(Business Enterprises)

In the last five years from 2000 to 2005 (with 2002 using the revised survey), the number of researchers in business enterprises increased by 5.1% (an average annual rate of increase of 1.00%, from 434,000 researchers to 456,000), which, while slowing, is still increasing compared to other organizations. This hints that industry, as well, has come to place great importance on research and development (Figure 2-2-5)

As for the number of researchers by type of industry, the information and communication electronics and equipment industry registered the highest number, followed in order by the transportation industry, the electrical machinery, equipment and supplies industry, the general machinery industry, the chemical products industry, the electronic parts and devices industry, the software and information processing industry, the drugs and medicines industry (Figure 2-2-6). As for

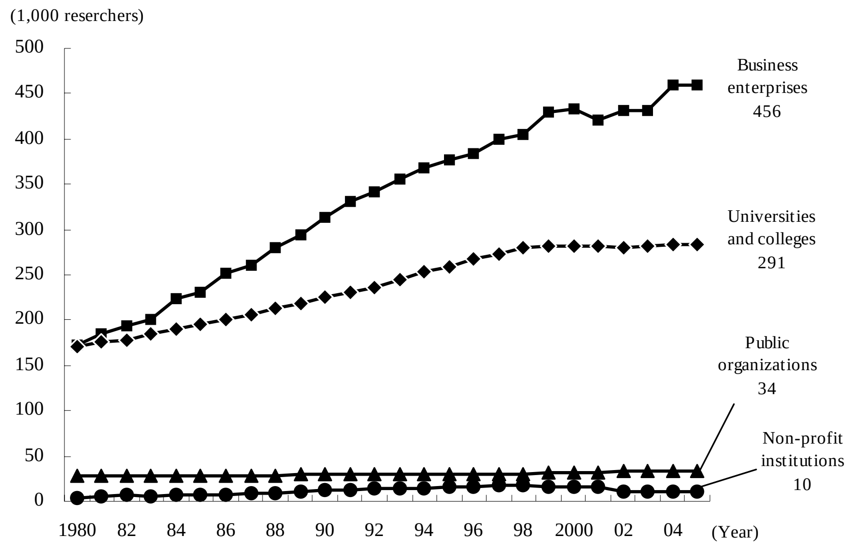


Figure 2-2-5 Trends in the number of researchers by sector in Japan

Note: 1. Numbers include researchers in the humanities and social sciences and are as of March 31 of each year, except for FY2001, which is as of April 1.
2. Survey categories were changed in FY2002; numbers up to FY2001 are for researchers whose primary duty is research at the following organizations (except at universities and colleges, where the number inclu-des those who conduct research as an additional post).

After 2002	up to 2001
Enterprises	Companies
Non-profit institutions	Private research institutions
Public organizations	Research institutions excluding private research institutions
Universities and colleges	Universities and colleges

3. In Japan, the software industry has been covered in the survey since FY1997 and the wholesale industry since FY2002.

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (11)

the number of researchers out of 10,000 employees, except for academic research institutions, the information and communication electronica equipment industryhad the largest number, at more than 2.9 times higher than the average for all industries, followed in order by the electronic and electrical measuring instruments industry, the oils and paints industry, the precision machinery industry, and the industrial chemical and chemical fibers industry (Figure 2-2-7). By field of research, engineering ranks the highest. Next is physical science, followed by health, and finally agricultural sciences. Within the engineering field, researchers are concentrated in “electrical engineering and telecommunications engineering,” and “mechanical engineering, shipbuilding and aeronautical engineering.” Within the physical sciences, chemistry has the majority. These three fields employ more than 70% of all Business enterprises rese- archers (Figure 2-2-8).

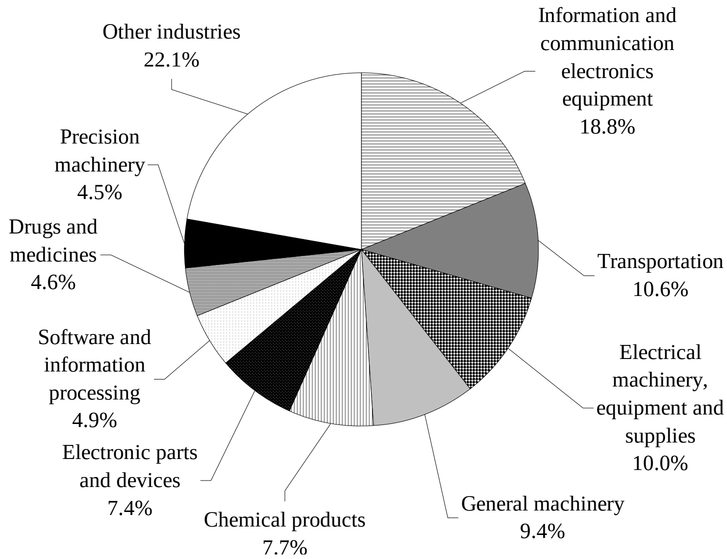


Figure 2-2-6 Researchers at business enterprises, by type of industry (2005)

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (9))

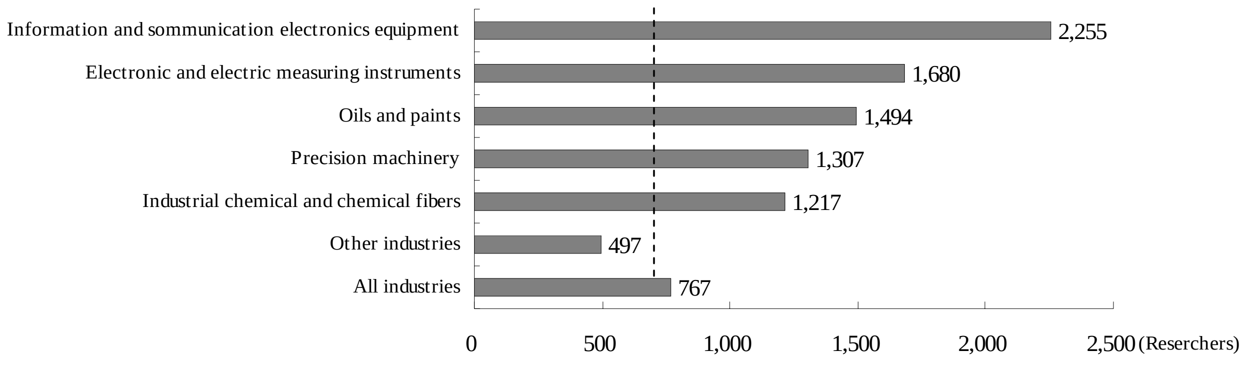


Figure 2-2-7 Number of researchers per 10,000 employees at business enterprises (top fiveindustrial categories except academic research institutions) (2005)

Notes: 1. Regarding researchers per 10,000 employees, the data for number of employees and number of researchers are as of March 31, 2005.
2. Academic research institutions (5,341 researchers per 10,000 employees) are not shown on graph.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (9))

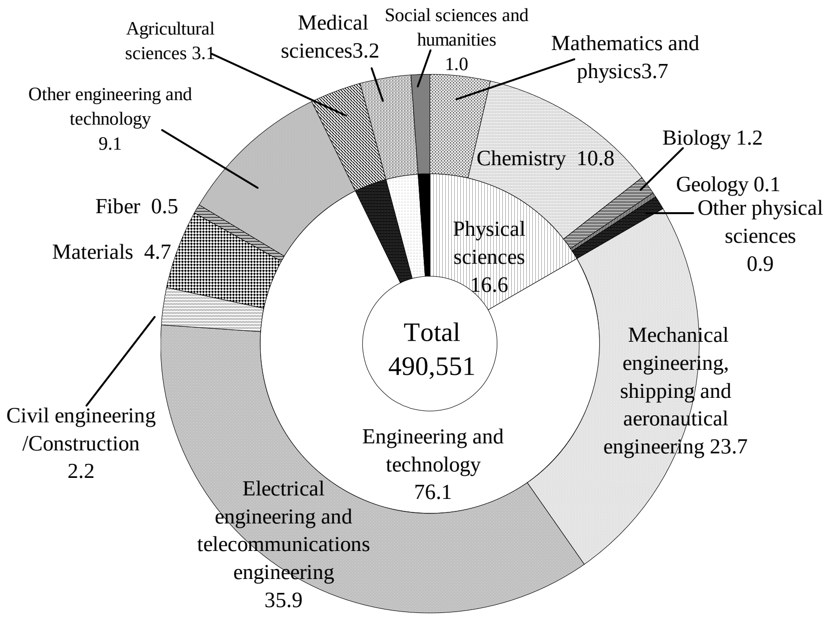


Figure 2-2-8 Composition of number of business enterprises researchers by field of research (2005)

Note: Figures are their shares in percentages to total company researchers.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

(Non-profit Institutions and Public Organizations)

A chronological comparison of the number of researchers is made difficult by the transformation of national experimental research institutions into incorporated administrative agencies, in addition to the revision of the Statistics Bureau's "Survey of Research and Development." However, the number of researchers in 2005 stands at 10,000 in non-profit institutions and within public organizations, at 3,400 in national institutions, 13,600 in local government-owned institutions, and 16,900 in public corporations and incorporated administrative agencies (Figure 2-2-9).

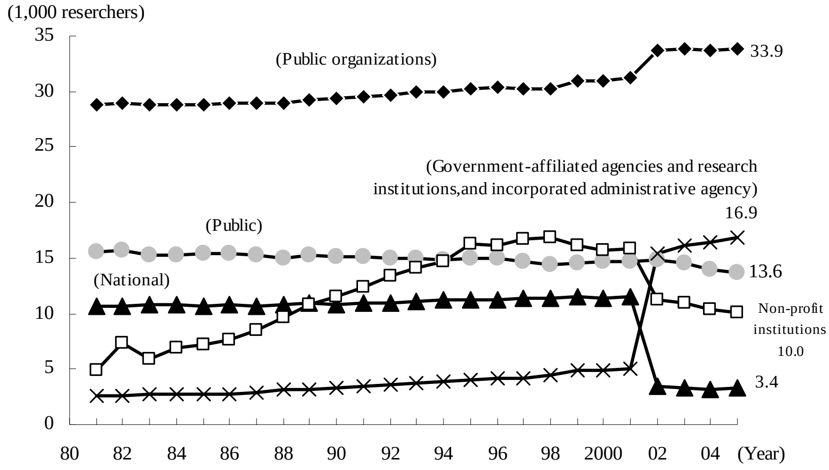


Figure 2-2-9 Trends in the number of researchers in nonprofit Organizations and public institutions

Notes: 1. Numbers include researchers in the humanities and social sciences and are as of March 31 of each year, ecept up to 2003, which is as of April 1.
2. Survey coverage categories were changed in FY2002; numbers up to FY2001 for non-profit institutions use the values of private research institutions.
3. Values up to FY2001 are for researchers whose primary duty is research.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (8))

When looking at sector composition, a disproportionately large share of researchers was seen in engineering at non-profit institutions and among public organizations, in health and engineering at national institutions, in agricultural sciences at local government-owned institutions, and in engineering and the physical sciences at public corporations and incorporated administrative agencies (Figure 2-2-10).

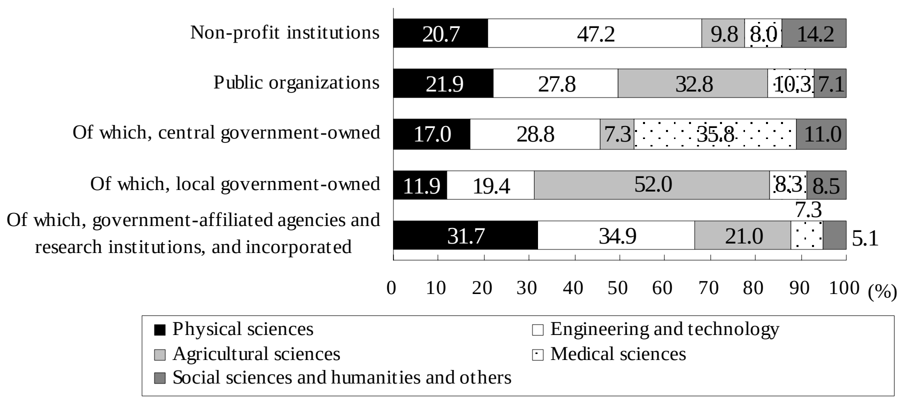


Figure 2-2-10 Composition of researchers in non-profit institutions and Public organizations by organization and field (2005)

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

(Universities and Colleges)

The number of researchers at universities and colleges, including those in the humanities and social sciences, has increased by 3.5% in the last five years (2000-2005, an average annual rate of increase of 0.69%) up to 291,000 researchers from 281,000. Looking at the number of researchers by type of institution in 2005, private universities and colleges have 134,900 researchers, followed by national universities and colleges (134,000), after which comes local public universities and colleges (22,300) (Figure 2-2-11). However, in terms of researchers whose primary role is research, the order becomes national universities (127,000), followed by private universities (122,000), and then local public universities (19,000).

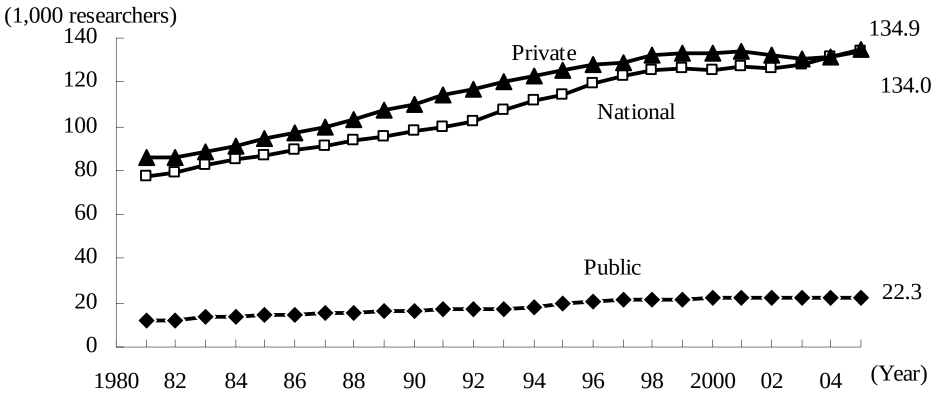


Figure 2-2-11 Trends in the number of researchers in universities and colleges

Note: Numbers include researchers in the humanities and social sciences and are as March 31 of each year, except up to 2001, which are as April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (8))

Researchers in universities and colleges consist of faculty members, doctoral students, medical staff and others. Looking at the composition of researchers by type of institution, in national universities and colleges, doctoral students make up a large ratio of the researchers, and private universities and colleges have a greater ratio of teachers and medical staffs and a smaller ratio of students for doctoral degrees. The figures for public universities and colleges fall in between those for the national universities and the private universities and colleges (Figure 2-2-12).

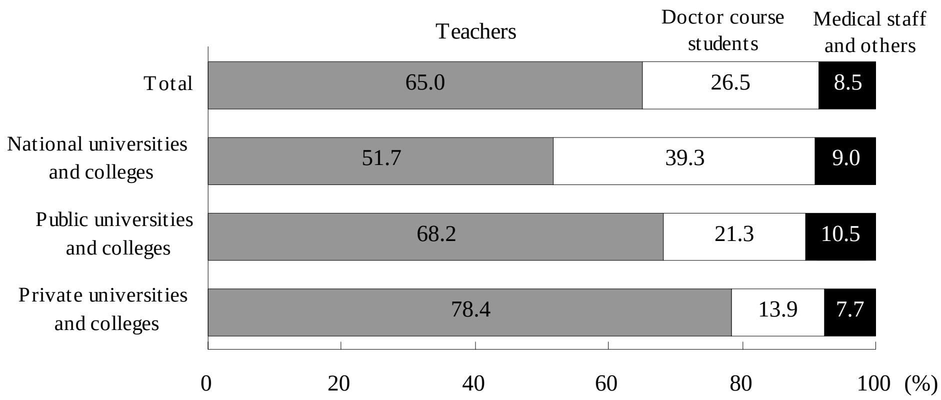


Figure 2-2-12 Composition of researchers in universities and colleges (2005)

Note: Numbers include researchers in the humanities and social sciences as of March 31, 2005.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

By sector composition, a large share of university researchers were health specialists, whether faculty members, doctoral students, or medical staff. Other sectors with relatively high shares of the total were engineering, for teachers, and science, for students in doctorate programs (Figure 2-2-13).

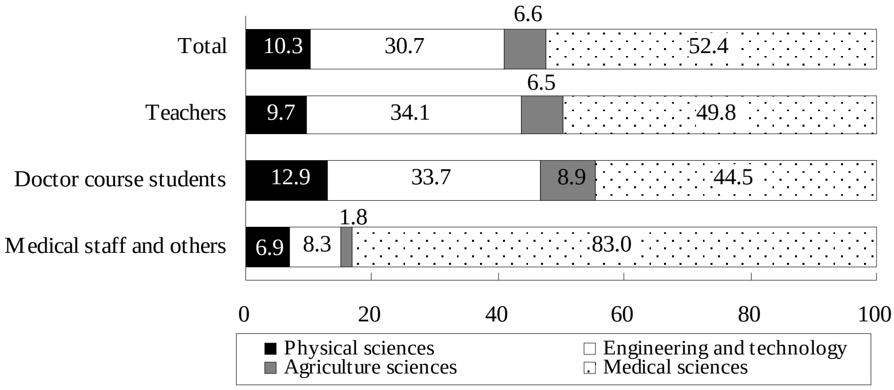


Figure 2-2-13 Share of researchers in the natural sciences at universities and colleges by field (2005)

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

For the number of researchers by academic field in the most recent five-year period (2000-2005), balanced annual growth rates are seen in the engineering (at 2.21%), agriculture science (at 0.78%), and physical sciences (0.24%), while the health sciences registered a decline of an average annual rate of 0.22% (Figure 2-2-14). Looking at specific sectors, the materials (mining and metallurgy) (average annual growth rate of 9.05%), electrical and telecommunications sectors (average annual growth rate of 2.75%), pharmaceutical sciences (average annual growth rate of 2.72%) and civil engineering and architecture (average annual growth rate of 1.41%) are showing particularly fast increases in the number of researchers (Figure 2-2-15).

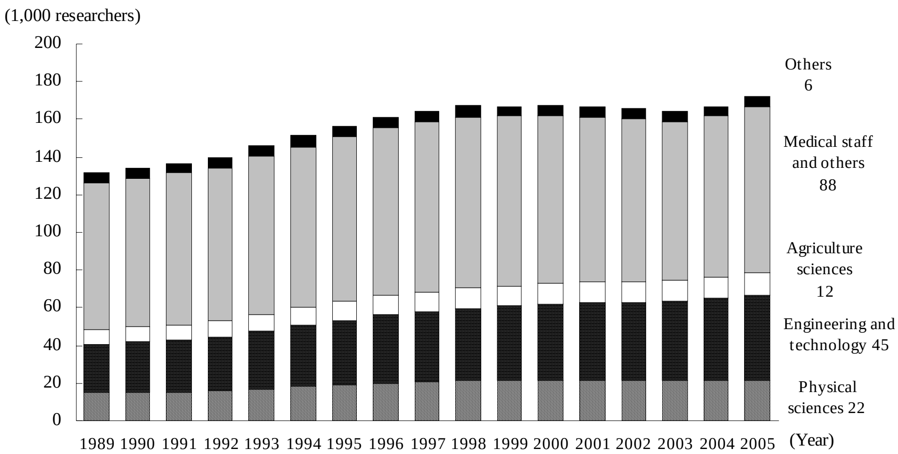


Figure 2-2-14 Trends in the number of researchers at universities and colleges by field and specialty

Note: The number of researchers is for the natural sciences only and is as of March 31 of each year, except up to 2001, which are as of April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

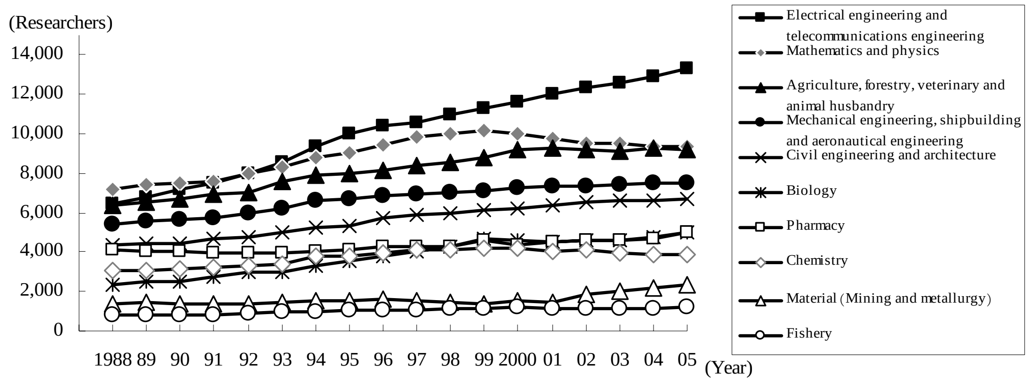


Figure 2-2-15 Trends in the number of researchers at universities and colleges by detaild filed and specialty

Notes: 1. The number of researchers is for the natural sciences only and is as of March 31 of each year, except up to 2001, which are as of April 1.
2. “Mining and metallurgy” was changed in 2002 to “materials,” to which was added materials engineering, raw materials engineering, and materials process engineering, etc.
3. The number of researchers excluded those in medical sciences and dentistry

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

2.2.1.4 Women Researchers

Women researchers, including those in the humanities and social sciences, have steadily increased year by year, reaching 99,000 in 2005, representing about 11.9% of the total number of researchers (Figure 2-2-16). But looking at all workers, 26.33 million women employees accounted for 41.4% of the total of 63.56 million employees in Japan in 2005, according to the “Labor Survey of the Ministry of Internal Affairs and Communications.” It is clear that the ratio of women engaged in the R&D field remains lower than that of women in the labor market in general. The proportion of women researchers by type of organization was 6.4% at companies, etc., 10.2% at non-profit institutions, 12.2% at public organizations, and 21.1% at universities and colleges, clearly demonstrating that universities and colleges provide women researchers more opportunities than elsewhere.

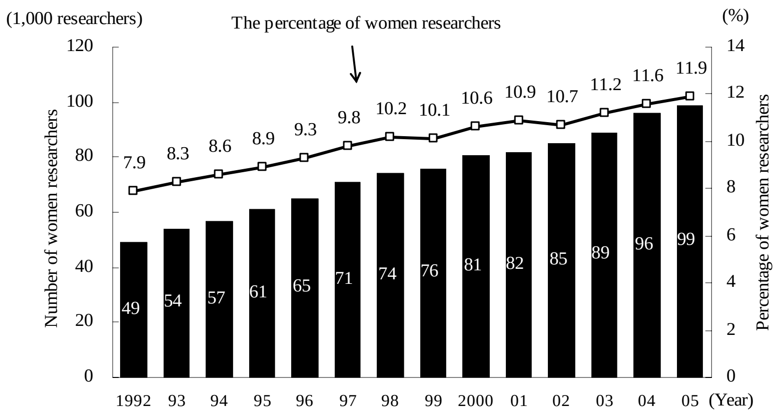


Figure 2-2-16 The percentage of all researchers that are women

Note: Numbers include researchers in the humanities and social sciences and are as of March31 of each year, except up to 2001, which are as of April 1.

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

2.2.2 Personnel Engaged in R&D

The definition of personnel engaged in R&D, which includes both regular researchers and research support staff, varies in scope from one country to the next, so that simple comparisons are probably untenable. Nevertheless, in just such a comparison with the selected countries of Europe, Japan had the largest number of personnel engaged in R&D at 1,010,000, followed in order by Germany, France, and the United Kingdom.

Japan has relatively low numbers of personnel who are engaged in R&D but are not researchers themselves, with 0.28 research support staff for each researcher, a figure that is one-third the standard for European nations (Figure 2-2-17).

The number of research and development-related workers in Japan showed a 1.2% decline in the most recent five-year period (2000-2005). The downward trend in the number of research assistants was in the same five-year period, declining by 15.8%, an annual average of -3.4% (Figure 2-2-18).

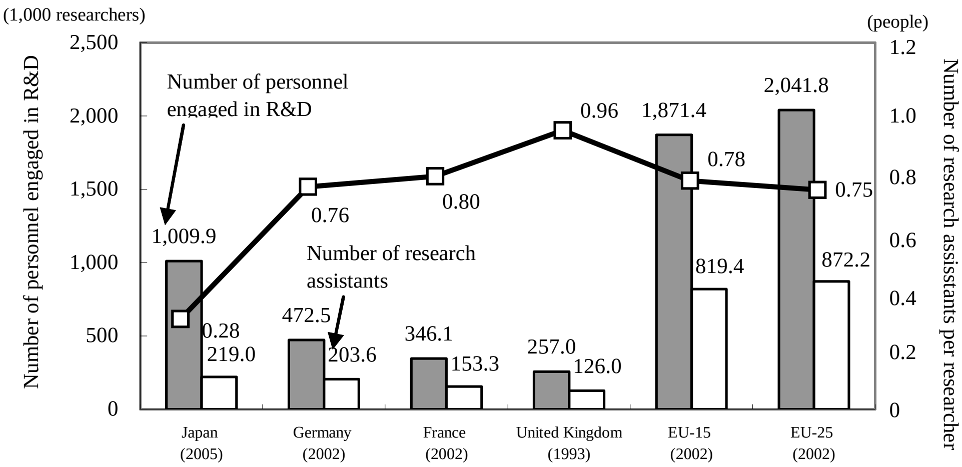


Figure 2-2-17 Number of research assistants per researcher in selected countries

Notes: 1. For comparison, figures for all countries include social sciences and humanities.
2. Figures for EU-15 and EU-25 are OECD estimates.
3. Research assistants refers to people who assist researchers, people who provide technical services that add value to research, and people employed in research administration, which in Japan is referred to as assistant research workers, technicians, and clerical and other supporting personnel.

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

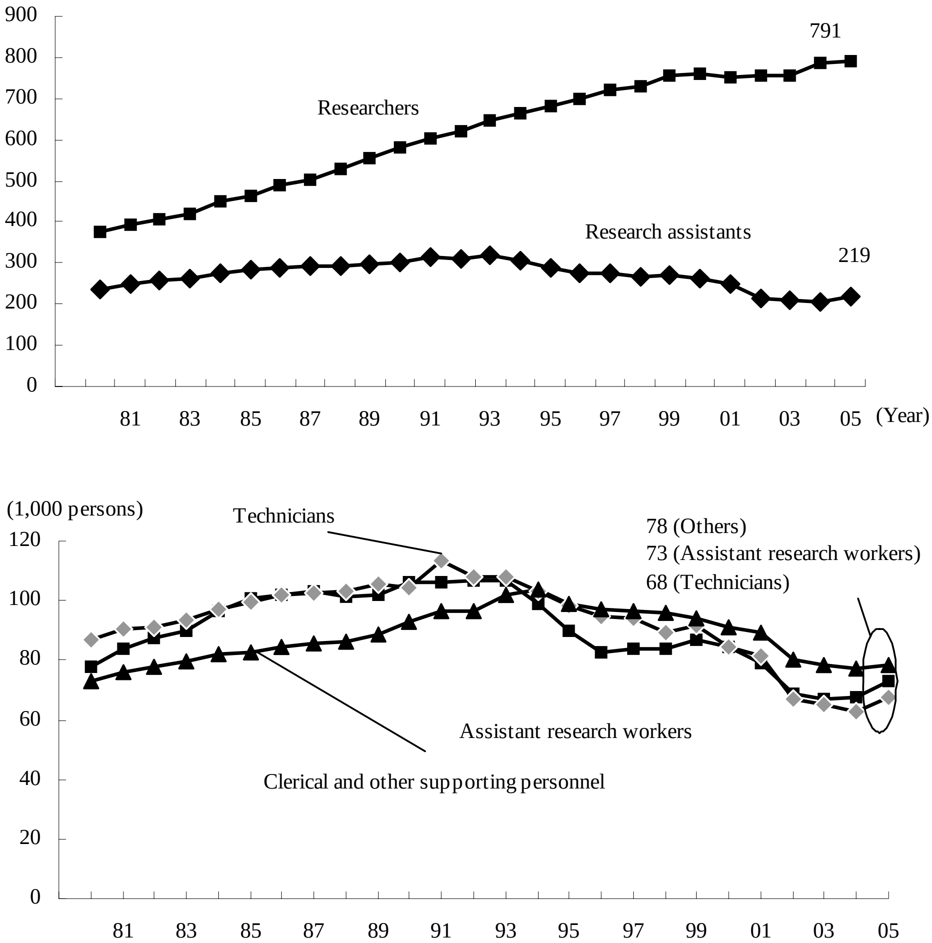


Figure 2-2-18 Trends in persons engaged in R&D in Japan

Note: Numbers include personnel in the humanities and social sciences and are as of March 31 of each year, except up to 2001, which are as of April 1.
Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (7))

Regarding R&D-related personnel in 2005, the number of researchers increased to 791,000, assistant research workers to 73,000, technicians to 68,000 and clerical and other support staff to 78,000 (Figure 2-2-18). The number of research assistants per researcher continued to decrease. (Figure 2-2-19).

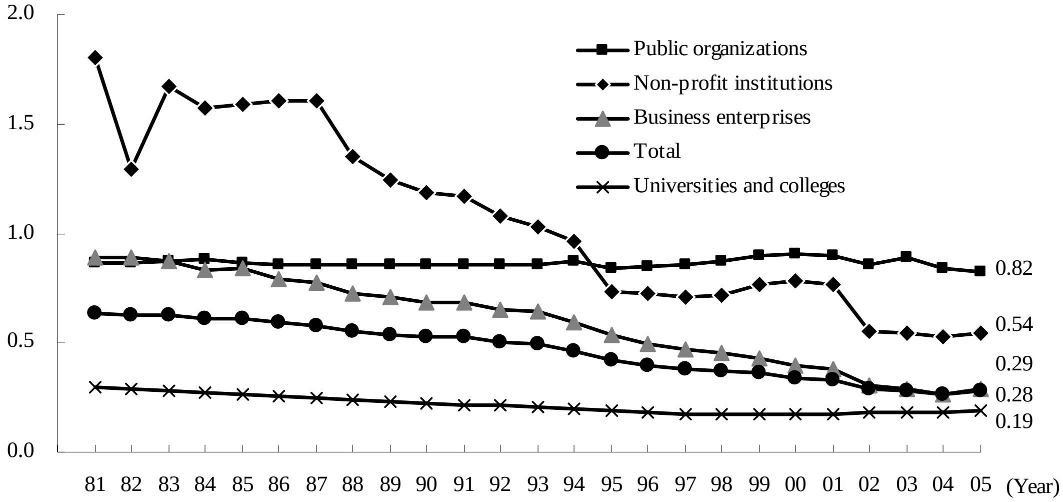


Figure 2-2-19 Trend in the number of research assistants per researcher in Japan

Notes: 1. The numbers of researcher and research assistants include those in the humanities and social sciences and are as of March 31 of each year, except up to 2001, which are as of April 1.
2. Survey categories were changed in 2002; numbers up to 2001 are for researchers at the following organizations:

Up to 2001	After 2002
Companies	Enterprises
Private research institutions	Non-profit institutions
Government research institutions	Public organizations
Universities and colleges	Universities and colleges

Source: Statistics Bureau. "Report on the Survey of Research and Development"
(See Appendix 3. (7))

The composition by organization of the number of personnel engaged in R&D in Japan reveals that all universities and colleges, including both public and private schools, have the lowest number of research support staff per researcher (Figure 2-2-20).

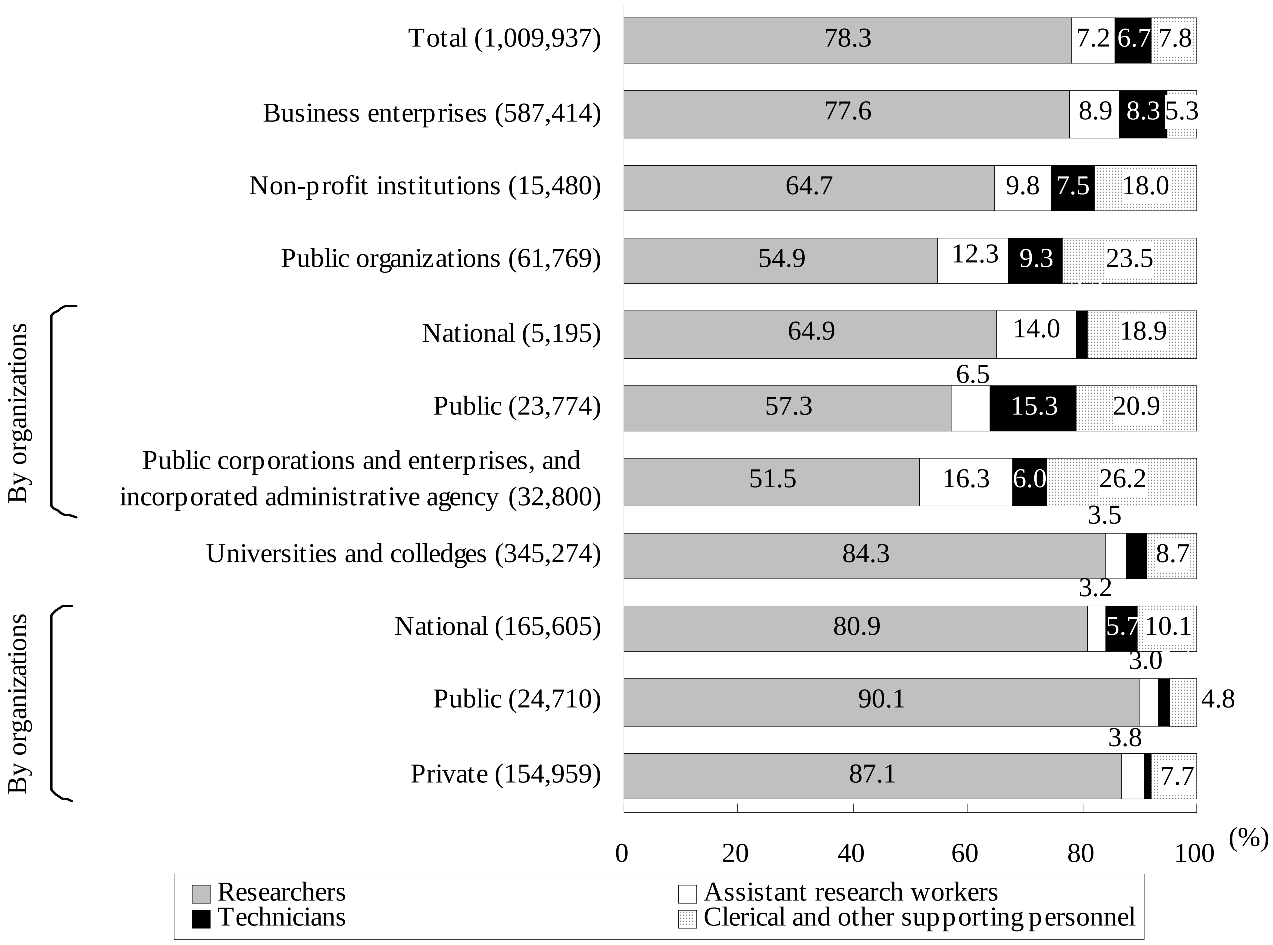


Figure 2-2-20 Composition of personnel engaged in R&D by sector in Japan (2005)

Note: Numbers for all personnel engaged in R&D include those in the humanities and social sciences and are as of March 31, 2005.
Source: Statistics Bureau. "Report on the Survey of Research and Development"

2.2.3 Production and Employment of Research Personnel

2.2.3.1 Overall Degree Trends

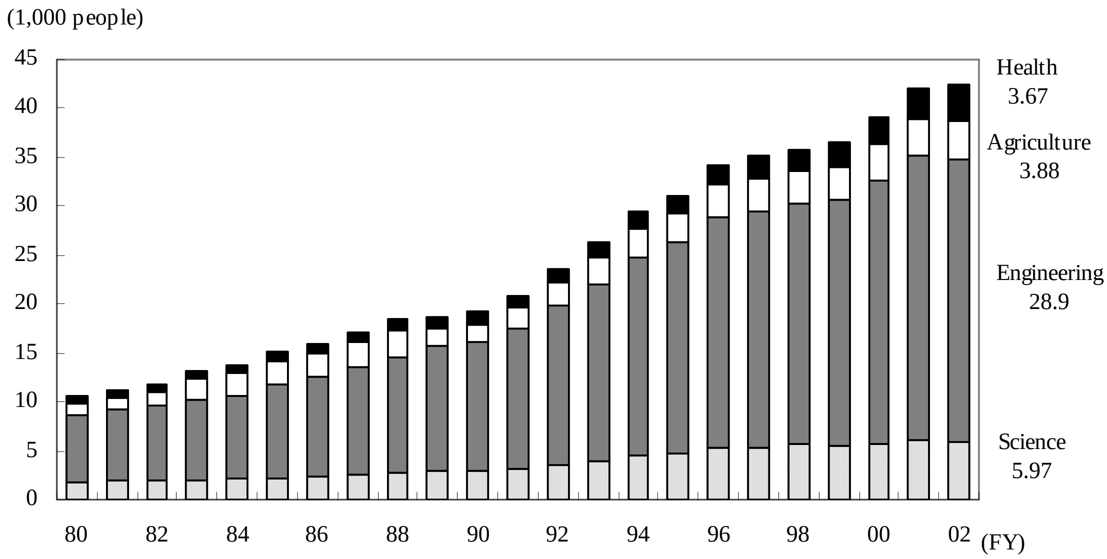
The number of people acquiring a master's degree or doctoral degree in the natural sciences in Japan has been rising alongside an expansion of graduate schools. While the number of doctorates decreased in 1999, those conferred in 2000 exceeded those conferred in 1998. During the five-year period from 1997 to 2002, the number of master's degrees conferred rose by 1.11 times (average annual growth rate of 2.1%), and the number of doctorates by 1.11 times (average annual growth rate of 2.2%). Looking at degrees by major for 2002, the engineering field accounted for the largest number of new master's degree holders at 28,893, while the largest number of new Ph.D.s was in the health science field at 6,853 (Figure 2-2-21).

Master's and doctoral degrees differ from country to country due to differences in culture and educational systems. Social factors such as industrial structure and numbers of students can affect the number of awarded degrees. Thus, it is difficult to compare the data at face value. It is useful, however, to compare trends, and this section describes the degree trends in the natural sciences and engineering in selected countries.

The United States awards the largest number of degrees, a little over three times as many as does Japan. Compared to 1980, the ratio of engineering and health science degrees to total degrees has increased. Japan is second in number of degrees awarded, following the U.S., and has a higher ratio in engineering. The United Kingdom, France and Germany follow in the order named. Of these countries, Germany has a higher ratio in the physical science and health science fields, and the U.K. is higher in physical science and engineering. Also, if we look at doctorates only, the number in physical science fields in Japan is quite a bit lower than in other selected countries (Figure 2-2-22).

The number of graduate school students as a proportion of all university students is also lowest in Japan among selected countries (Figure 2-2-23).

(1) Master's degree



(2) Doctorates

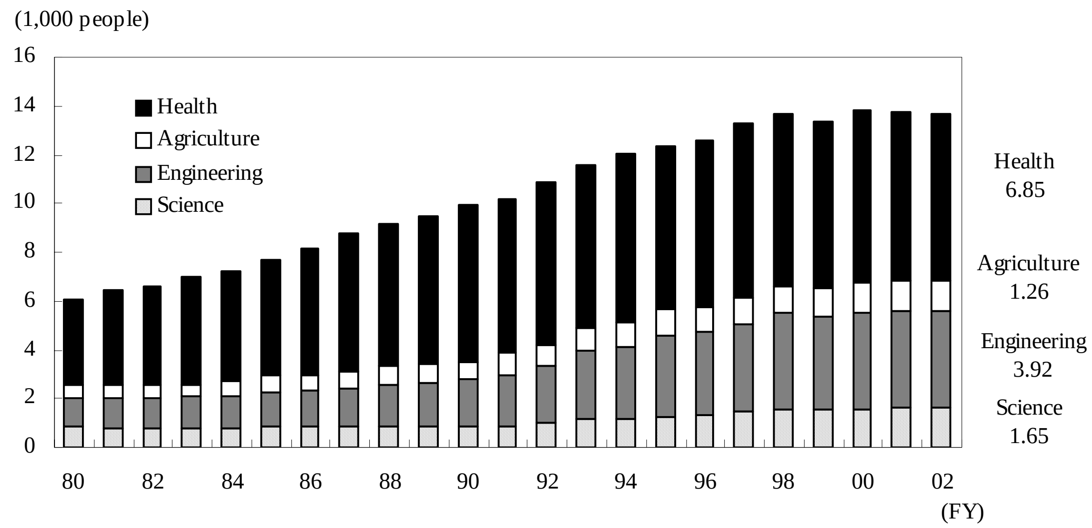
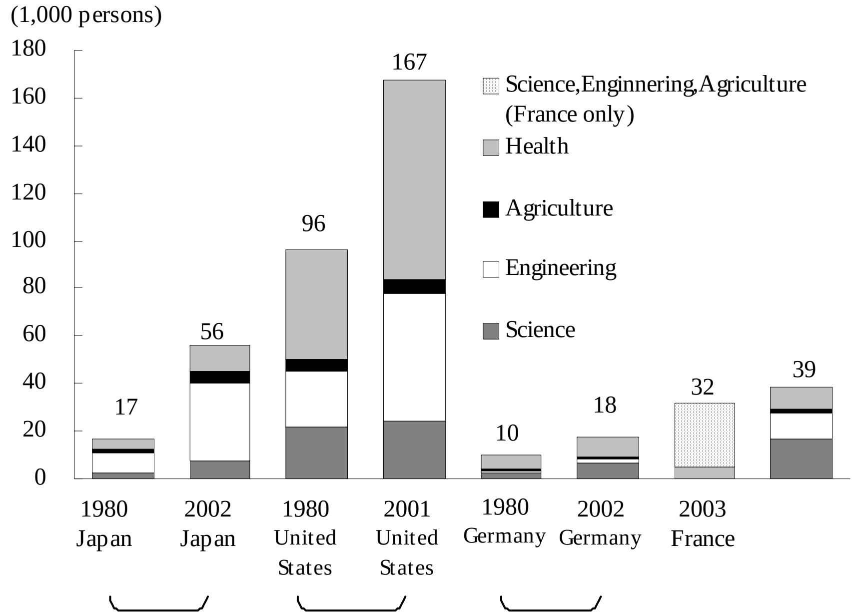


Figure 2-2-21 Degree trends in Japan (natural science)

Note: The figures are awarded degrees in FY2002.
Source: MEXT. "Statistical Abstract of Education, Science and Culture 2006."

(1) Total (awarded at graduate schools)



(2) Doctorates

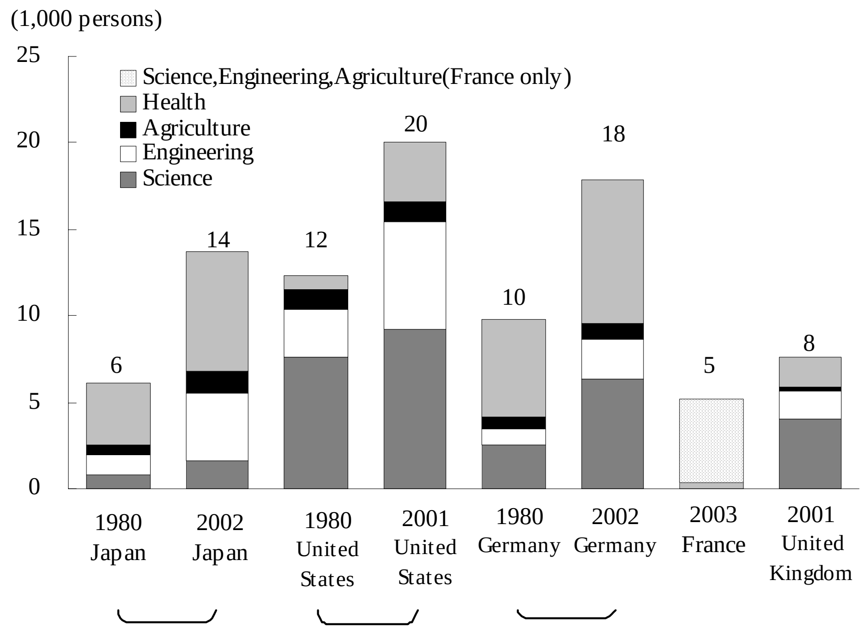


Figure 2-2-22 Number of awarded degrees in selected countries (natural science)

Notes: 1. Totals include master's and doctoral degrees (Germany: only doctorates). U.S. health sciences include first-professional degrees.
2. 1980 data for Germany are for the former West Germany.
3. France does not distinguish between physical sciences, engineering, and agricultural sciences.
Source: MEXT. "International Comparison of Education Indexes 2003, 2006"

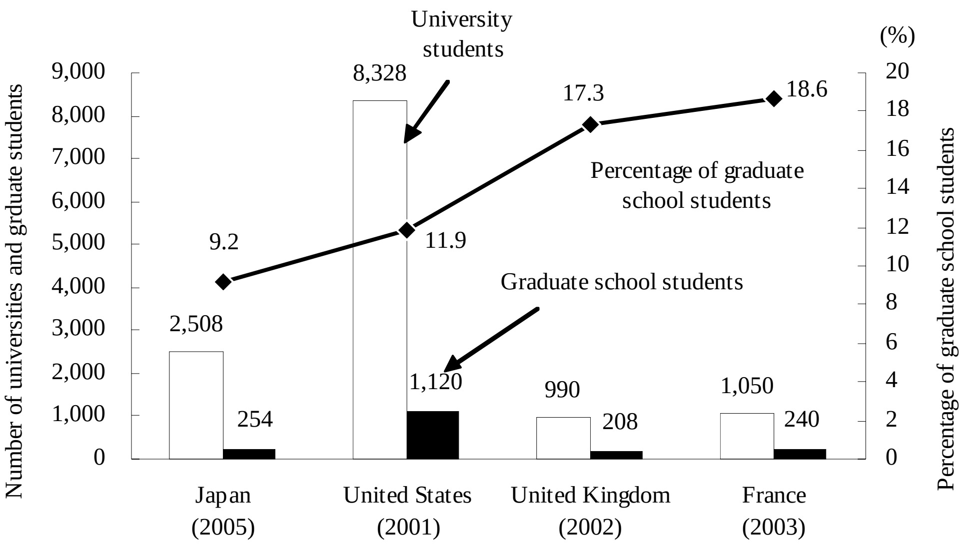


Figure 2-2-23 Number of graduate and university students,and percentage of graduate school students in selected countries

Note: Numbers for the United States and the United Kingdom are for fulltime students.
Source: MEXT. "International Comparison of Education Indexes 2006"

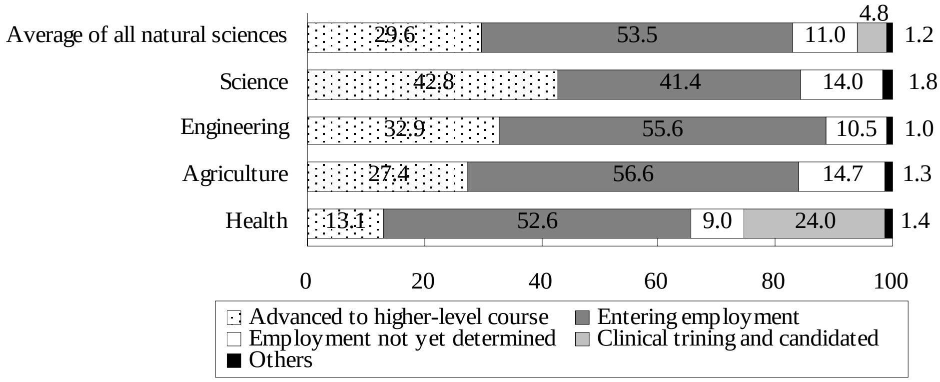
2.2.3.2 Employment of Research Personnel

In order to enable the utilization of the skills of research personnel who have received a university and/or graduate school education, it is important that they would be ensured an easy transition into industry or research institutions, etc. after graduation.

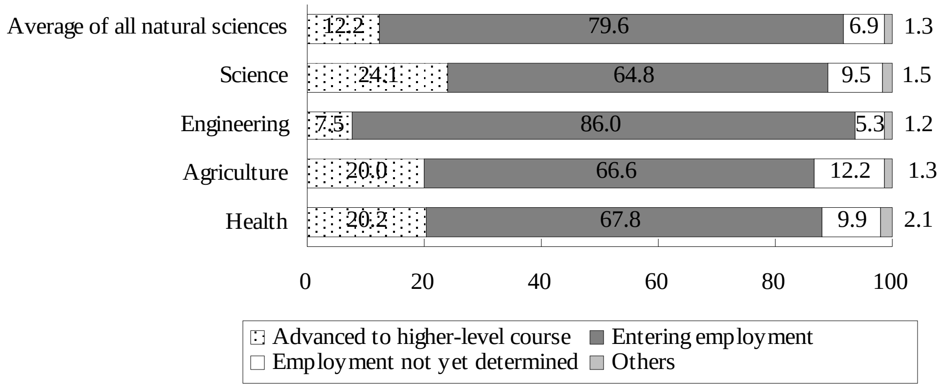
Here, we shall look at the employment situation for Japan’s research personnel from the viewpoint of careers chosen by people in the natural sciences after graduating from university, or after completing master’s or doctoral courses. At the university graduate stage, 42.8% of science specialists continue on to graduate work, a proportion that is higher than other specialties. After completing master’s degrees, the proportion of engineering specialists who continue on with education drops (to 7.5%), with the vast majority (86.0%) turning to employment. After completing doctoral courses, a large proportion (about 30%) of people in physical science and agricultural science fields do not have definite plans for the time after receiving their doctorates (Figure 2-2-24).

If we look at a number of industries to examine their characteristics in terms of which field of the natural sciences their employees tend to come from, manufacturing industries such as the electrical machinery and tools industry, and the transport machinery and tools industry, consist almost entirely of engineering specialists. By contrast, other manufacturing industries, such as the chemicals industry, take people broadly from all four fields: the physical sciences, engineering, agricultural sciences, and health sciences. In addition, while the electrical machinery, tools manufacturing and other manufacturing industries have a high proportion of personnel who have completed master’s courses, they also have an exceptionally low proportion of people who have completed doctoral courses (Figure 2-2-25).

(1) Upon university graduation



(2) Upon completion of master's degree



(3) Upon completion of doctor's degree

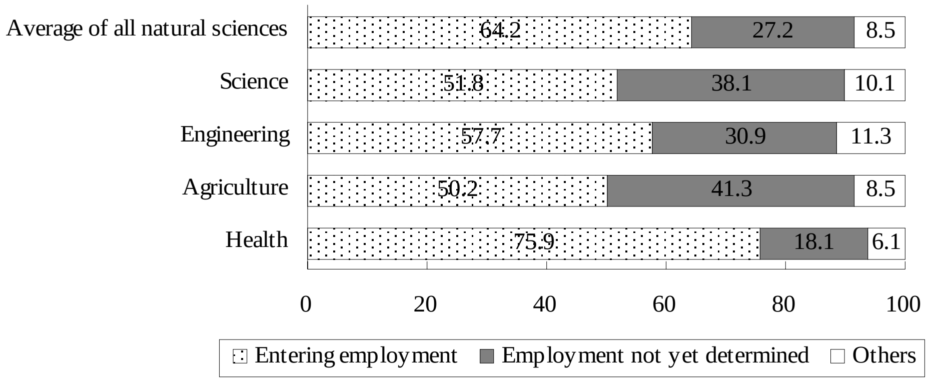
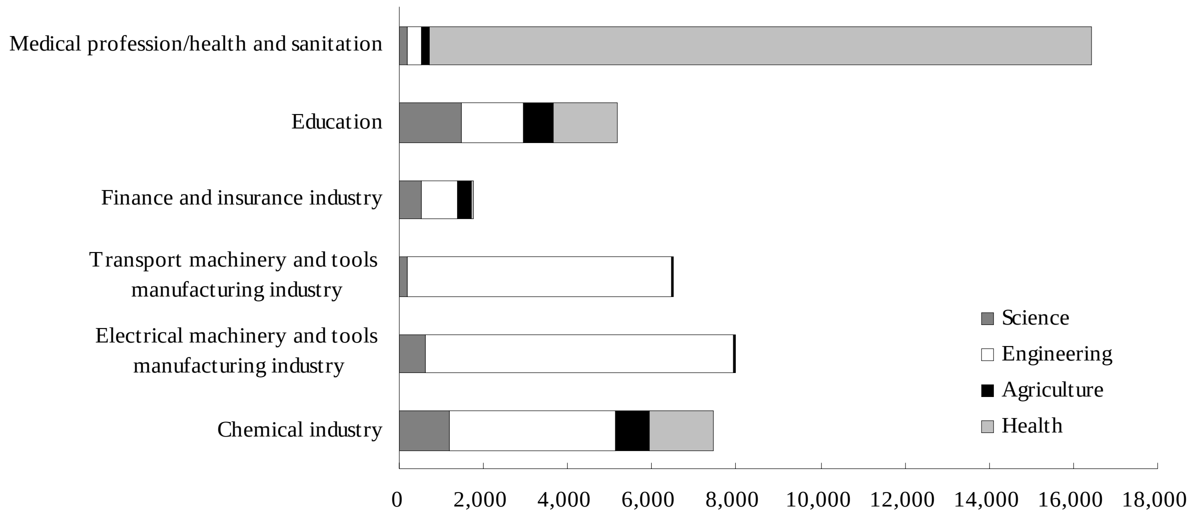


Figure 2-2-24 Trends in career choice, by university degree level (March 2005)

Notes : 1. "Average of all natural sciences" is the average value of science, engineering, agricultural, and health.
2. "Employment not yet determined" refers to people who are employed in a temporary work, engaged in housework, are not still at school working as a researcher, have not entered a technical school or other type of school, a school in a foreign country, or an employment skills development facility, etc., or are clearly neither engaged in any employment nor enrolled in advanced education.
3. "Others" for those who are university graduation and have completed a master's degree refers to people who are deceased or unidentified.
4. "Other" for those who have completed a doctor's degree refers to people who have advanced to higher-level course, are engaged in clinical training to be a physician, or who are deceased or unidentified.

Source : MEXT. "Basic Survey Report on Schools 2005."

(1) By academic field



(2) By academic degree

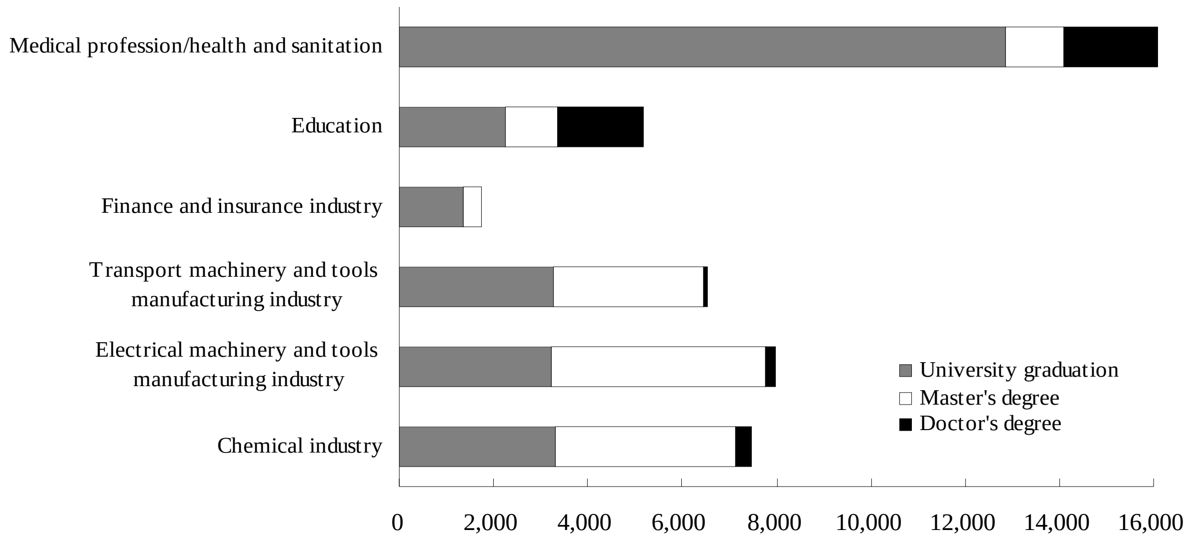


Figure 2-2-25 Employment situation in major industries,by academic field and by degree (March 2005)

Source: MEXT. "Basic Survey Report on Schools 2005"

2.3 Trends Related to Research Performance

The data on numbers of scientific papers, numbers of patents applied for and granted, technology trade balances, and high-tech product trade balances, which indicate the results of R&D activities in science and technology, reflect a nation’s activity and level and strength of R&D activities. These statistics are considered to be significant indicators demonstrating levels of R&D and technological strength. This chapter describes these trends in Japan and selected countries.

2.3.1 Scientific Papers

Scientific papers are the results of R&D. It is impossible to make a simple comparison between scientific papers because of the language normally used by the researchers and the language they are written in, etc. However, here is a comparison of the number of scientific papers and the number of citations on the basis of the database[18] compiled by the Thomson Scientific.

2.3.1.1 Trends in the Number of Scientific Papers, and Number of Citations, in Selected Countries

Of the scientific papers published in major scientific journals around the world between 1981 and 2004, Japan’s share of scientific papers and citations was as shown in Figure 2-3-1. Japan’s share of scientific papers in 1981 was fourth in the world, after the United States, the United Kingdom, and Germany.

However, ever since Japan surpassed the United Kingdom in 1992 to obtain the No.2 ranking, Japan has maintained its position at No.2.

Moreover, since excellent papers tend to attract large numbers of citations in other papers, the number of citations can be viewed as one indicator of a paper’s quality. A look at the number of citations of papers authored by Japanese researchers through the year 2000 by year of publication reveals that Japan’s share of total citations has tended to rise over time. Nevertheless, Japan has ranked after the United States, the United Kingdom, and Germany in the number of citations ever since 1989, and the ratio to total citations remains much lower than the share of the total number of scientific papers published (Figure 2-3-1).

[18] Thomson Scientific’s database: About 8,730 journals are listed in the Web of Science database (original data of the National Science Indicators), of which about 5,900 are natural science journals, about 1,700 are social science journals, and about 1,130 are arts and humanities journals. The selection standards for the listing of journals are determined according to the following criteria: (1) International editorial conventions, (2) Timeliness of publication, (3) Article title, abstract, and keywords, at the very least, noted in English and (4) Quality sufficiently maintained through the use of peer review or complete implementation of citations.

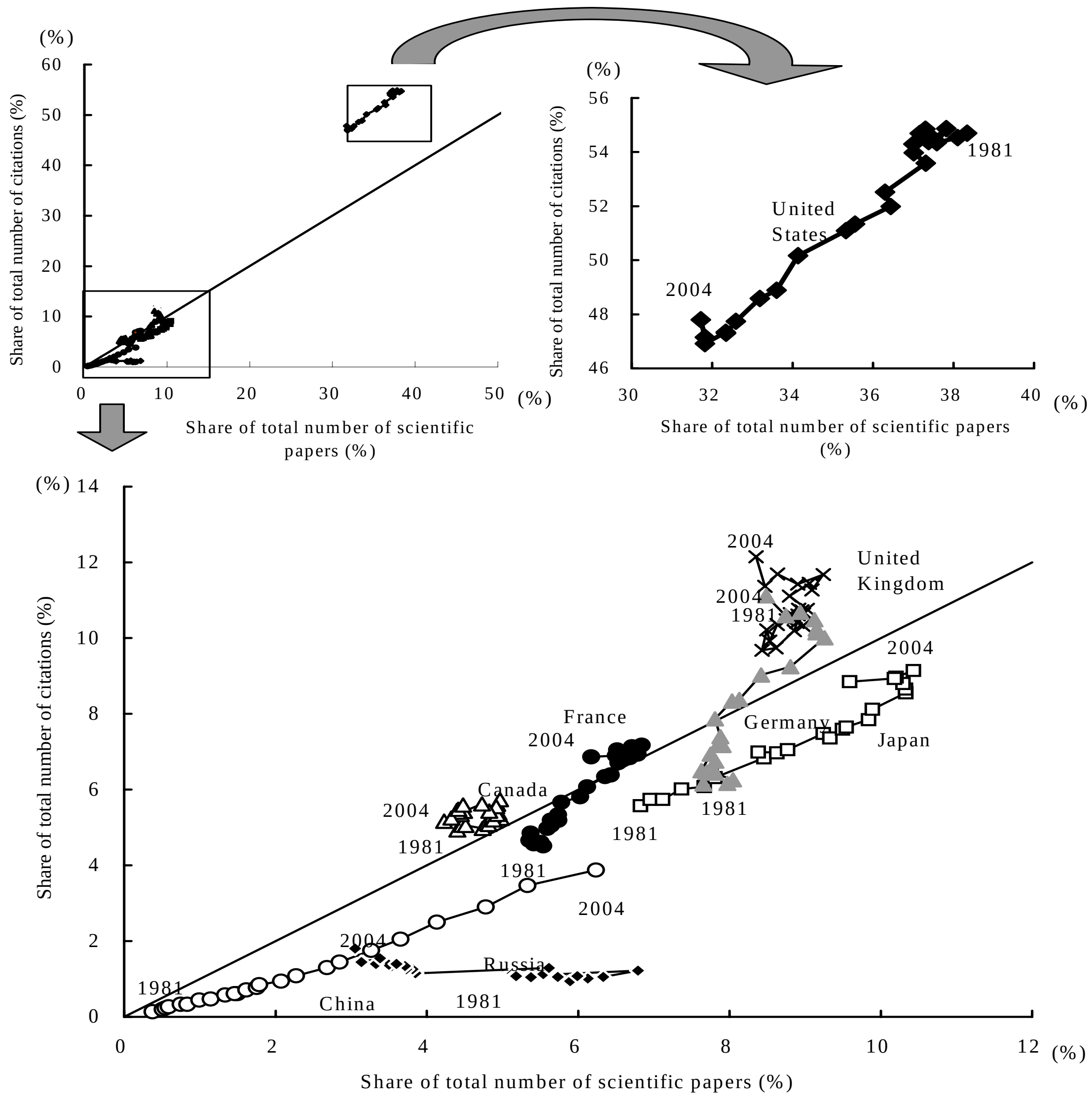


Figure 2-3-1 Relationship between the world total for scientific papers and for citations in scientific papers

Notes: 1. The figures for Russia include those for the Soviet Union.
2. The figures for Germany include those for the former East Germany.

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2004" (Thomson Scientific)

2.3.1.2 Relative Citation Impact for Scientific Papers in Selected Countries

The Relative Citation Impact (RCI) shows the number of citations per scientific paper from Japan divided by the number of citations per scientific paper for the world as a whole. Japan's RCI value is less than 1.0, putting it in a position relatively lower than other major selected countries. Where the RCI for Japan and the United States has stayed relatively stable since 1981, it has risen in the other major countries, with particularly strong increases seen in recent years for the United Kingdom, Germany and France (Figure 2-3-2).

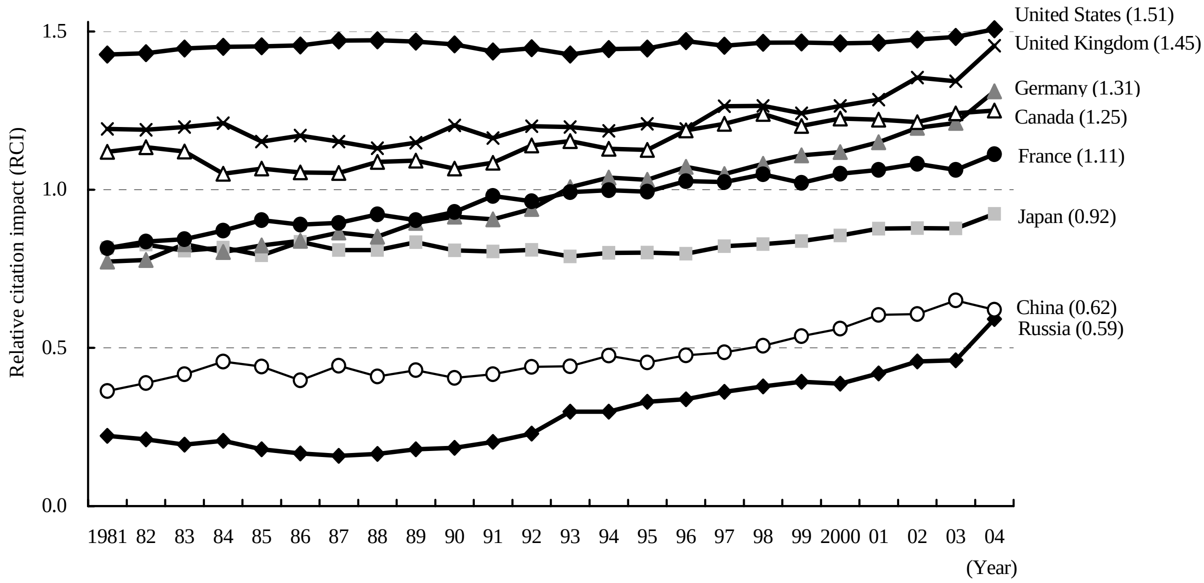


Figure 2-3-2 Trends in the relative citation impact for scientific papers in selected countries

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2004" (Thomson Scientific)

For Japan's RCI by field, excepting immunology, materials science and space science, no sector exceeds 1.0, and the results are generally low across fields (Table 2-3-3).

Table 2-3-3 Relative citation impact in Japan, by field

Rank	Research field	Relative citation impact
1	Immunology	1.05
2	Material science	1.04
3	Space science	1.03
4	Chemistry	0.99
5	Physics	0.99
6	Plant and animal science	0.98
7	Geosciences	0.93
8	Engineering	0.92
9	Biology and biochemistry	0.87
10	Molecular biology and genetics	0.87
11	Agricultural science	0.86
12	Medicine	0.81
13	Mathematics	0.79
14	Pharmacology	0.76
15	Ecology / environment	0.75
16	Neuroscience and behavior	0.75
17	Microbiology	0.71
18	Computer science	0.53

Note: Data is for 2000-2004
Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2004" (Thomson Scientific)

2.3.1.3 Trends in the Number of Scientific Papers in Selected Countries, by Field

The share of scientific papers written in selected countries by fields from 2000 to 2004 is shown in Figure 2-3-4. The life sciences field, which includes papers in the medical sciences, biology, agricultural sciences, and plant and animal science, accounts for the relatively high proportion of as much as 60% of all scientific papers in the United States and the United Kingdom. In Japan, Germany, and France, by contrast, the life sciences field accounted for about 50% of all scientific papers, with the fields of physics and chemistry accounting for a relatively high 30% of their totals.

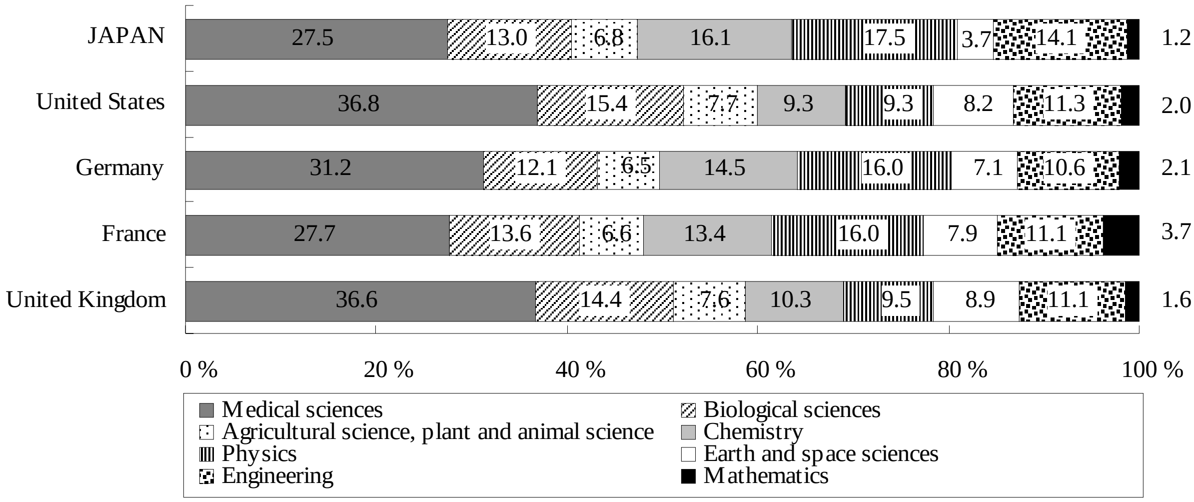


Figure 2-3-4 Number of scientific papers in selected countries, by field

Notes : 1. The composition of each field is as follows. Eighteen fields listed in the Thomson Scientific's National Science Indicators database are here amalgamated into eight fields.
(1) Medical sciences: Clinical medicine, immunology, neuroscience and behavior, and pharmacology
(2) Biological sciences: Biology and biochemistry, microbiology, and molecular biology and genetics
(3) Agricultural sciences, science: Agricultural sciences, plant and animal sciences
(4) Chemistry: Chemistry
(5) Physics: Physics
(6) Earth and space sciences: Space science, ecology/environment, and geosciences
(7) Engineering: Computer science, engineering, and materials science
(8) Mathematics: Mathematics
2. Figures of shares are calculated based on the numbers from 2000 to 2004

Source : Collected by the Ministry of Education, Culture, Sports, Science and Technology based on “National Science Indicators, 1981-2004” (Thomson Scientific)

Figure 2-3-5 shows Japan's scientific papers as a share of all papers written worldwide, by field, for the years 2000 to 2004. Materials science, physics, pharmacology, and chemistry are above Japan's average for all fields, demonstrating that Japan's research in these areas is relatively flourishing.

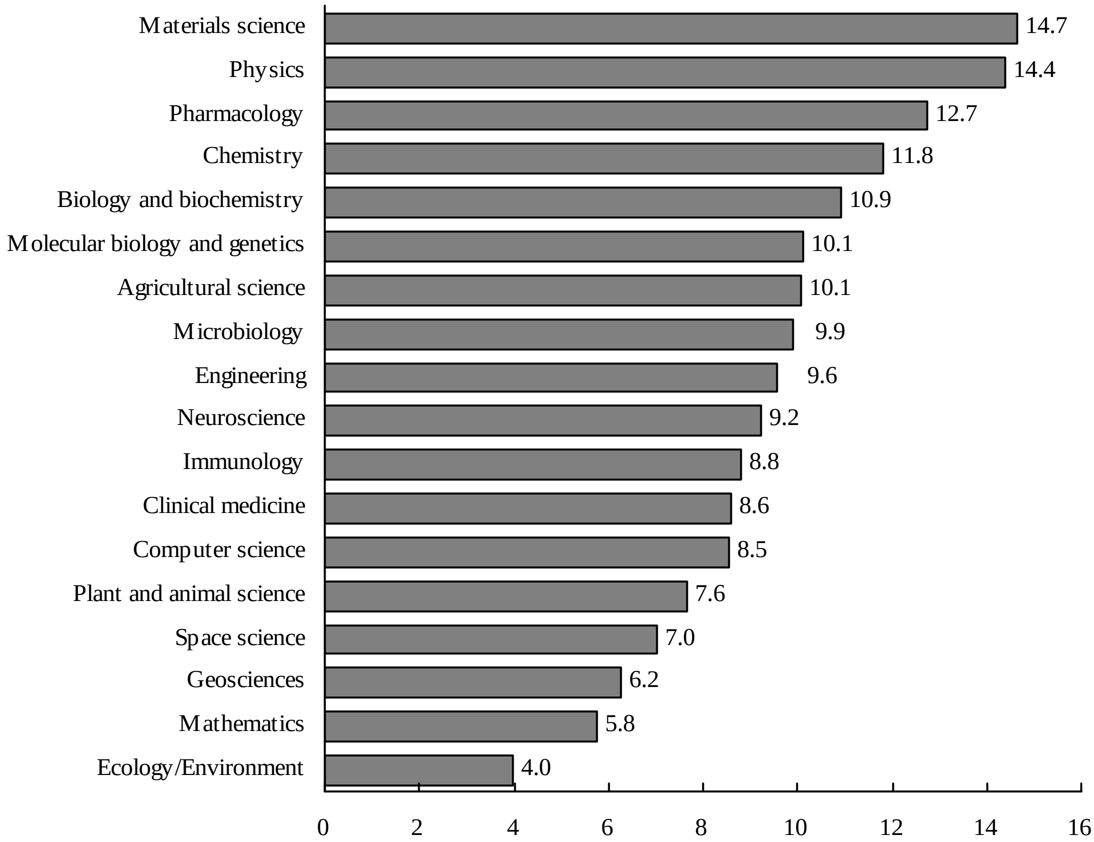


Figure 2-3-5 Japan's share of scientific papers, by field

Notes: 1. Figures are calculated from the aggregate values for 2000-2004.
2. Figures are Japan's share of all scientific papers in the world for each sector.

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2004" (Thomson Scientific)

2.3.1.4 Relative Comparative Advantage of Japan's Scientific Papers by Field

Another indicator marking trends in scientific paper production by field is the "Relative Comparative Advantage (RCA)" indicator. This takes the ratio of a country's scientific papers in a certain field to the country's total number of papers, and compares that ratio to the worldwide ratio of field papers to the total number. Figure 2-3-6 shows the trends in RCA for Japan's scientific papers. We can see that the value for chemistry has generally followed a downward trend through the years, while Earth/space is rising slightly.

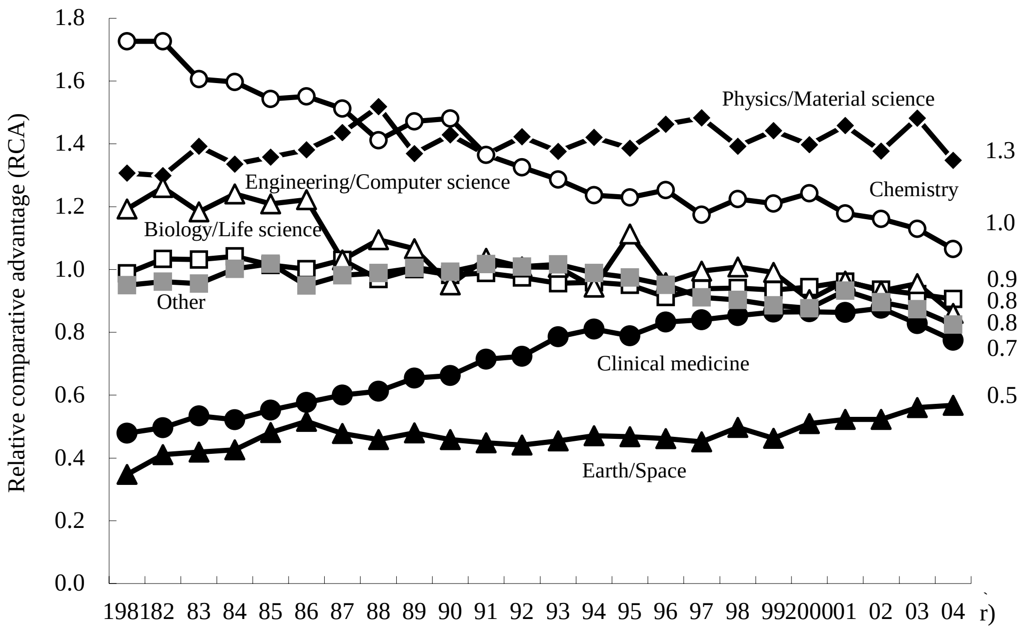


Figure 2-3-6 Trends in relative comparative advantage of scientific papers in Japan, by field

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2004" (Thomson Scientific)

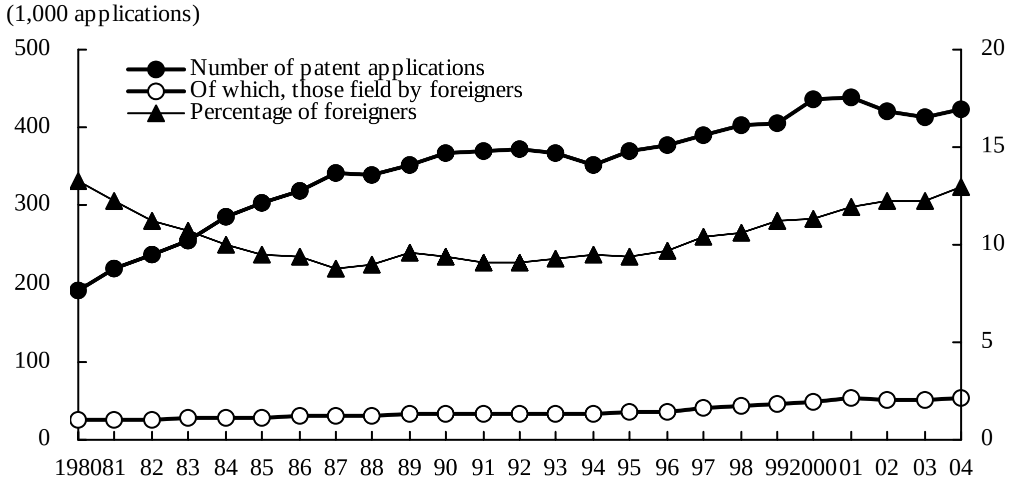
2.3.2 Patents

2.3.2.1 Trends in Patent Applications and Patents Granted in Japan

The number of patent applications in Japan peaked in 1992, but then fell when a new system was introduced allowing multiple inventions to be filed under a single patent application. The number of patent applications resumed their increase in 1995. Patent applications in Japan by foreign applicants have been relatively flat in recent years.

Meanwhile, the number of patents granted in Japan has been rising even as the share of patents granted to non-Japanese has decreased (Figure 2-3-12). Note that the sharp increase seen between 1995 and 1996 was mainly due to the patent post-grant objection system, which speeded up the grant process.

(1) Patent applications



(2) Granted patents

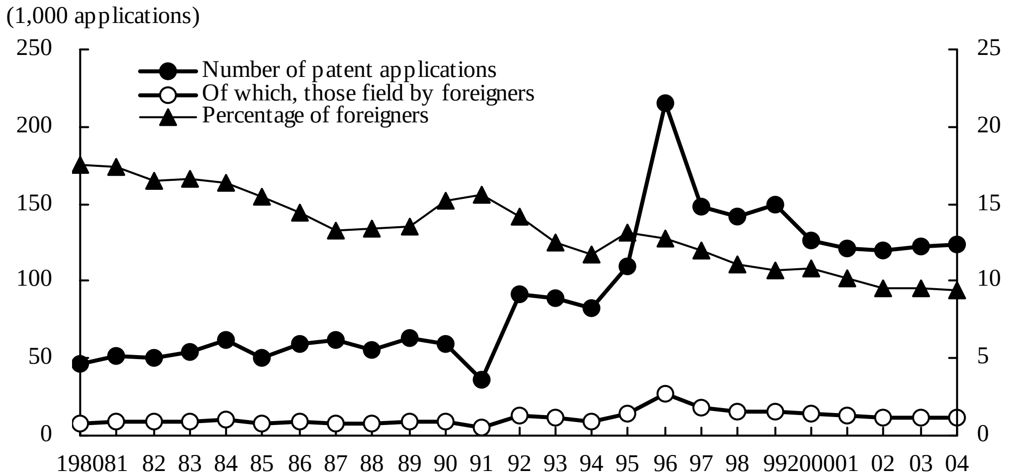


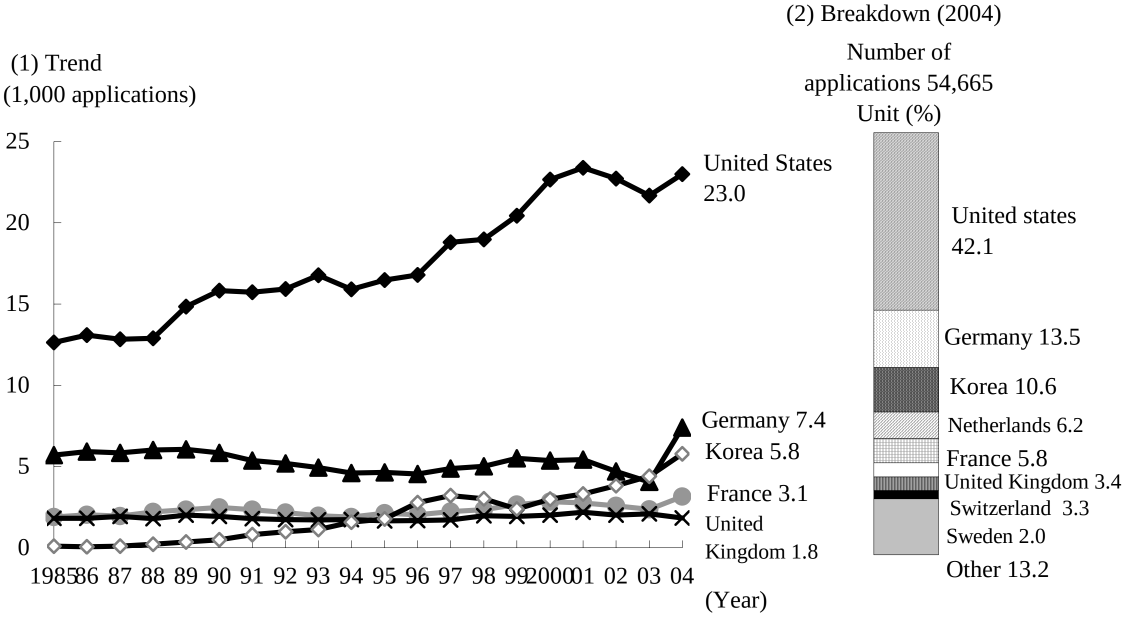
Figure 2-3-7 Trends in number of patent applications and granted patents in Japan

Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"

2.3.2.2 Foreign Patent Applications and Patents Granted in Japan

A look by nationality at the number of patent applications by non-Japanese in Japan reveals that while patent applications from the United States returned to increase recently, and Germany and South Korea have been increasing and those from other countries have been generally flat. The number of patents granted peaked in 1996 and has been declining since then (Figure 2-3-8).

(1) Patent applications



(2) Granted patents

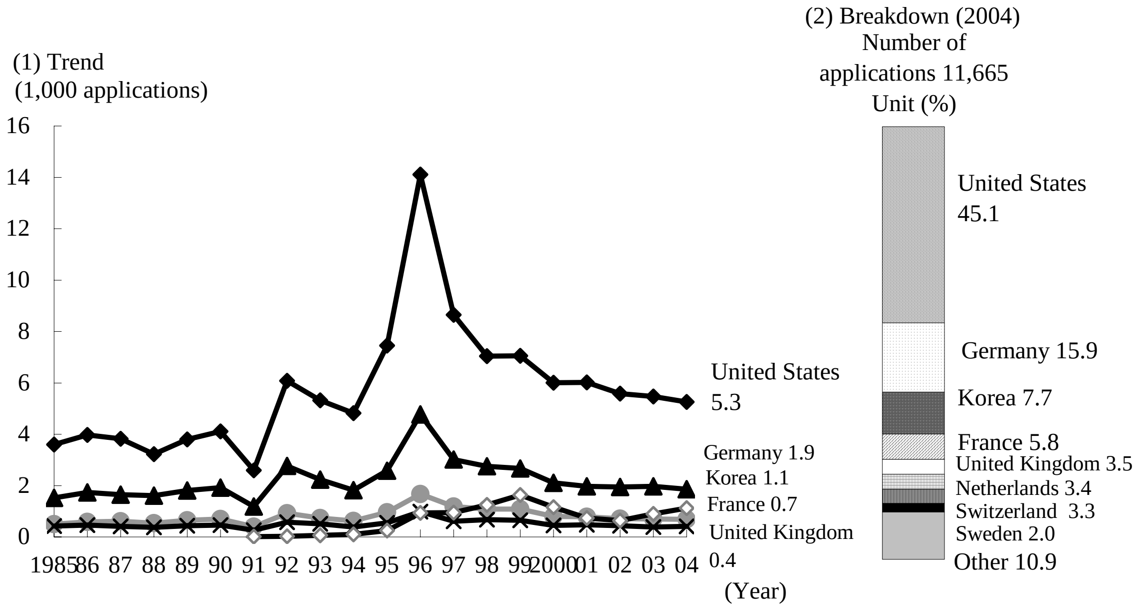


Figure 2-3-8 Number of patent applications and granted patents by nationality of foreign inventors

Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"IBT

2.3.2.3 Patent Applications in Japan by Field

Patent applications by category[19] in 2003 showed no change in ranking from the previous year (Table 2-3-9).

Table 2-3-9 Number of patent applications by field of technology in Japan (2003)

Fields of technology	Number of applications	Composition rate (%)
Human necessities	47,399	11.5
Performing, operations, transportation	70,223	17.1
Chemistry, metallurgy, textiles	51,016	12.4
Fixed construction	14,609	3.6
Mechanical engineering	34,796	8.5
Physics	99,428	24.2
Electricity	93,585	22.8
Total	411,056	100

Source: Japan Patent Office. "Japan Patent Office Annual Report 2004"

[19] Patent classifications are assigned to patents at the point when the applications are disclosed (after a period of 18 months or more).

2.3.3 Technology Trade

Patents, utility models, and technical know-how result from R&D efforts in science and technology. In addition to being used by corporations for their own purposes, they are traded internationally, for example in the form of transfer of rights, approval of utilization, and others. These transactions are what are known as technology trade.

2.3.3.1 Trends in the Technology Trade

The import-export value of technology trade in major selected countries has been growing in response to the advancing globalization of corporate activities, and to trends in recent years that put greater emphasis on intellectual property rights (Figure 2-3-10). While differences in the methods for gathering statistics in each country make simple comparisons difficult, the United States appears to have by far the largest technology trade imports and exports, with the export value, in particularly, soaring far beyond all other countries.

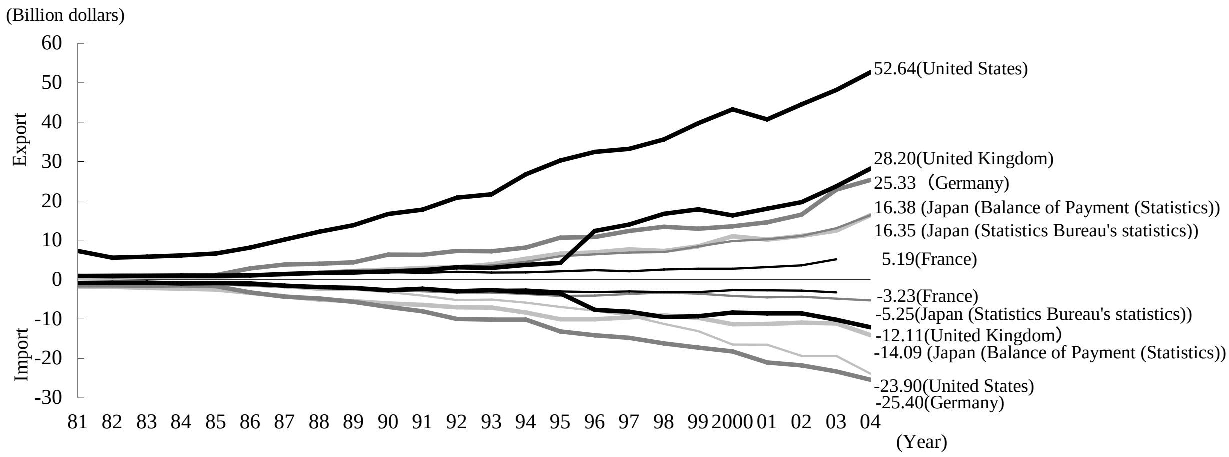


Figure 2-3-10 Trend in technology trade of selected countries

Notes: 1. The amounts are converted into dollars, based on IMF exchange rate.
2. (Balance of Payments Statistics) refers to "Balance of Payments Monthly" published by the Bank of Japan. (Statistics Bureau's statistics) refers to the "Report on the Survey of Research and Development," published by the Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications.
3. The figures are totals for the calendar year; the fiscal year is used only for the figures of Japan ("Report on the Survey of Research and Development").
4. The major reasons for differences between the figures provided by the Bank of Japan and those provided by the Statistics Bureau are as follows.
1) Survey Method: The Balance of Payments Monthly contains compilations of all sums listed in the balance of international payments item "Royalties and License fees" in reports submitted based on the Foreign Exchange and Foreign Trade Law, while the report on the Survey of Research and Development contains compilations of responses to surveys mailed to companies and handled as designated statistics based on the Statistics Law.
2) Survey Coverage: The Balance of payments Monthly covers all residents who remitted foreign exchange by invisible trade involving 5 million yen or more, while the Survey of Research and Development omits industries such as retail and restaurants from its target.
3) The Scope of Technology Trade: The Balance of Payments Monthly includes rights and technical guidance, etc., for patents, utility models, and know-how, as well as compensation for trademark, industrial designs, and copyrights. Furthermore, the Balance of Payments Monthly does not include technology trade cases where foreign ex-change transfers cover the value of the technology export portions of plant export.
5. For Germany, figures up to FY1989 are for the former West Germany.

Sources: Japan-Bank of Japan. "Balance of Payments Monthly," Statistics Bureau. "Report on the Survey of Research and Development"
Others-OECD “Main Science and Technology Indicators”

Sources for the value of Japan's technology trade include the Bank of Japan's "Balance of Payments Monthly" (hereinafter in this chapter referred to as "Balance of Payments statistics") and " Report on the Survey of Research & Development" (hereinafter in this chapter referred to as "Statistics Bureau's statistics") by the Statistics Bureau (Ministry of Internal Affairs and Communications). Where the Statistics Bureau's statistics focus on the state of research activities in Japan, the Balance of Payments statistics focus on foreign currency management.

From the perspective of balance of payments, the Balance of Payments statistics show that the values of imports and exports are nearly equal, while the Statistics Bureau's statistics show an excess of exports.

2.3.3.2 Trends in the Technology Trade Balance

Japan's technology trade balance has been rising, while that for the United States has been falling, with the result that the Statistics Bureau's statistics for 2002 show Japan in the No.1 ranking. While the Balance of Payments statistics had shown an excess of imports, the trade balance has been improving and has rolled over to an excess of exports (Figure 2-3-11). Elsewhere, France and the U.K. have moved into an excess of exports, and Germany is going to shift to an excess of exports.

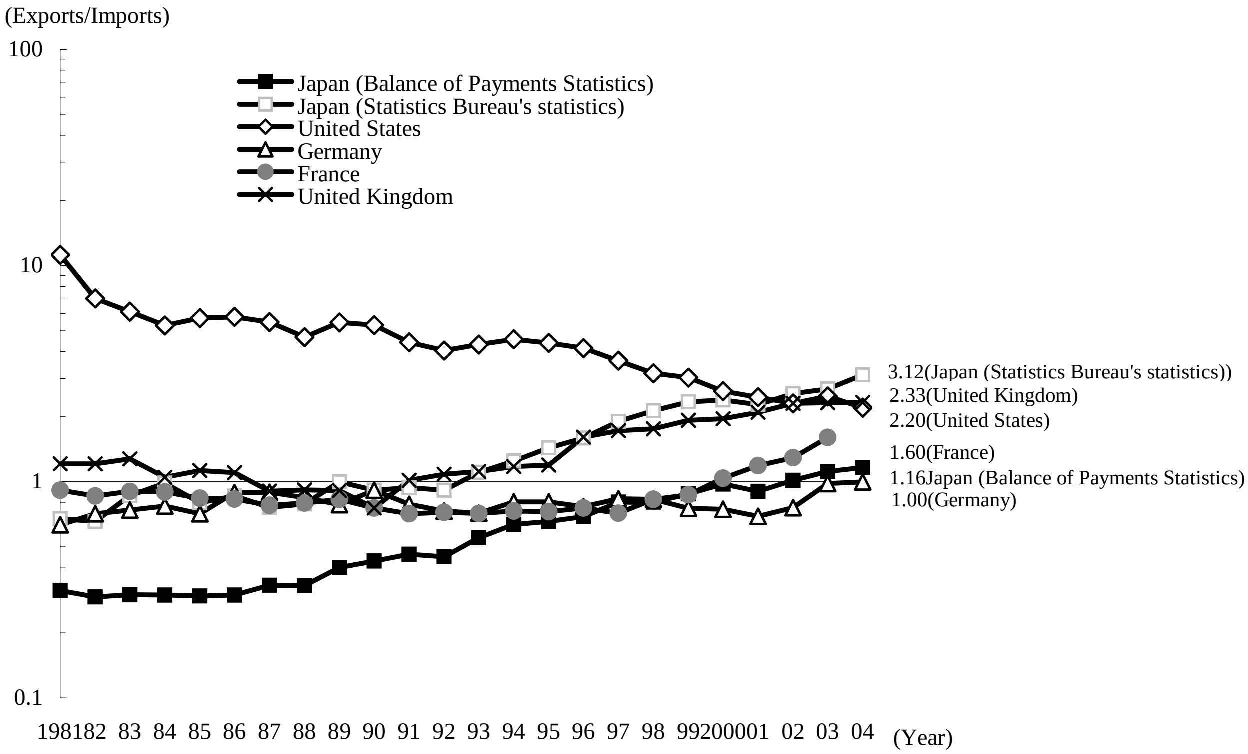


Figure 2-3-11 Trends in the technology trade balance of selected countries

Source: Same as in Figure 2-3-10

For the technology trade balance between Japan and major selected countries, the Balance of Payments statistics and the Statistics Bureau's figures show conflicting trends, with the former showing an excess of imports, and the latter showing an excess of exports (Table 2-3-12).

Table 2-3-12 Japan's technology trade balance with individual selected countries

	Technology trade couterpart	United States	Germany	France	United Kingdom
(2003)	Balance of Payments Statistics	0.75	0.54	0.34	1.22
	Statistics Bureau's statistics	1.79	1.01	0.38	2.94
(2004)	Balance of Payments Statistics	0.77	0.36	0.46	1.66
	Statistics Bureau's statistics	1.89	1.40	0.71	4.08

Note: The trade balance is a ratio derived by dividing the total export value by the total import value.
Source: Bank of Japan. "Balance of Payments Monthly," Statistics Bureau. "Report on the Survey of Research and Development"

2.3.3.3 Trends in Japan's Technology Trade with Other Countries (Regions)

Japan's technology trade balance with major countries is improving in the long run, with fluctuations in some years, according to the Statistics Bureau's statistics (Figure 2-3-13).

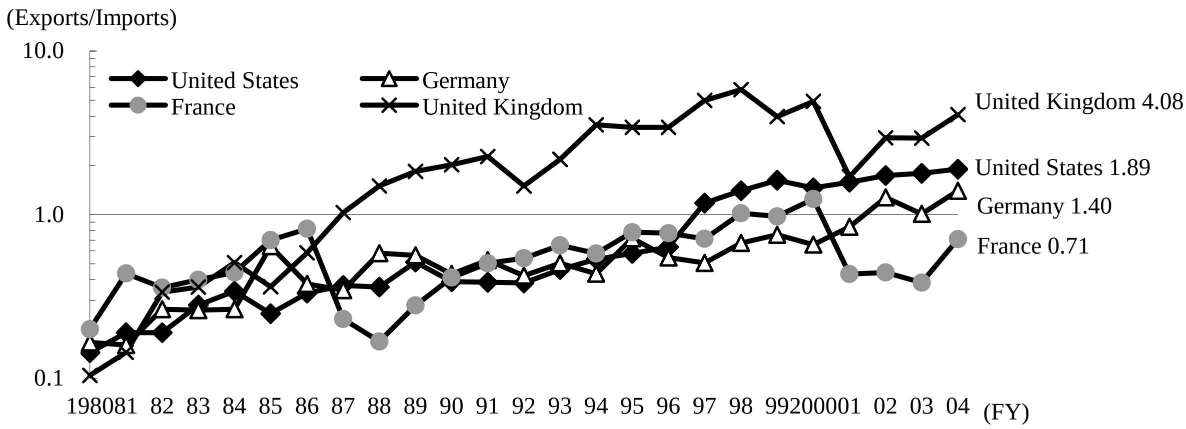


Figure 2-3-13 Trends in technology trade balance of Japan with other selected countries

Note: For Germany, figures up to FY1989 are for the former West Germany.
Source: Statistics Bureau, "Report on the Survey of Research and Development"
(See Appendix 3 (17))

A look at Japan’s technology trade for fiscal 2004 by region shows that North America was the destination for more than half of all technology exports by value, followed in order by Asia and Europe. The United States was the single largest export destination, with more than 40% of all exports by value, while in Asia the major partner countries (regions) were relatively closer to Japan. In Europe, the United Kingdom was the destination with the highest percentage of exports.

For technology imports by value, the United States was the overwhelmingly most important source, at two-thirds of all technology imports, while imports from Europe were distributed relatively evenly from all major European countries except France, which held a disproportionately high share (Figure 2-3-14).

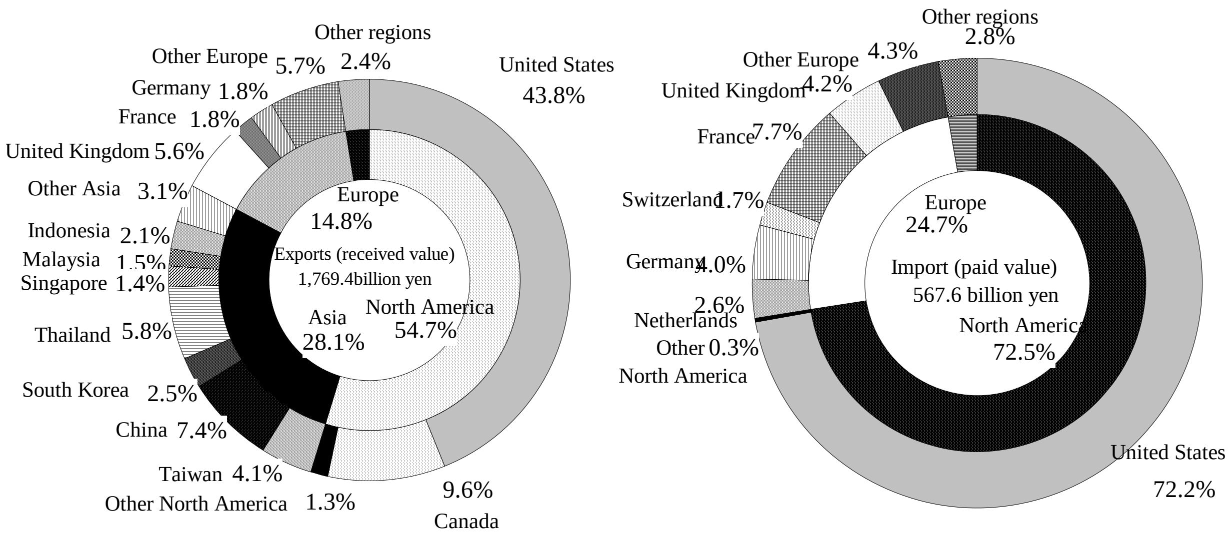


Figure 2-3-14 Composition of Japan's technology trade, by selected country and region (FY2004)

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

As late as fiscal 1996, Japan had an excess of imports with Europe and North America, and an excess of exports with Asia. Starting in fiscal 1997, however, Japan's technology trade balance shifted to an export surplus with all regions, and then to an import surplus with Europe in fiscal 2001 (Figure 2-3-15).

(Billion yen)

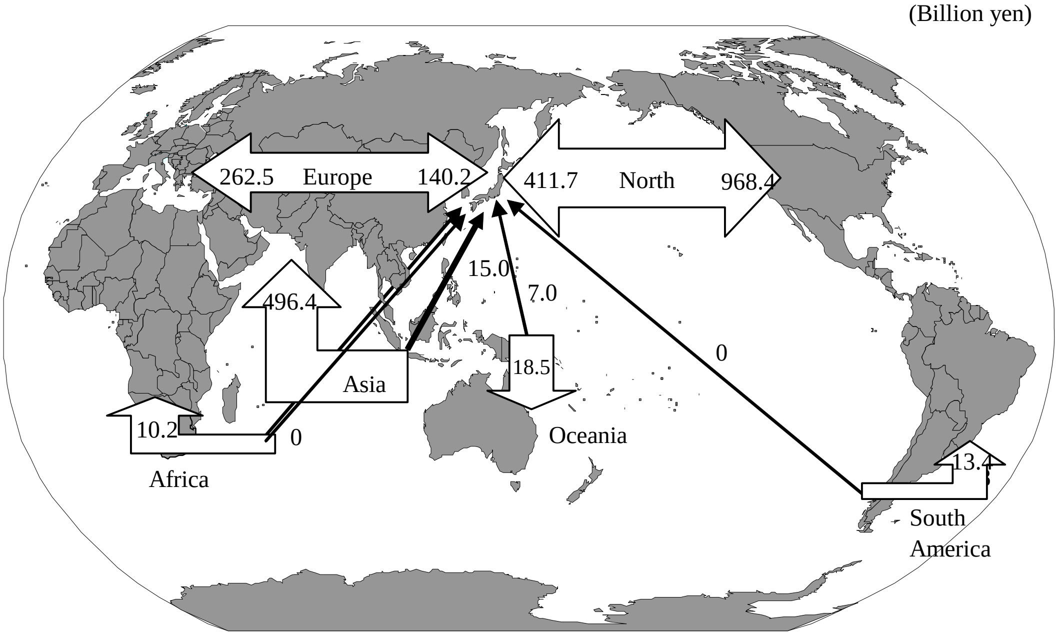


Figure 2-3-15 Technology trade by region (FY2004)

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

2.3.3.4 Trends of Japan's Technology Trade by Industry Sector

Using the Statistics Bureau's statistics to look at Japan's technology trade by industrial category in the manufacturing sector in fiscal 2004, we find that such high-tech related industries as the motor vehicles industry, the information and telecommunications machinery industry, the electrical parts and devices industry, the electrical machinery industry, and the pharmaceutical industry accounted for the majority of both exports and imports (Figure 2-3-16).

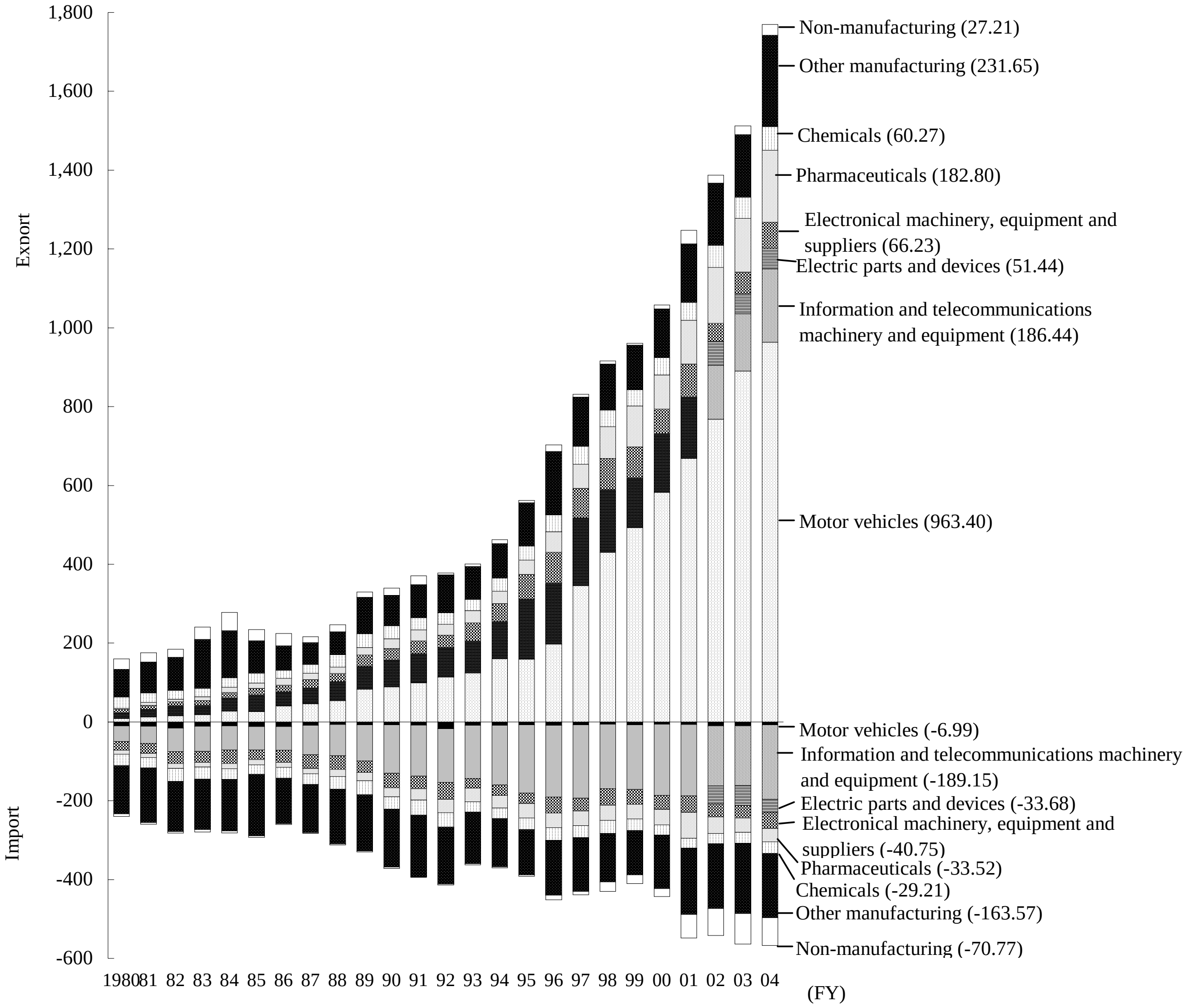


Figure 2-3-16 Trends in technology trade by industry sector

Note: The software industry in 1996, and the wholesale trade, banking and insurance, professional services, other services and academic research institutes in 2001 were newly added to the scope of the survey respectively. The 2002 revision of industrial categories split "telecommunications, electronics and electrical instruments into "Information and telecommunications machinery and equipment" and "Electrocis parts and devices".
Source: Statistics Bureau, "Report on the Survey of Research and Development

For the trends over time in the technology trade balance, the motor vehicles industry has long had an excess of exports and is steadily widening its technology trade balance. The electrical machinery, equipment and supplies industry, which had once been tilted toward imports, has had an excess of exports since fiscal 1993. While the drug and medicines industry tilted over to an excess of exports in fiscal 1996. The technology trade balance in the electrical parts and devices industry—a new category since fiscal 2002—has shown an excess of exports, while the information and communications machinery industry has shown an excess of imports. (Figure 2-3-17).

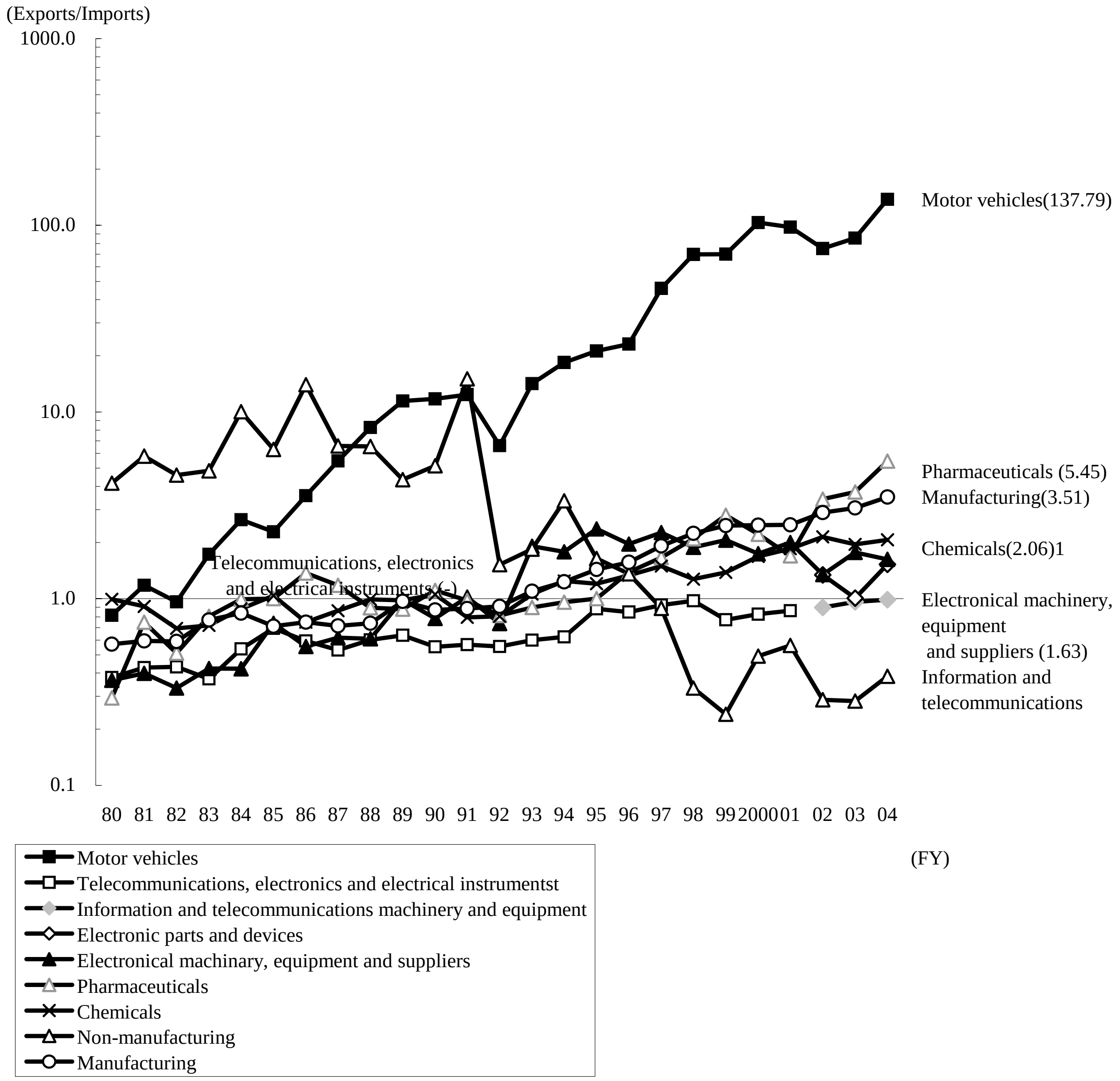


Figure 2-3-17 Trends in technology trade balance in major industry sectors

Note: The software industry in 1996, and the wholesale trade, banking and insurance, professional services, other services and academic research institutes in 2001 were newly added to the scope of the survey respectively. The 2002 revision of industrial categories split "telecommunications, electronics and electrical instruments into "Information and telecommunications machinery and equipment" and "Electrocis parts and devices".

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

For the balance of payments in technology trade by trade partner country, region and industrial category, the motor vehicle industry shows an excess of exports with all other countries, with a particularly large technology export trade by value with the United States. The information and telecommunications machinery and equipment industry generally shows a strong excess of exports with Asia, but holds an excess of imports overall. The drug and medicine industry trades overwhelmingly with Europe and the United States, and holds an overall export surplus (Figure 2-3-18).

Table 2-3-18 Technology trade balance of payments by trade partner country and region for major industrial categories in Japan (FY2004)

Motor vehicles (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
United States	498.5	3.0	495.5
Thailand	64.7	0.0	64.7
United Kingdom	50.7	0.4	50.3
China	24.0	0.0	24.0
Taiwan	18.0	-	-
South Korea	5.6	-	-
Other	301.9	3.5	298.4
Total	963.4	7.0	956.4

Information and telecommunications machinery and equipment (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
United States	47.3	148.3	-101.0
China	39.4	1.9	37.5
South Korea	13.3	0.3	13.0
Singapore	13.1	0.2	12.9
Malaysia	12.3	0.0	12.3
Netherlands	10.7	5.7	5.0
Taiwan	8.6	1.7	6.9
United Kingdom	1.6	8.8	-7.2
France	0.6	9.1	-8.5
Other	39.6	13.2	26.4
Total	186.4	189.1	-2.7

Pharmaceuticals (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
United States	117.3	13.6	103.7
United Kingdom	32.7	8.5	24.2
Germany	7.8	6.5	1.3
France	6.2	0.8	5.4
Switzerland	5.2	0.6	4.6
Sweden	0.1	0.4	-0.3
Netherlands	0.1	0.8	-0.8
Other	13.4	2.2	11.2
Total	182.8	33.5	149.3

Note: Symbol Key: "－" amounts to exactly zero.
Source: Statistics Bureau, "Report on the Survey of Research and Development"

2.3.4 High-tech Industries

High-tech industries[20] require large investments in R&D, as well as sophisticated technology during their manufacturing process.

For this reason, the size of high-tech product exports can be seen as an indicator of one aspect of an industry's international competitiveness in science and technology. Therefore, we use OECD data to look at the export shares of high-tech industries, and to make country comparisons of trade balances.

2.3.4.1 Trends in the Export Shares of High-tech Industries in Major Countries

Japan's share of high-tech industrial exports by value was third to the United States and Germany among OECD countries. This share had been declining. (Figure 2-3-19).

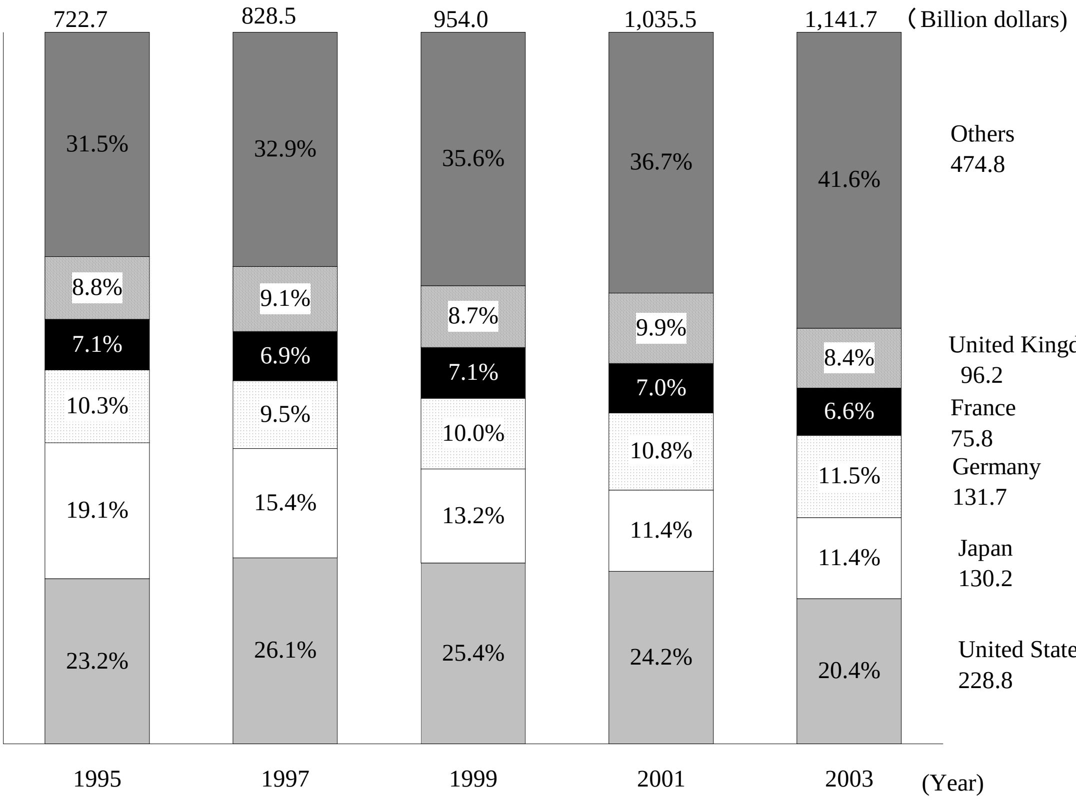


Figure 2-3-19 Export market shares for high-tech products by country in OECD countries

Note: The amount of export is converted into dollars.
Source: OECD "Main Science and Technology Indicators"

[20] High-tech industry: At the OECD, the ratio of R&D expenditures to production is calculated by industry sector, and the five industries with the highest ratios are classified as high-tech industries: aerospace, office and computing machinery, electronics, pharmaceuticals, and medical/precision/optical equipment.

The total value of high-tech industrial exports has declined in all major countries, while the share for other OECD countries is rising. Japan's share of the total was particularly high in the electronics industry and medical/precision/optical equipment industry. Japan's share was relatively low in the aircraft and the drug and products industry (Figure 2-3-20)

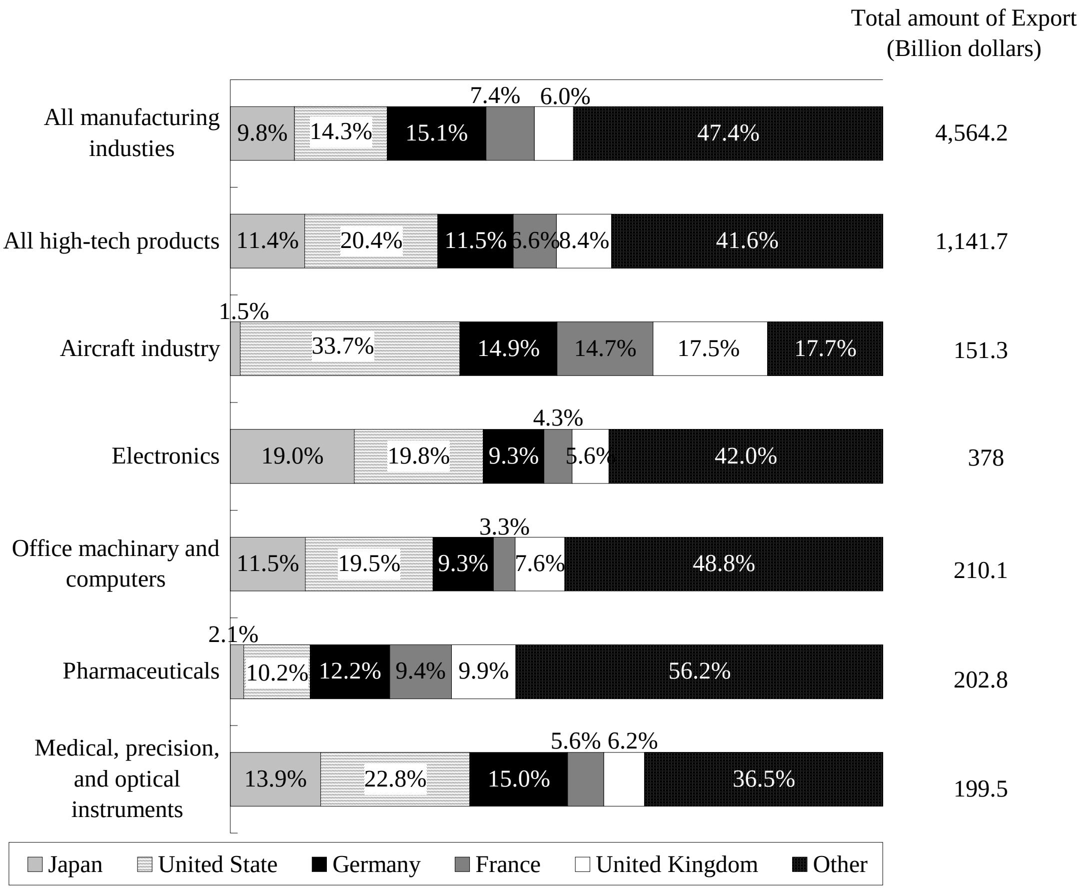


Figure 2-3-20 Share of high-tech products by country manufactured in OECD (2003)

Note: The amount of export is converted into dollars.
Source: OECD. "Main Science and Technology Indicators," "STAN Database"

2.3.4.2 Trends in Export from and Import to Japan's High-tech Industry

The trend for Japan's high-tech industry shows that both exports and imports increased slightly by value. It would appear that the high-tech industry is much less affected by changes in the business climate than the manufacturing industry as a whole (Figure 2-3-21).

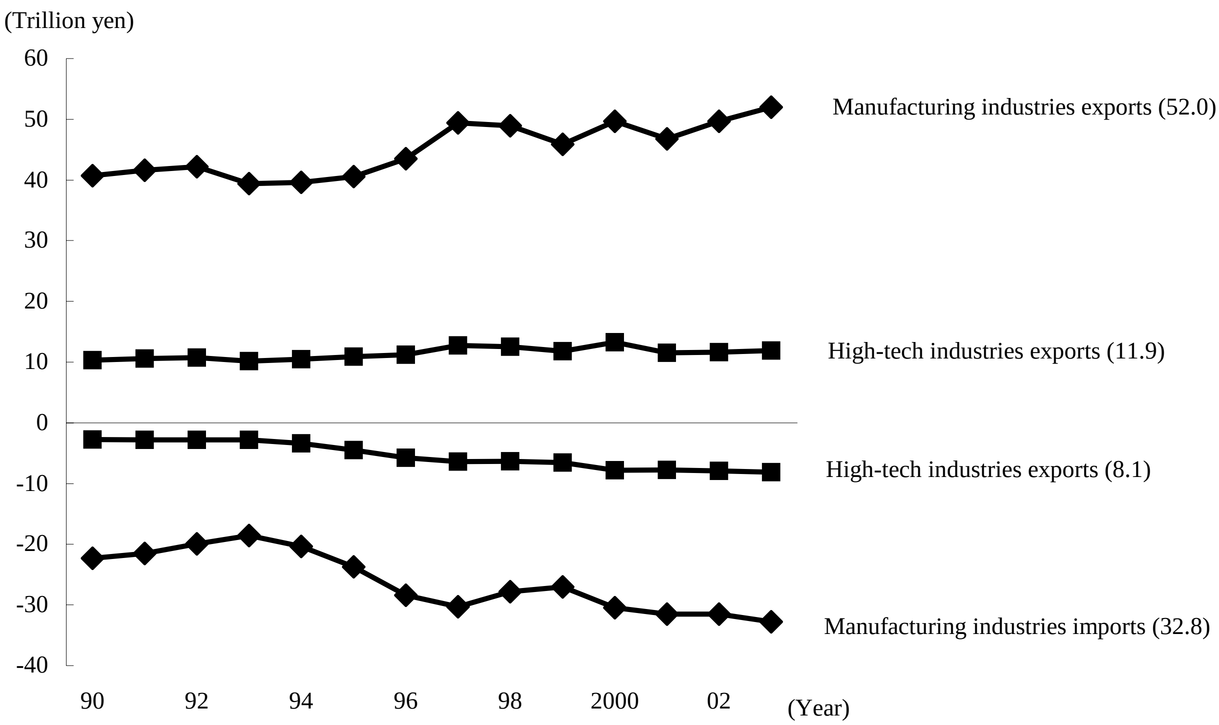


Figure 2-3-21 Trends in imports and exports, by value, for Japan's general manufacturing industry, and the high-tech industry

Source: OECD. "Main Science and Technology Industries," "STAN Database"

2.3.4.3 Trends in High-Tech Industry Trade Balances in Major Countries

A look at Japan's trade balance in high-tech industries shows that the balance of payments ratio is approaching 1.0. The United States, Germany, France and the United Kingdom have balance of payments ratios nearing 1.0 (Figure 2-3-22).

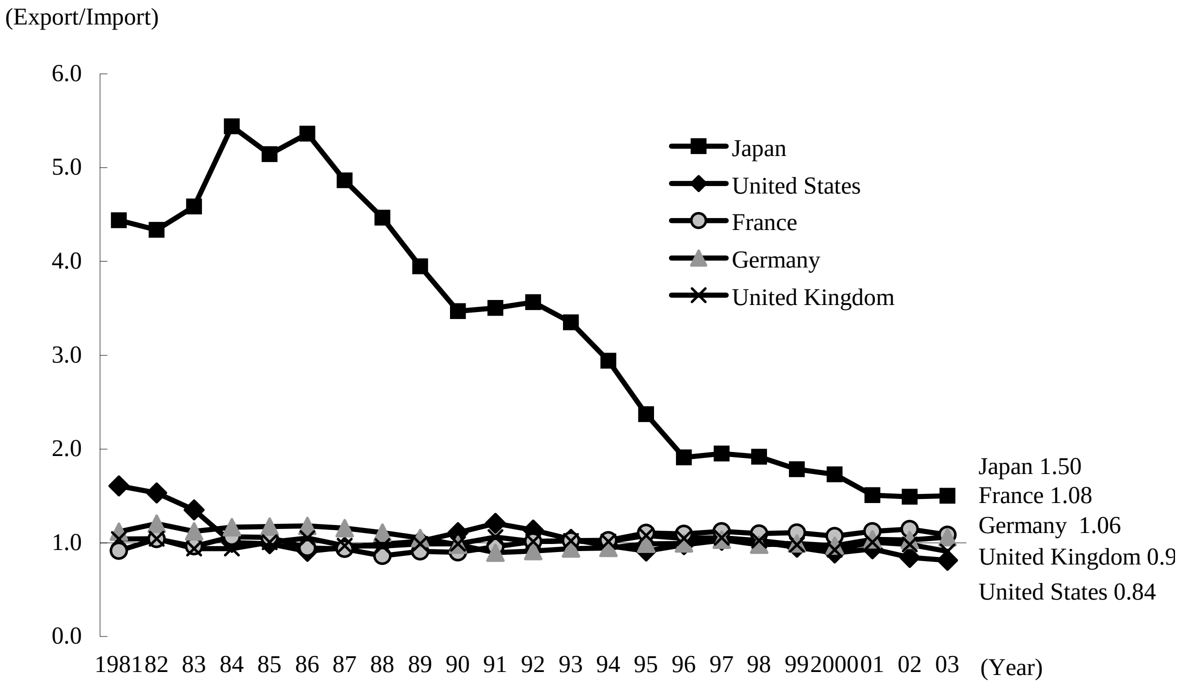


Figure 2-3-22 Trends in high-tech balance of payment ratios for selected countries

Source: OECD. "Main Science and Technology Indicators"

2.3.4.4 Balance of Payments for Japan's High-tech Trade, by Industries

The balance of payments for Japan's high-tech trade in 2003, by industry, was as shown in Table 2-3-23. The electronics and medical, precision, and optical equipment industries showed a higher balance of payments ratio than the high-tech industry overall. The drug and medicines industry and the aerospace industry, on the other hand, had extremely low balance of payment ratios, and were both heavily tilted toward imports.

Table 2-3-23 Balance of payments for Japan's high-tech trade, by industry (2003)

Export and import amounts	Exports (billion yen)	Imports (billion yen)	Trade balance
All manufacturing	51,989	32,778	1.59
All high-tech products	15,093	10,051	1.50
Electronics	8,329	3,685	2.26
Office Machinery & Computer Industry	2,801	2,807	1.00
Medical, precision, and optical equipment	3,211	1,909	1.68
Pharmaceuticals	484	860	0.56
Aerospace	269	791	0.34

Source: OECD. "Main Science and Technology Indicators," "STAN Database"

2.4 Efforts to Develop New Science and Technology Indicators

The indicators discussed in Chapters 2.1 to 2.3, such as R&D expenditures, numbers of researchers, numbers of scientific papers, numbers of patent applications and grants, and value of technology trade, are important as basic data for use in planning Japan's science and technology policies. While various surveys and investigations have helped to provide the above data, under the increasing complexity and globalization, etc., of scientific and technological activities in recent years, the current indicators and survey methods are being reviewed, and new indicators are being developed to grasp the shape of the national scientific and technological activities more accurately. In this section, we introduce the efforts being taken by the OECD and those being taken in Japan.

2.4.1 Efforts by the OECD

The OECD established the Working Party of National Experts on Science and Technology Indicators (NESTI) as a subsidiary organization within the Council for Science and Technology Policy (CSTP). The NESTI is working to improve methods for collecting internationally comparable data concerning science and technology activities, included R&D, and on the development of new indicators.

At its June 2005 meeting, NESTI adopted a revision proposal relating to the Oslo Manual, an international standard for the collection and interpretation of data on innovation activities. Japan had participated in the preparation of this revision proposal since 2003.

Additionally, NESTI is reviewing Field of Science (FOS) classifications used in R&D statistics and is also moving forward with a study aimed at the development of indicators regarding Human Resources in Science and Technology (HRST).

2.4.2 Efforts in Japan

2.4.2.1 Ministry of Internal Affairs and Communications

The Ministry of Internal Affairs and Communications has been conducting surveys of business enterprises, non-profit institutions, public organizations, and universities concerning science and technology indicators for R&D expenditure, the numbers of researchers, the amount of technology trade, etc., in Japan. This survey was originally started in 1953 as the Basic Statistical Survey of Research Institution, with the name changing in 1960 to the current Survey of Research & Development. Since that time, the coverage of the survey has been expanded and new variables added several times, to reach its present focus. To reflect the increasingly important roles of software and services in industry, and to improve the quality of international comparisons, the survey was subjected to an exhaustive review in fiscal 2001, after which a new survey was launched in fiscal 2002 with new survey categories and survey coverage.

2.4.2.2 Ministry of Education, Culture, Sports, Science and Technology

In November 2002, the MEXT conducted the “Survey of Full-time Equivalency Data at Universities,” targeting teachers and doctoral students at all types of universities across Japan in order to gain an understanding of the Full-Time Equivalency (FTE) of researchers at “universities” in the “Survey of Research and Development.”

The total results for valid replies showed that the full-time equivalencies of teachers and doctoral students at universities are annual averages of 46.5% and 70.9%, respectively.

Table 2-4-1 Full-Time Equivalency (FTE) for university faculty and doctoral students (2002)

	Persons	FTE factor	FTE
Faculty members	171.094	0.465	79.604
Doctoral students	64.019	0.709	45.419

Note: Data on the number of people comes from the "FY2002 Report on the Survey of Research and Development."

Since 1991, the National Institute of Science and Technology Policy (NISTEP) has revised the science and technology indicators and drawn up reports for the purpose of obtaining a comprehensive, objective grasp of scientific and technological activities. In the fifth edition of the “Science and Technology Indicators Report” compiled in April 2004, the previous science and technology indicators were revised mainly as follows.

1. Introduces indicators that demonstrate the progress of a knowledge-based society
2. Introduces indicators that demonstrate transformations in knowledge production methods for science and technology
3. Introduces data on coordination between industry and academia
4. Enhances indicators relating to dissertations and patents
5. Improves the reliability and applicability of comprehensive science and technology indicators

In addition to the above revision, since fiscal 2001 data has been updated and published once a year.