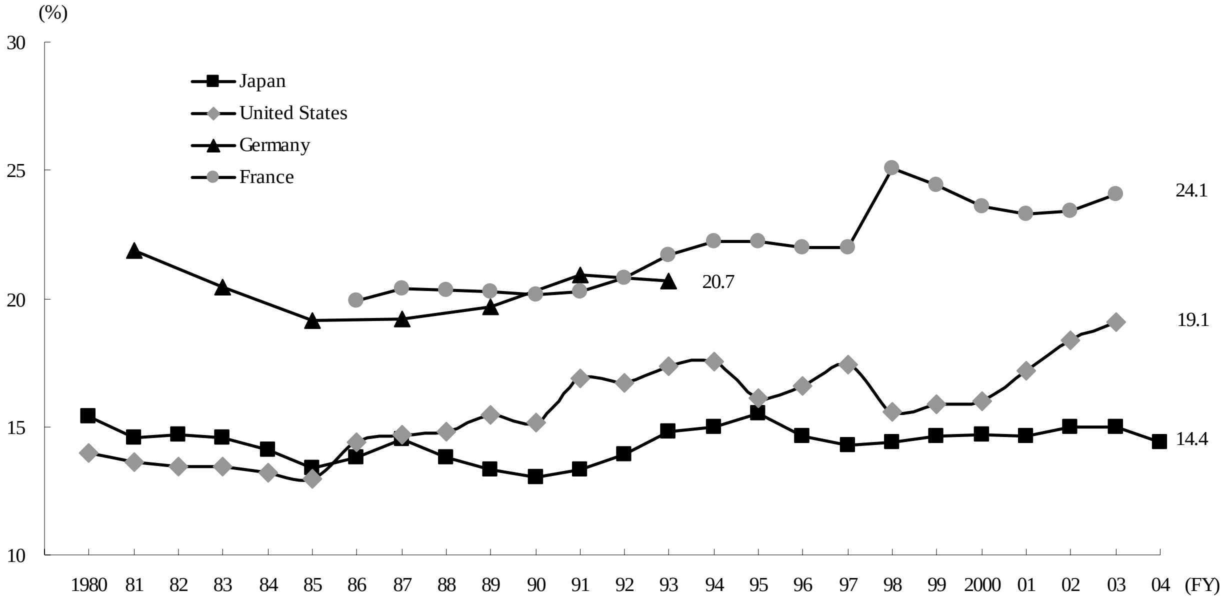


Figure 2-1-19 Trends in the proportion of basic research expenditures in selected countries

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

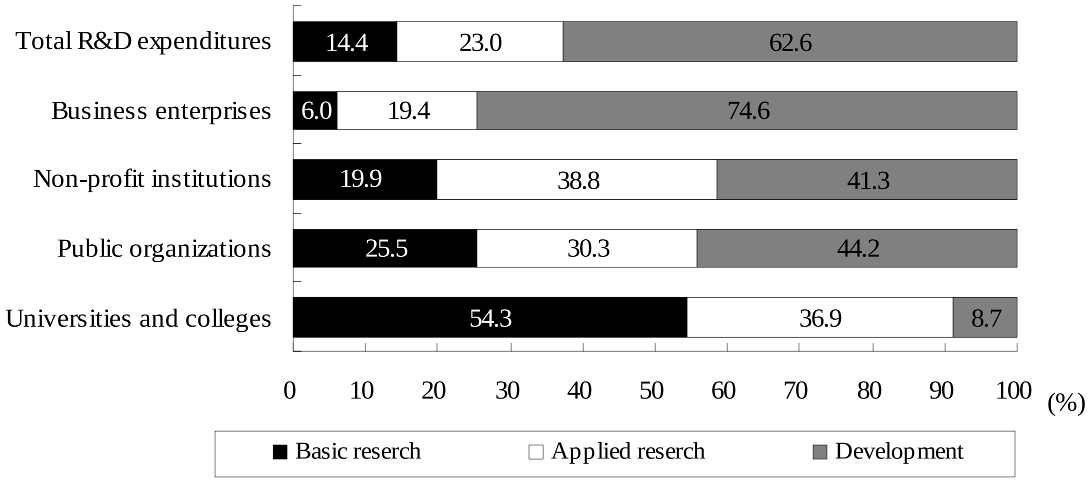


Figure 2-1-20 Composition of R&D expenditures by character of work by sector in Japan (FY2004)

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"

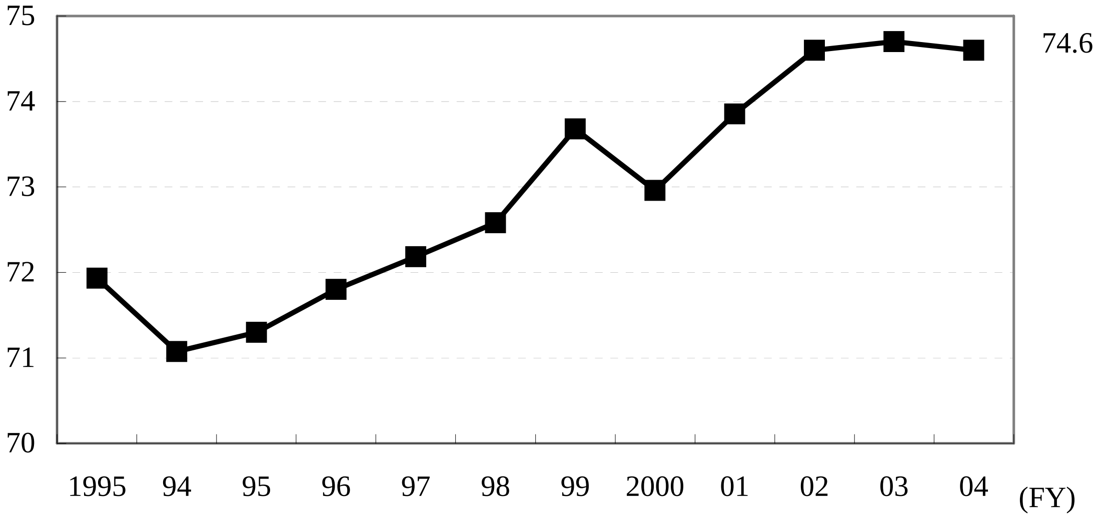


Figure 2-1-21 Trend in the share of development expenditures out of total research expenditures of companies

Note: The share of research expenditures in only for the natural sciences.
Source: Statictics 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).

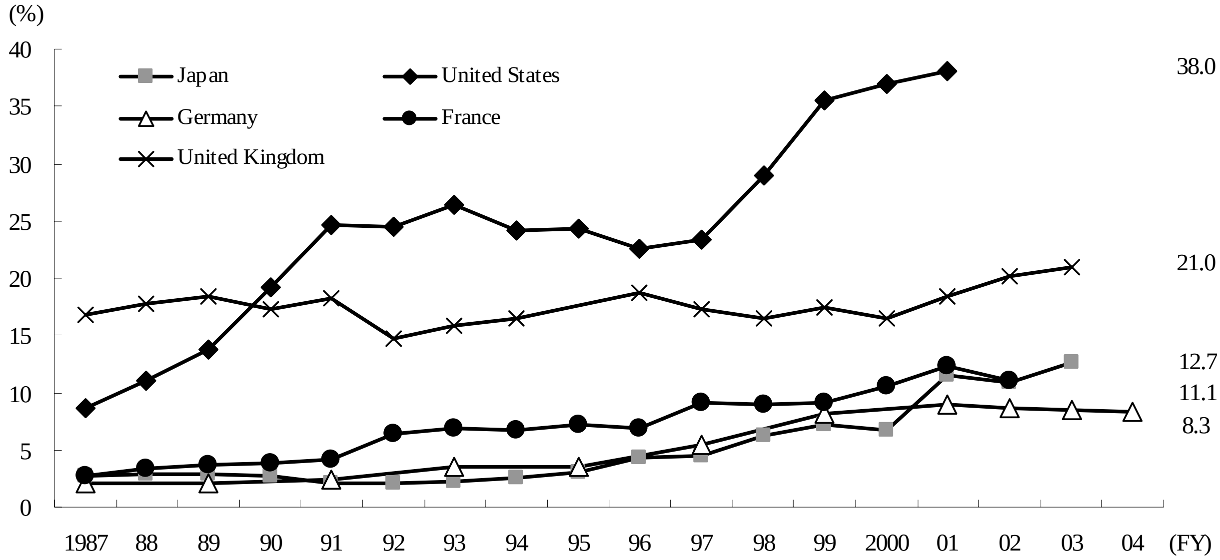


Figure 2-1-22 Share of services industry in total R&D expenditures

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"

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 information and telecommunications machinery and equipment industry, the automobile industry, and the electrical machinery and apparatuses industry accounted for 48.0% of the total in Japan; in the United States, the chemical industry, the precision instrument, and the automobile industry accounted for 49.6%; in Germany, the automobile industry, other machinery industries, and the electronics industry, accounted for 55.4%; 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).

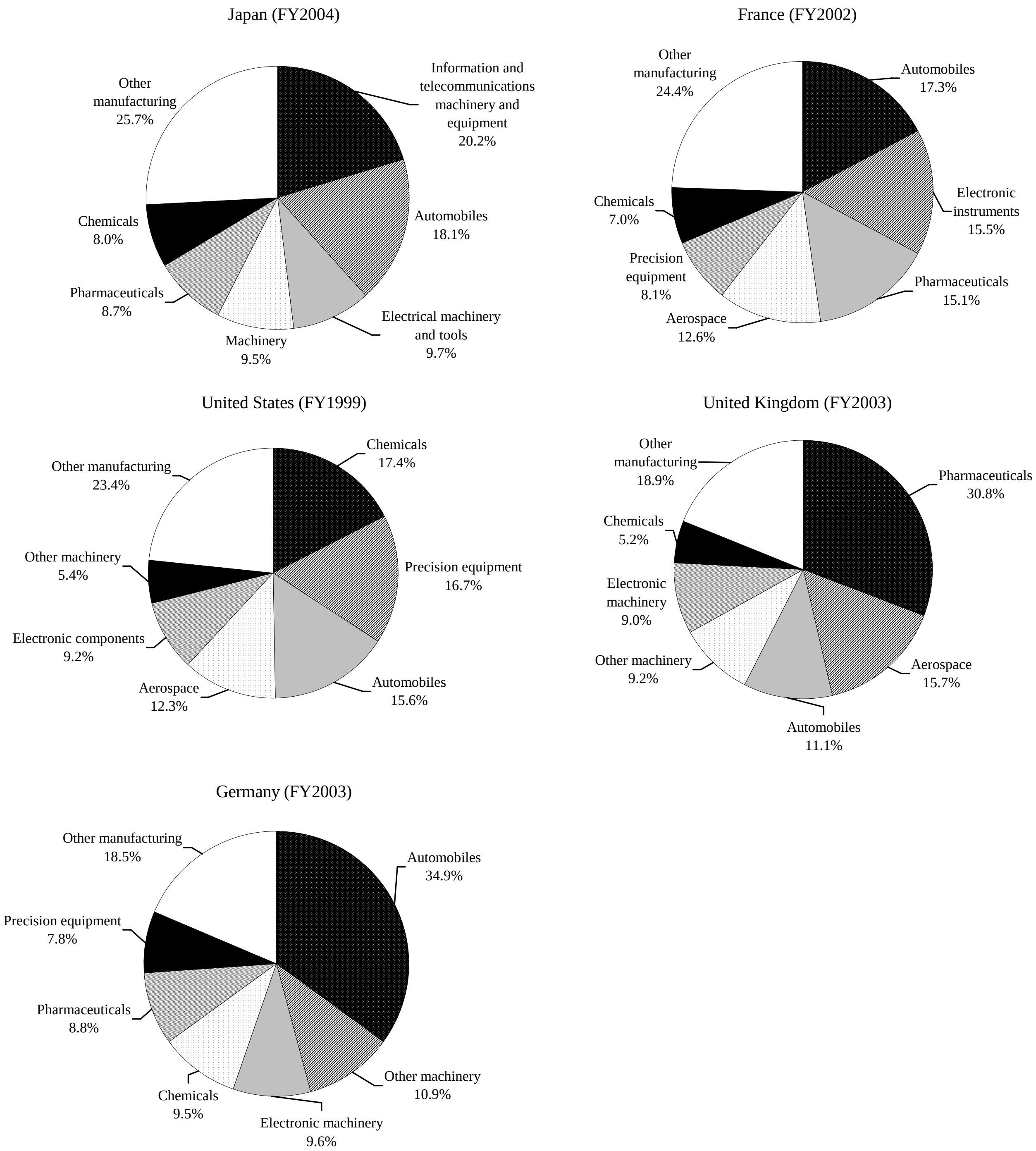


Figure 2-1-23 Manufacturing industry research expenditures in selected countries, by Industry

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[12] on the basis of the Survey of Research and Development (2005) conducted by the Ministry of Internal Affairs and Communications.

2.1.6.1 Business Enterprises[13]

According to the survey, the business enterprises that engaged in research in fiscal 2004 numbered 24,000 companies, with the manufacturing industry accounting for the vast majority of these, at almost 72.0% 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 2004 rose by 0.9% from the previous fiscal year to 11.8673 trillion yen, accounting for about 70.1% 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 1.3% 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 71.4% of the total, a result that showed R&D expenditures were concentrated in larger corporations. Furthermore, growth rates since fiscal 2003 show that companies with a capitalization of 100 million yen and less have experienced declines while companies with a capitalization of more than 100 million yen have witnessed year-on-year increases (Table 2-1-24).

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

Capitalization	R&D expenditures (Million yen)	Growth rate over the previous year (%)	Component ratio (%)
10 million to 100 million yen	502,224	-23.8	4.2
100 million to 1 billion yen	783,865	0.9	6.6
1 billion to 10 billion yen	2,101,466	3.6	17.7
10 billion yen or more	8,460,304	2.7	71.4
Total	11,847,859	1.2	100.0

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

2.1.6.2 Non-profit Institutions[14]

In fiscal 2004, the government and the private sec-tor were sources for nearly equal shares of funding for non-profit institutions. The total R&D expenditures at non-profit institutions were 298.8 billion yen, accounting for about 1.8% of Japan's total R&D expenditures (Figure 2-1-25).

[12] 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.
[13] 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.
[14] Non-profit institutions: Corporations, groups, etc. such as incorporated foundations or incorporated bodies that carry out research and do not seek private profit.

2.1.6.3 Public Organizations[15]

The government was the source for nearly all R&D expenditures at public organizations in fiscal 2004, with private-sector funding accounting for only about 1.0%.

Total R&D expenditures at government research institutions increased by 2.6% over the previous fiscal year to 1.4975 trillion yen, representing 8.8% of Japan's total R&D expenditures. When looking at expenditures by type of institution, national government-owned institutions, publicly-owned research institutions, and public corporations and incorporated administrative agencies witnessed yearon-year declines (Figure 2-1-25).

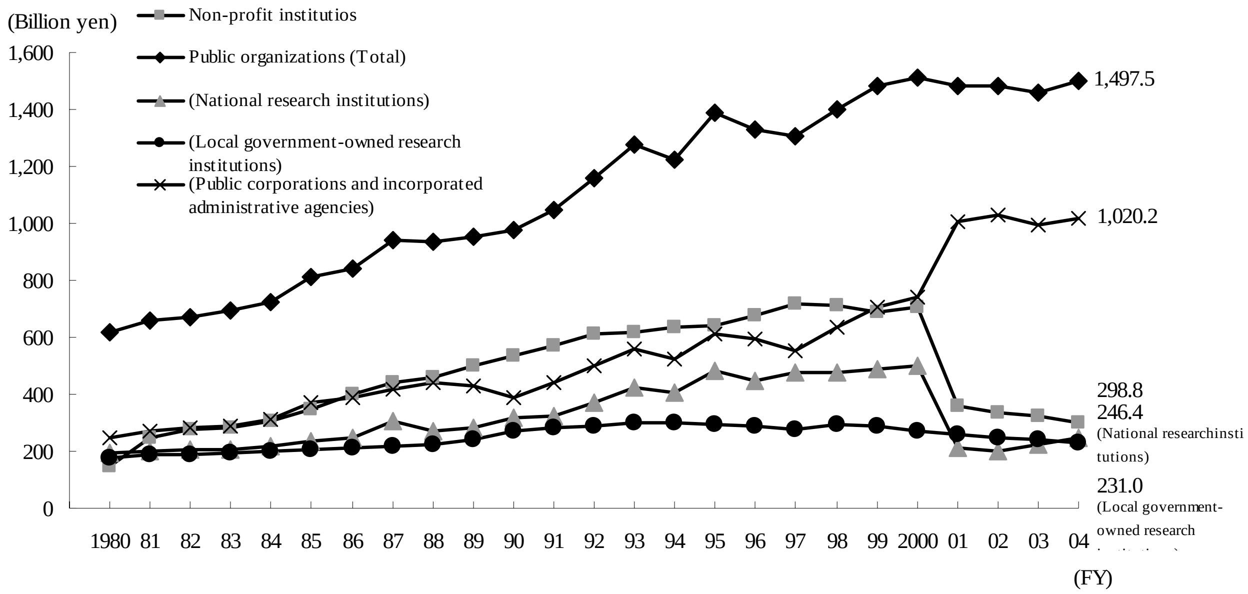


Figure 2-1-25 Trends in R&D expenditures for non-profit institutions and public organizations

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] Public organizations: National and local government-owned research institutions and public corporations and independent administrative institutions whose primary business is research and development.

2.1.6.4 Universities and Colleges[16]

By source of funding for R&D expenditures at universities and colleges in fiscal 2004, the government accounted for about 50% of the total. The total R&D expenditures at universities and

colleges increased by 0.3% over the previous fiscal year to 3.2740 trillion yen, accounting for 19.3% of Japan's total R&D expenditures .

For trends in R&D expenditures by type of univesity, national and private universities registered year-on-year increases. Likewise, by type of field, agricultural sciences and health sciences registered year-on-year increases, but physical sciences and engineering registered decreases (Figure 2-1-26).

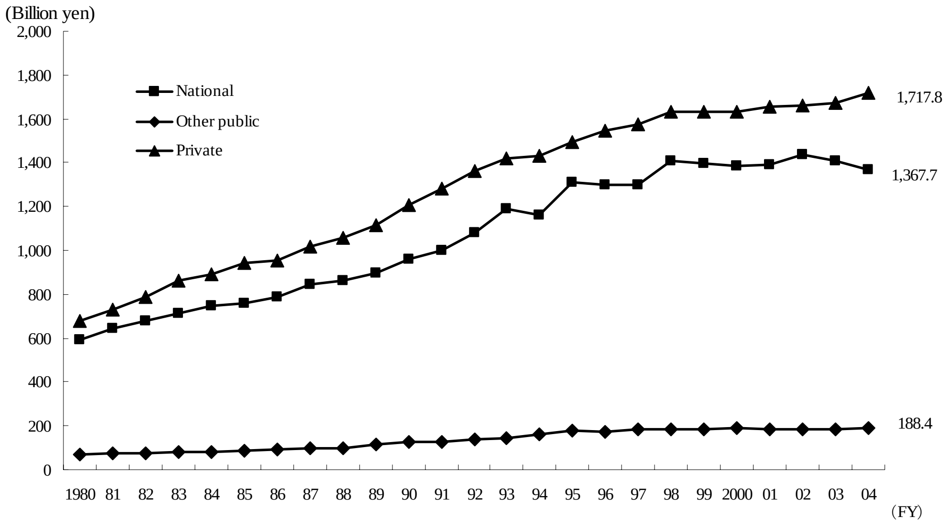


Figure 2-1-26 (1) Trends in R&D expenditures at universities and colleges, by type of university

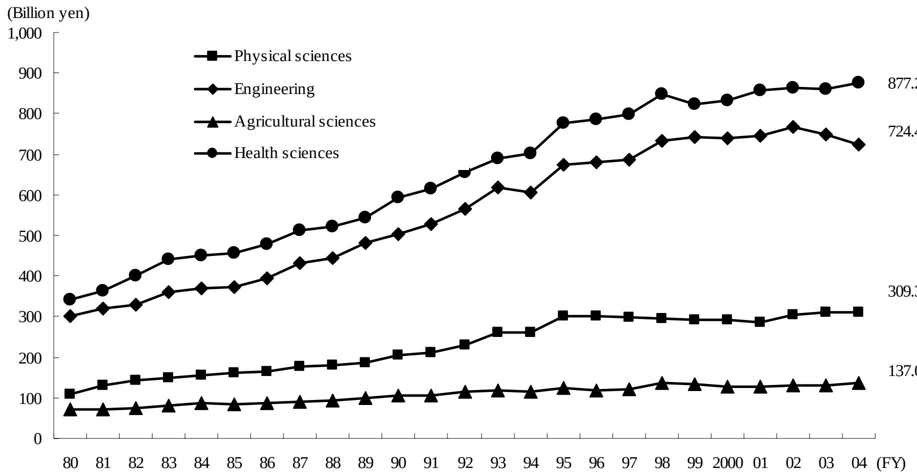


Figure 2-1-26 (2) Trends in R&D expenditures at universities and colleges, by field

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

[16] 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.

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 2004 decreased by 0.3% over the previous fiscal year to 7.6115 trillion yen. The total expenditures for materials increased by 1.1% over the previous fiscal year to 2.8169 trillion yen. The total expenditures for tangible fixed asset purchases decreased, registering a 10.1% decrease over the previous fiscal year to 1.5627 trillion yen. On the other hand, the total expenditures for lease fees decreased by 1.4% over the previous fiscal year to 178.4 billion yen. The share of other expenses required for research, such as books and journals, utilities, travel, and telecommunications, etc., increased by 6.7% over the previous fiscal year to 4.7681 trillion yen (Figure 2-1-27).

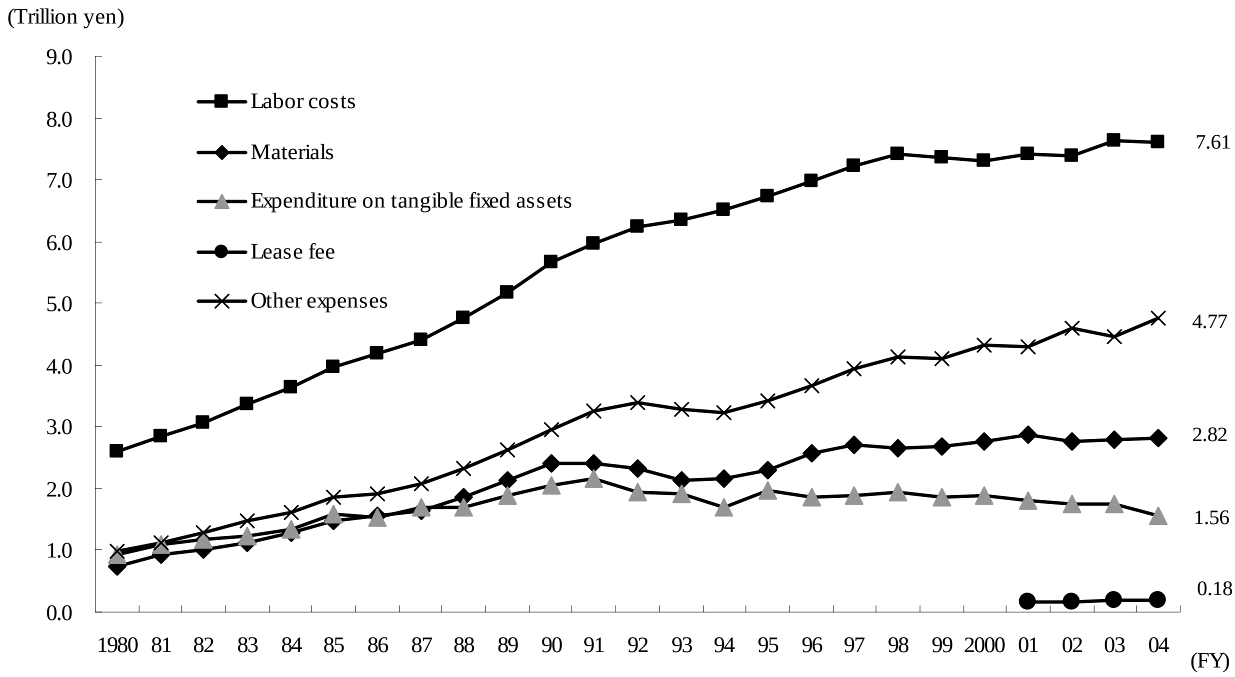


Figure 2-1-27 Trends in R&D expenditures by type

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"

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 2004, company R&D expenditures were characterized by decreases in labor costs, tangible fixed assets and lease fees, and rises in material costs and other expenditures (Figure 2-1-29).

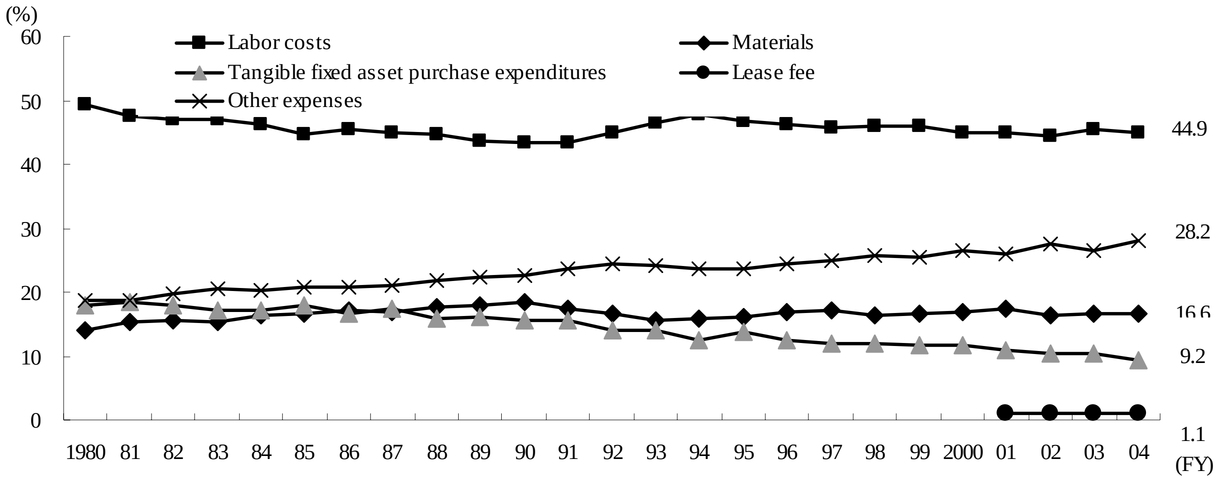


Figure 2-1-28 Trends in R&D expenditures by constituent elements

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"

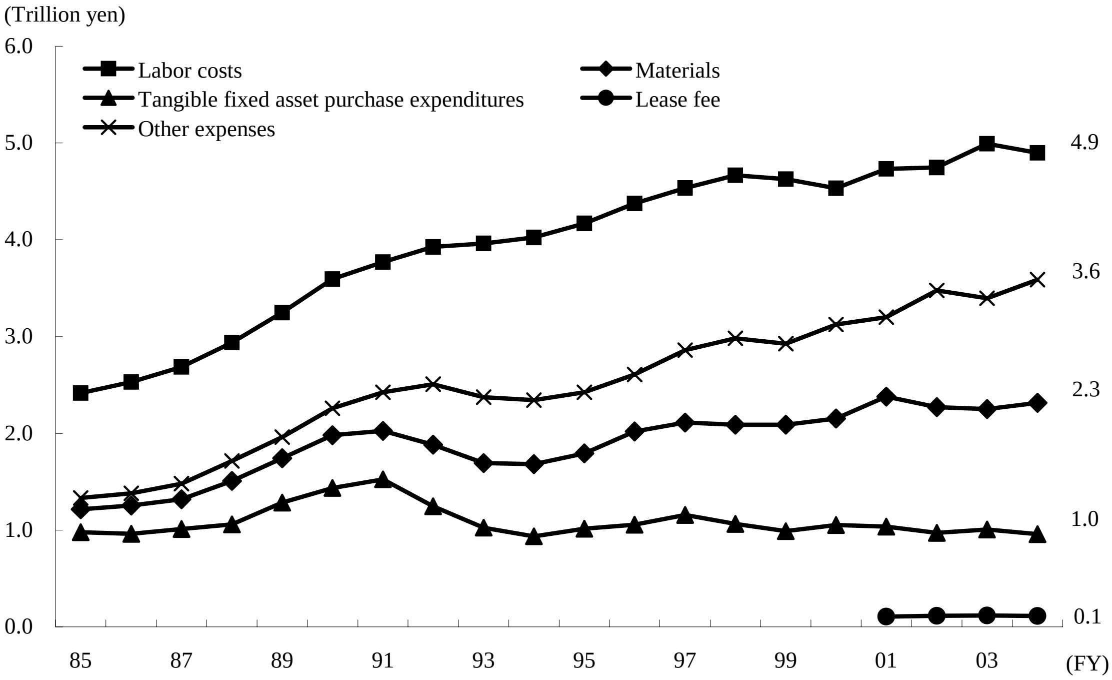


Figure 2-1-29 Trends in R&D expenditures at business enterprises, by type

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"

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 chara- cterized 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 65.9% 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 as-sets (Figure 2-1-31).

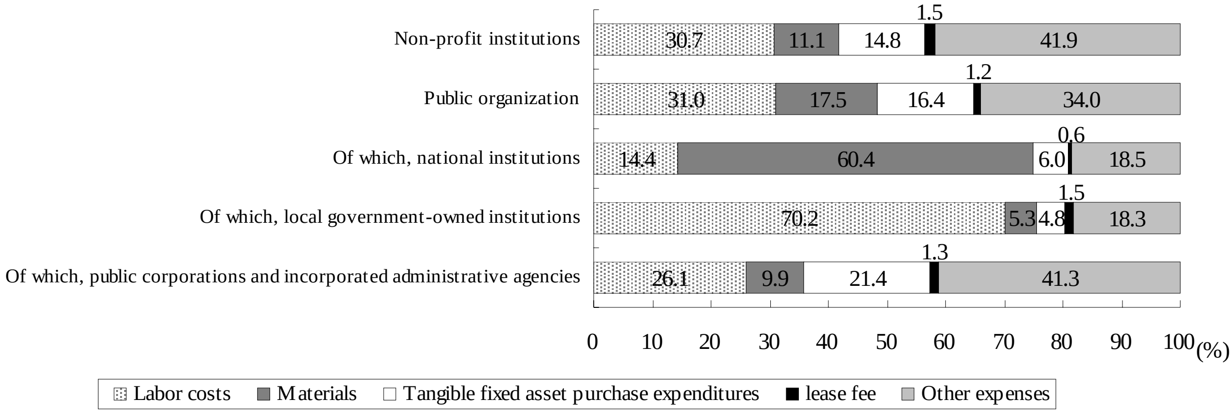


Figure 2-1-30 Composition of research expenditures at non-profit institutions and public organizations by type (FY2004)

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

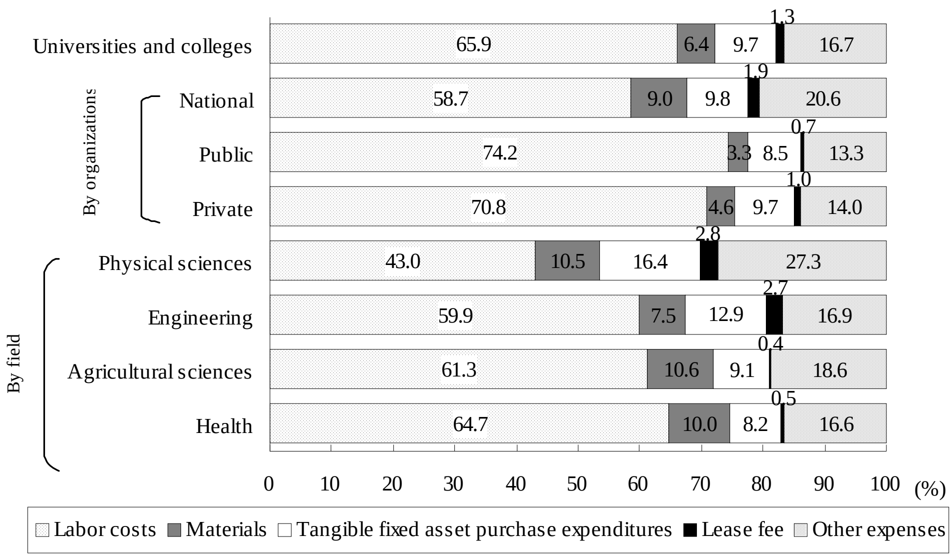


Figure 2-1-31 Composition of R&D expenditures at universities and colleges, by type (FY2004)

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"

2.2 Research Personnel

Statistics on research personnel, along with those on R&D expenditures, are another effective indicator of the extent of research activities. Personnel engaged in R&D[17] can be classified as researchers and support personnel (assistant research workers, technicians, and clerical and other supporting personnel).

2.2.1 Researchers

2.2.1.1 Number of Researchers

Countries use different methods for determining the number of researchers. The Frascati Manual defines researchers as “professionals engaged in the conception or creation of new knowledge, product processes, methods, and systems, and in the management of the projects concerned.” But this definition is quite vague, and countries that follow the Frascati Manual also specify their own definitions of the term “researcher” for counting researchers.

For this reason, there are differences between countries in methods for measuring the number of researchers, and international comparisons are difficult. In comparison between Japan and the United States, the number of researchers counted in the Report on the Survey of Research & Development conducted by the Statistics Bureau of Japan’s Ministry of Internal Affairs and Communications is not exactly equivalent to the researchers counted in the U.S. National Science Foundation’s National Patte- rns of R&D Resources. Differences of methods for determining the numbers of researchers are shown in Table 2-2-1, and would appear to be obstructing a fair statistical comparison.

The category of researcher at universities and colleges, in Japan, consisting of teachers, doctoral students, medical staff, etc., differs between Japan and the United States in the following ways.

(1) Teaching Staff

In 1999, a year in which it is possible to compare teachers in Japan and the United States, 169,070 teachers at universities and colleges in Japan, including those in the humanities and social sciences, were classified as researchers. On the other hand, according to Table 8 in the “National Patterns of R&D Resources: 2002 Data Update,” in the United States, only 118,000 college and university teaching personnel who responded that they had obtained a doctoral degree and were primarily engaged in research were classified as researchers—a smaller result than in Japan.

It would appear, then, that the number of teaching personnel in the United States who are involved in research is much larger than in Japan when the same kind of statistics are used. On the other hand, if the same statistical method used in the United States were applied to Japan, the number of Japanese researchers would be smaller.

[17] Research personnel: “Report on the Survey of Research and Development” compiled by the Statistics Bureau classifies personnel engaged in R&D as follows. (2002 revision)

Researcher: Persons who hold a university degree (or persons who have equivalent or greater knowledge in their specialty), who are engaged in research activities in their own chosen subject. “Researchers” as used herein, refers only to full-time researchers, and excludes those who also perform other duties in addition to research.

Assistant research workers: Persons who assist researchers and who are engaged in research activities under their direction and who have the possibility of becoming researchers in the future.

Technicians: Persons, other than researchers and assistant research workers, who are engaged in technical services related to research activities under the guidance and supervision of researchers and assistant research workers.Clerical and other supporting personnel: Excepting those mentioned above, persons who are engaged in miscellaneous activities, clerical work, accounting, etc., relating to research activities. Japanese statistics on persons engaged in R&D are as of April 1 of the appropriate year up to 2001, and as of March 31 for 2002.

Table 2-2-1 Comparison of Japanese and U.S. definitions of researchers

Country	Japan	United States
Companies, etc.	• Have university graduate (or higher) qualifications • Have a research theme in which conducting research	• University graduate level, or have equivalent or higher level of expert knowledge • Engaged in research themes
	• Researchers calculated by FTE	• Researchers calculated by FTE
NPO	• Have university graduate (or higher) qualifications • Have a research theme in which conducting research	• People who have Ph.D.s, and who state that they are mainly engaged in research and development
	• Researchers calculated by FTE	• Actual number of researchers (head count)
Public institutions	• Have university graduate (or higher) qualifications • Have a research theme in which conducting research	• People who have Ph.D.s, and who state that they are mainly engaged in research and development (excluding military-related personnel)
	• Researchers calculated by FTE	• Actual number of researchers (head count)
Universities and colleges	•Teachers, enrolled doctoral students, medical staff, or •Those who have university graduate (or higher) qualifications ・Engaged in research themes (including teaching staff)	• People who have Ph.D.s, and who state that they are mainly engaged in research and development, and university graduates engaged in research assistance
	• Actual number of researchers (head count) (FTE values are also reported to the OECD)	• Actual number of researchers (head count), excluding graduate students • Graduate students are FTE converted with a 50% coefficient

Source: Japan-Ministry of Internal Affairs and Communications, Statistics Bureau (Statistics Bureau). "Report on the Survey of Research and Development"
United States-National Science Foundation. "National Patterns of R&D Resources: 2002 Data Update"

(2) Number of Graduate School Students

A comparison for 1999 reveals that 59,057 people who were studying in doctoral courses, including the humanities and social sciences, in Japan were classified as researchers. This figure is virtually identical to the 1999 figure of 59,007 graduate school students in doctoral courses counted in the Ministry of Education, Culture, Sports, Science and Technology's "Handbook of Education, Culture, Sports, Science and Technology Statistics (2003 edition)."

In the United States, however, the number of graduate school students receiving remuneration for research assistance work is 91,300 people (NSF, "Science and Engineering Indicators 2004, Appendix Table 5-28"), which is reduced by the FTE (Full-Time Equivalent) rate coefficient of 50% to arrive at a total of about 45,700 researchers. In the United States, therefore, while the count extends beyond doctoral courses to include people in Master's course programs as well, it is limited to students who are engaged in research assistance work, and is further reduced by a predetermined coefficient. Thus, it is highly probable that the estimate for number of researchers would yield a lower result than Japan's method of including all students engaged in doctoral course programs. According to Table 8 in the "National Patterns of R&D Resources: 2002 Data Update," 68,026 graduate school students are regarded as students who are engaged in research assistance work.

Therefore, when making comparisons between Japan and the United States, it is important to remember that the measurement of researcher numbers in Japan is overestimated, primarily at the universities. In 2002, the Ministry of Education, Culture, Sports, Science and Technology conducted a "Survey of Full-time Equivalency Data at Universities and Colleges," the results of which will be used in the future to estimate the number of researchers.

As a result, while there may be differences in the methods of measuring researcher numbers, it is useful, however, to look at general trends for each country from its own methods. The United States had the largest number of researchers (1999: 1,261,000), followed by Japan, at 791,000 (2005), at 677,000 using FTE (2004), and Germany (2003: 269,000) (Figure 2-2-2).

The total number of researchers in Japan increased by 0.13% in 2003 over the previous year (decrease of 4.34% using FTE), by 3.95% in 2004 over the previous year (increase of 4.45% using FTE), and was followed by a year-on-year increase of 0.47% in 2005 (increase of 0.28% using FTE). However, the 1997 survey included expantion of surveyed industries, and in 2002 included expansion of surveyed industries, a changed survey date, and an altered definition of researchers, etc. The annual average rates of increase since 1985 (using FTE) were 4.60% from 1985-1990, 3.33% from 1990-1995, 2.22% from 1995-2000 and 0.75% from 2000-2005.

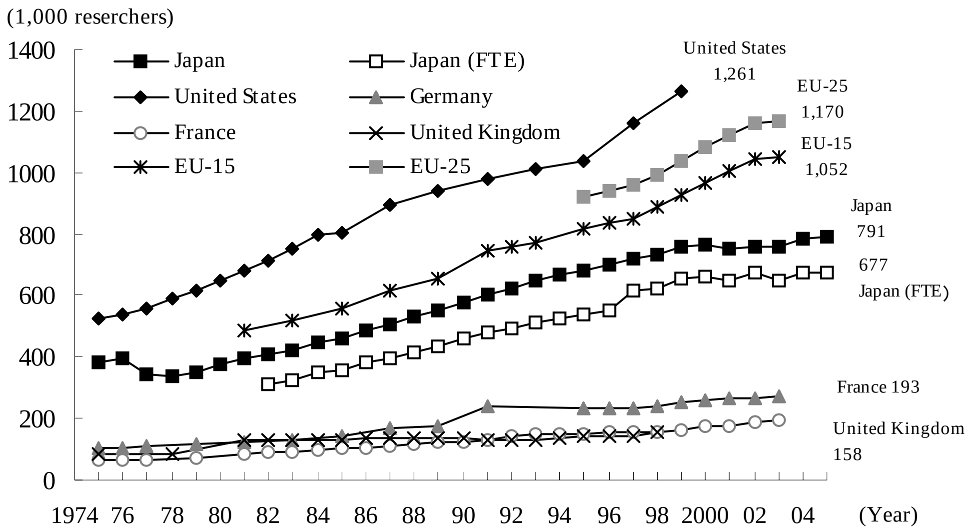


Figure 2-2-2 Trends in the number of researchers in selected countries

Notes: 1. The figures for all countries include social sciences and humanities.
2. Figures for Japan's number of researchers up to 2001 are as of April 1, after 2002 are as of Mach 31
3. Japan's FTE values up to 1996 are OECD estimates.
4. In Japan, the software industry has been covered in the survey since FY1997 and the wholesale industry since FY2002.
5. U.K. figures through 1983 show total number of researchers in industrial (scientists and researchers) and national institutions (degree-holding researchers and above), and do not include universities and private research institutions.
6. EU -15 (15 countries: Belgium, Germany, France, Italy, Luxembourg, Nether-lands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden) figures are OECD estimates.
7. EU -25 (10 countries with EU-15: Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak, and Slovania) figures are OECD estimates.

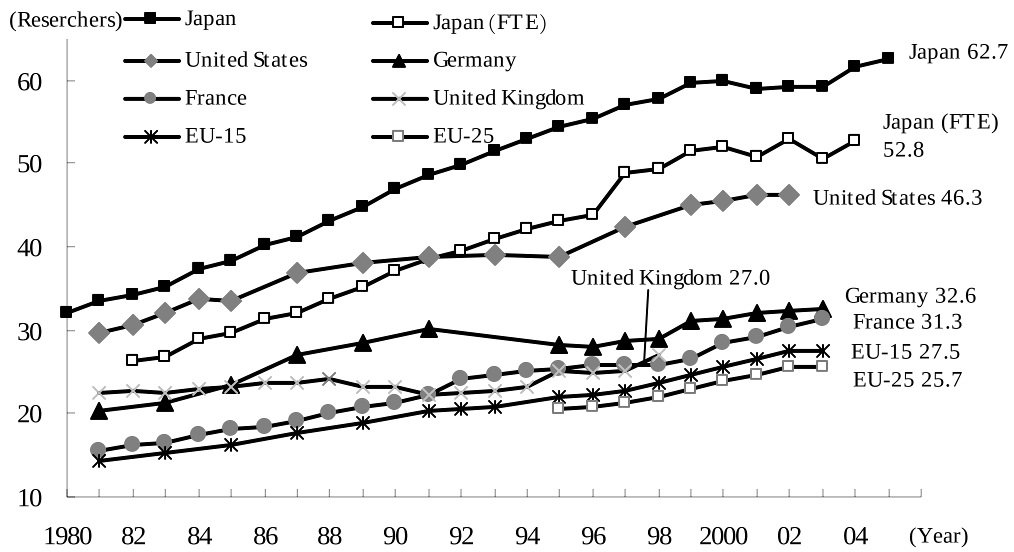
Source: Japan-Statistics Bureau. "Report on the Survey of Research and Development"
Others with Japan (FTE values)-OECD, "Main Science and Technol-ogy Indicators"

2.2.1.2 Number of Researchers per 10,000 Population and per 10,000 Laborers

In Japan, the number of researchers per 10,000 people was 62.7 in 2005, while the number of researchers per 10,000 people was 118.2, the highest figures among the advanced nations (Figure 2-2-3).

But the trends in recent years show that the numbers of researchers per 10,000 people and per 10,000 laborers have been flat in Japan since around 2000, but increased again at 2004.

(1) Number of researchers per 10,000 people



(2) Number of researchers per 10,000 labores

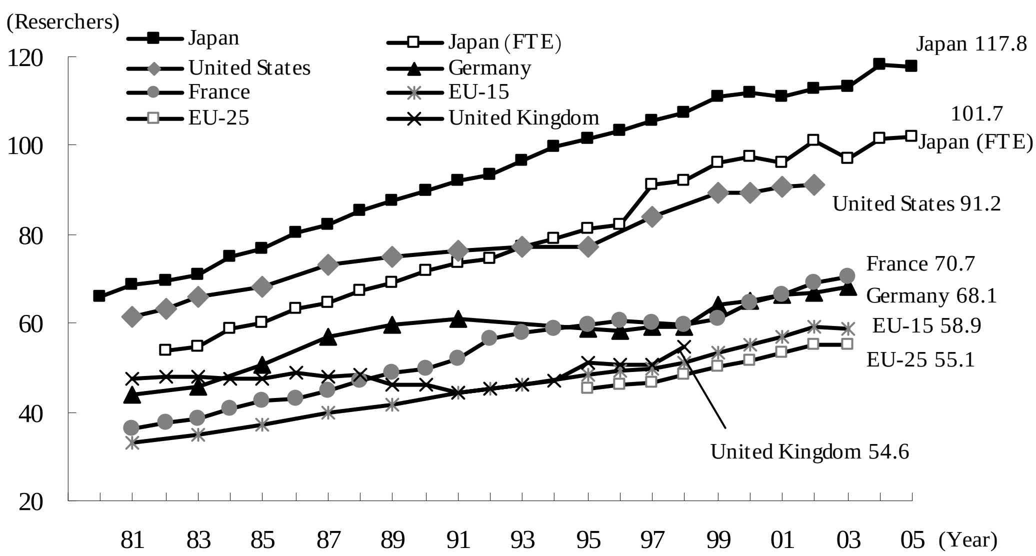


Figure 2-2-3 Trends in the number of researchers per 10,000 people and 10,000 laborers

Notes : 1. The figures for all countries include social sciences and humanities.
2. Figures for Japan's labor force and number of researchers are as of March 31 of each year, except up to 2001 are as of April 1.
3. EU-15 and EU-25 figures are OECD estimates.

Source: Number of researchers data: Same as in Figure 2-2-2.
Population and labor force data: Japan-Statistics Bureau. "Population Estimates Series", "Monthly Report on the Labor Force Survey" Other countries include Japan's FTE value-OECD. "Main Science and Technology Indicators"

2.2.1.3 Number of Researchers by Sector

As for the number of researchers by type of organization, industry (companies) had the most in Japan at 57.6% of the total, followed by universities and colleges at 36.8% and government research institutions (public institutions) at 4.3%.

The United States has a greater percentage of researchers working in industry, and the percentage of researchers in its government research institutions is low, similar to Japan. In Europe, meanwhile, research personnel are concentrated to a high degree in government research (Figure 2-2-4).

The following sections show the characteristics of researchers in Japan by sector.

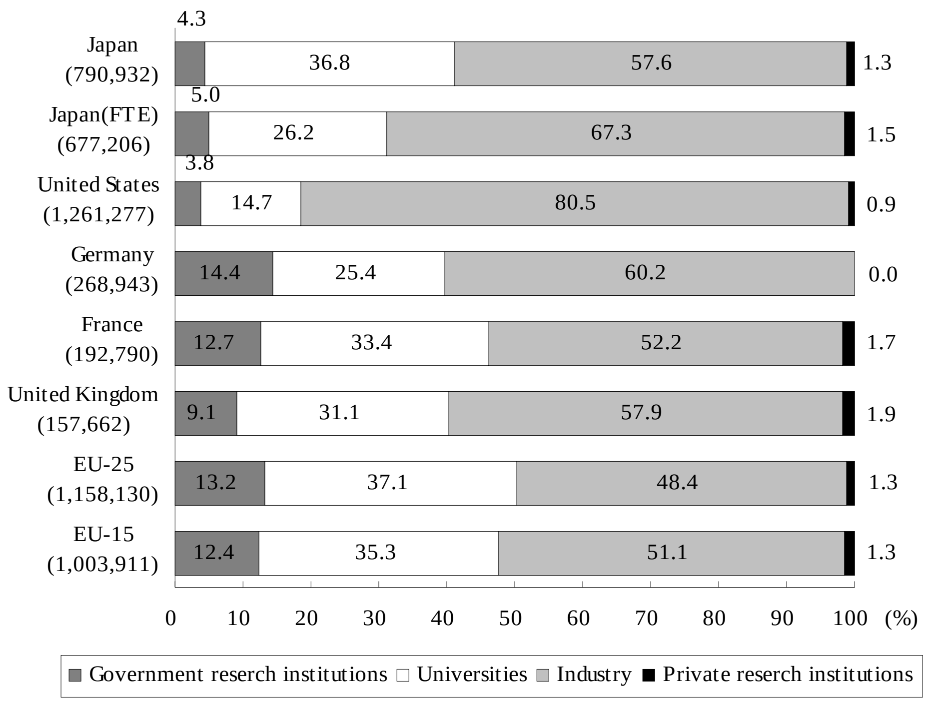


Figure 2-2-4 Share of researchers by sector in selected countries

Notes: 1. For the comparison, statistics for all countries include research in social sciences and humanities. Statistics for Japan, as of March 31, 2005, include the FTE value for public institutions, universities and colleges, companies, and nonprofit organizations.
2. Japan's FTE values are Statistics Bureau data.
3. The data are estimates for the United Kingdom in 1998, the United States in 1999, and Germany and France in 2003, EU-15 in 2001 and EU-25 are in 2002.
4. Data for private research institutions in Germany is included in data for government research institutions.

Source: Japan -Statistics Bureau. "Report on the Survey of Research and Development"
Others-OECD. "Main Science and Technology Indicators"