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.

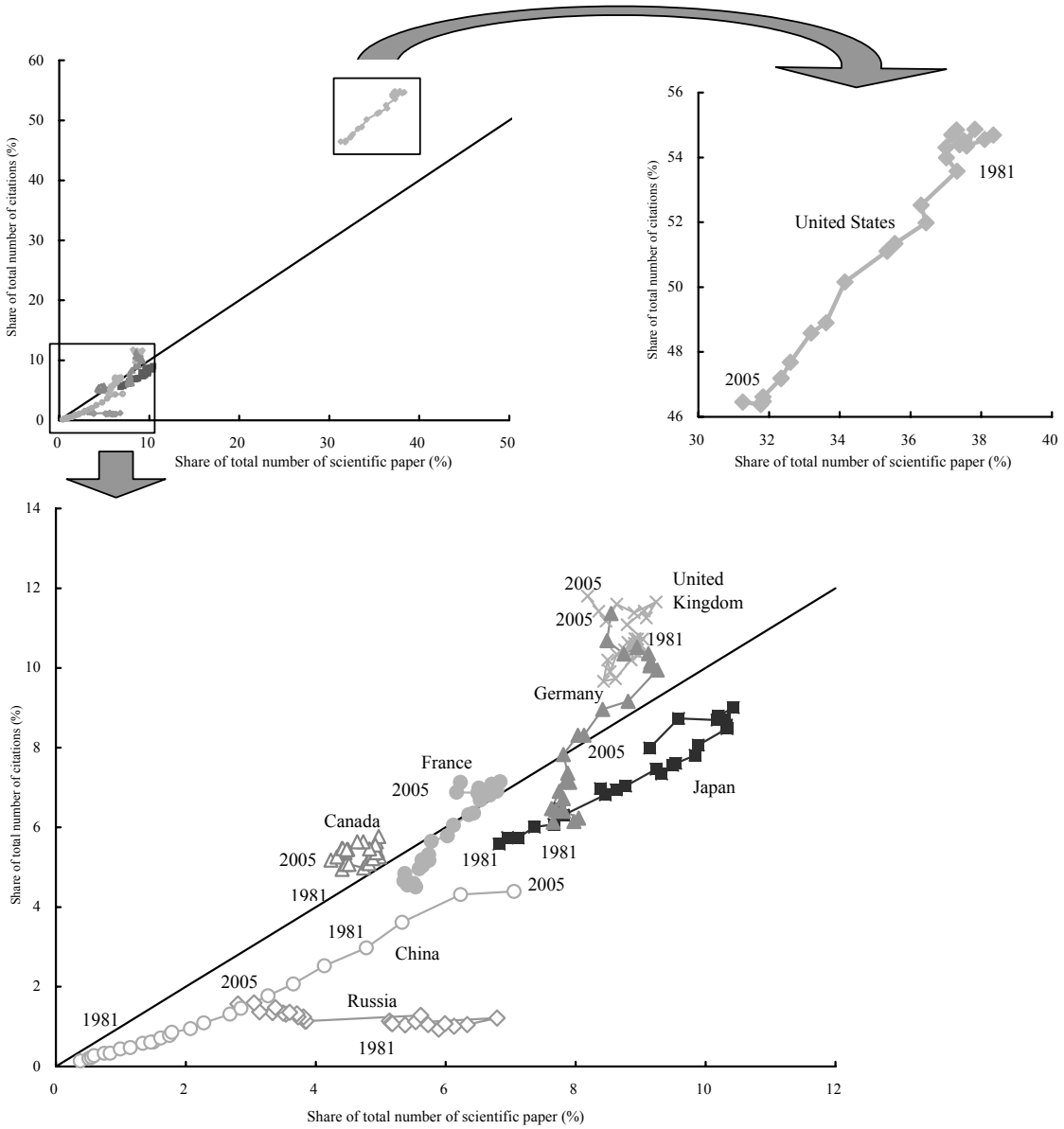


Figure 2-3-1 Relationship between the world total for scientific papers and for citations in scientific papers

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, 1981-2005" (Thomson Scientific)

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[19] 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 2005, 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 1990 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 2005 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 1990, and the ratio to total citations remains much lower than the share of the total number of scientific papers published (Figure 2-3-1).

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

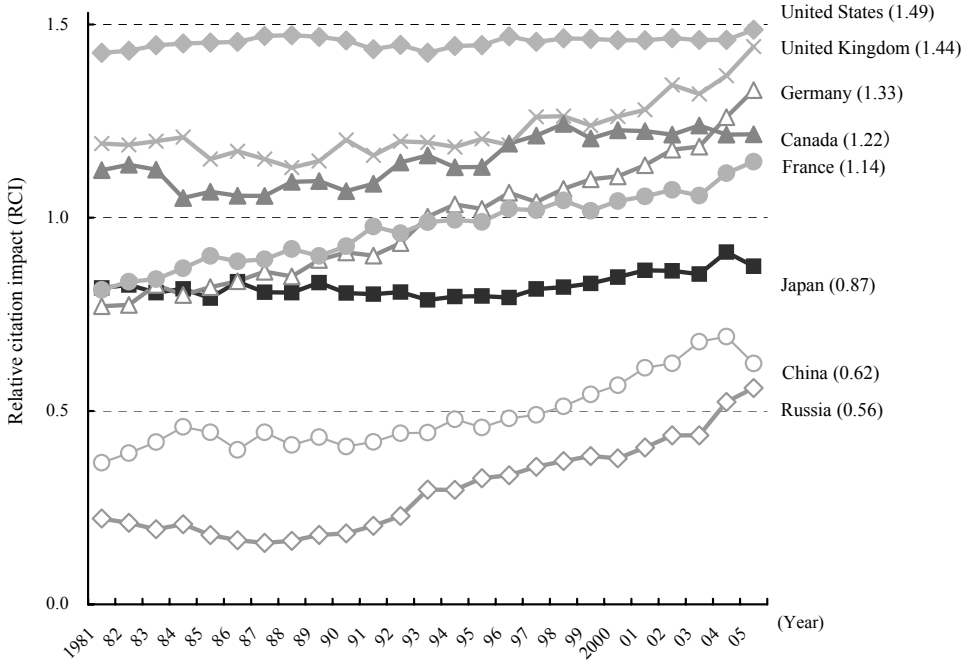


Figure 2-3-2 Trends in the relative citation impact for scientific papers in selected countries

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2005" (Thomson Scientific)

[19] 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.

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).

For Japan's RCI by field, excepting space sciences, immunology, materials science, plant and animal science and physics, 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 citaion impact
1	Space science	1.11
2	Immunology	1.07
3	Materials science	1.03
4	Plant and animal science	1.01
5	Physics	1.00
6	Chemistry	0.99
7	Engineering	0.96
8	Geosciences	0.95
9	Molecular biology and genetics	0.88
10	Agricultural sciences	0.87
11	Biology and biochemistry	0.87
12	Clinical medicine	0.82
13	Ecology/environment	0.81
14	Mathematics	0.79
15	Pharmacology	0.78
16	Neurosciences and behavior	0.75
17	Microbiology	0.72
18	Computer science	0.52

Note: Data is for 2000-2005
Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2005" (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 2001 to 2005 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 2-3-5 shows Japan's scientific papers as a share of all papers written worldwide, by field, for the years 2001 to 2005. 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.

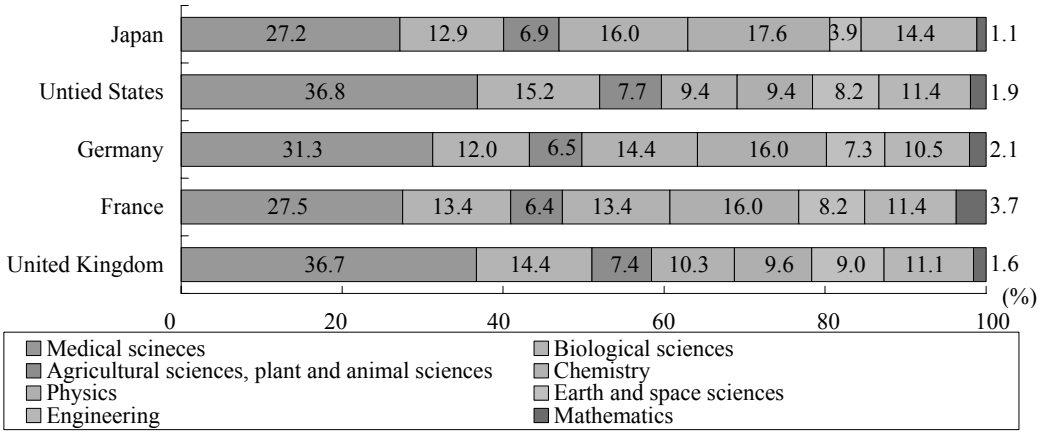


Figure 2-3-4 Number of scientific papers in selected countries by field

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, plant and animal science: Agricultural sciences, plant and animal science
(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 2001 to 2005.

Source : Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2005" (Thomson Scientific)

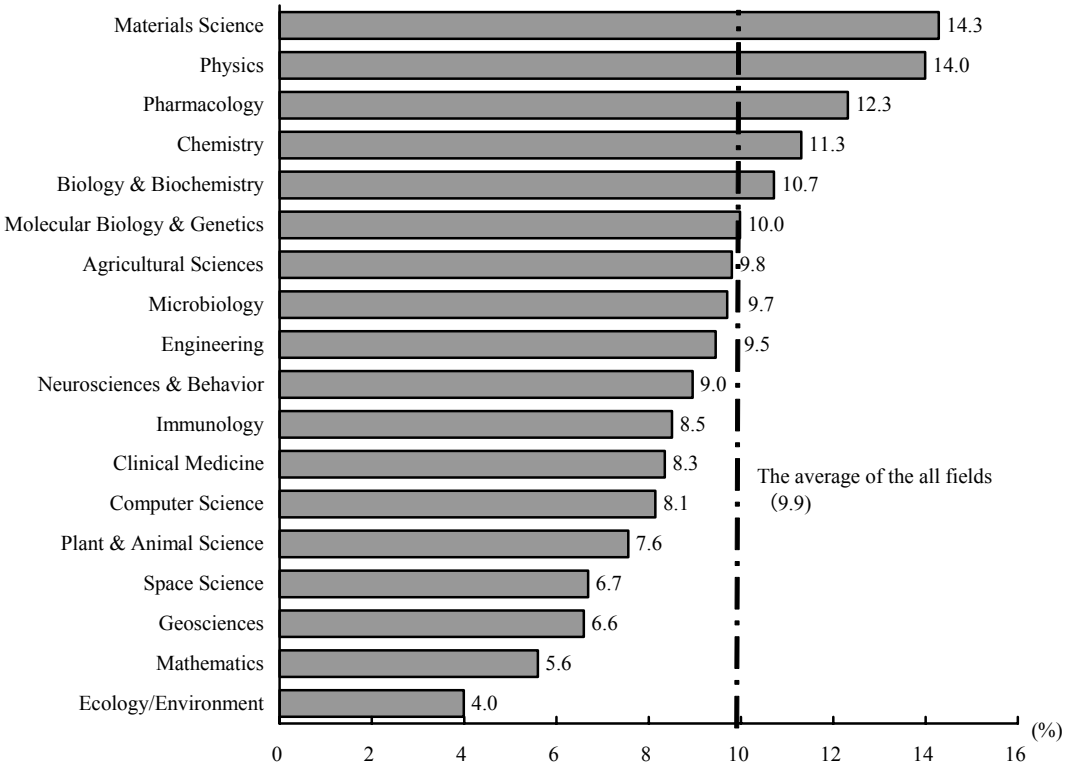


Figure 2-3-5 Japan's share of scientific papers by field

Notes: 1. Figures are calculated from the aggregate values for 2001 to 2005.
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, 1981-2005" (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.

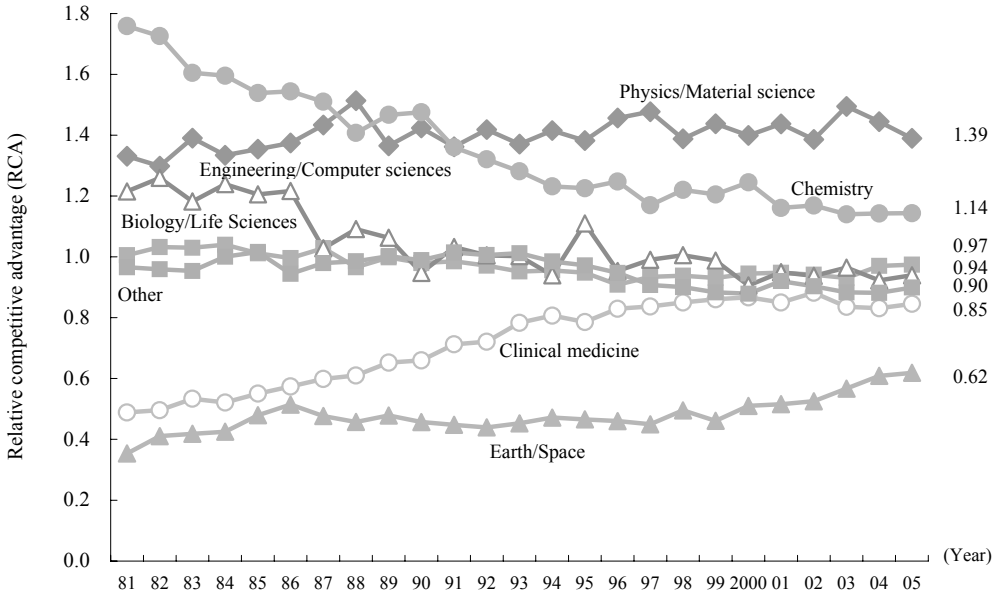


Figure 2-3-6 Trends in relative comparative advantage of scientific papers in Japan by field

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2005" (Thomson Scientific)

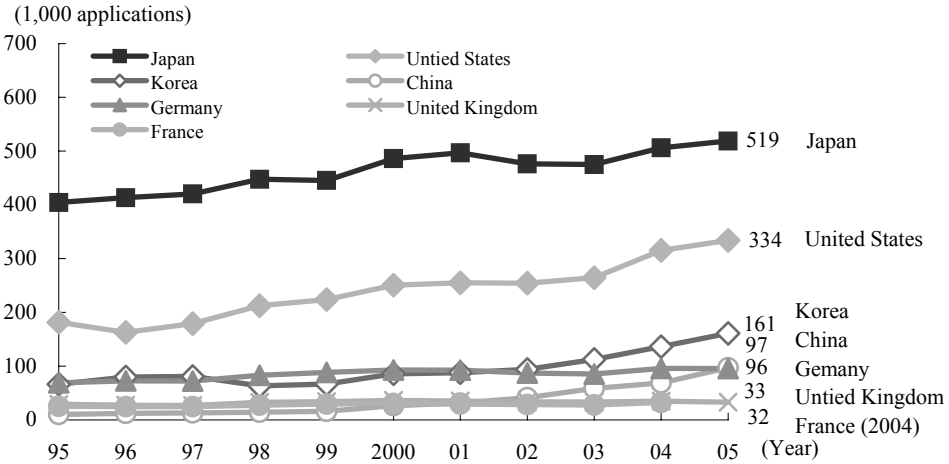
2.3.2 Patents

A country with many patent applications is generally considered to have active R&D of business enterprises and other organizations. In addition, a country that has many patent applications and registrations abroad, when classified into nationality, is thought to be developing positive strategy to secure future overseas production bases and markets.

2.3.2.1 Trends of Patent Applications and Registrations of Selected Countries

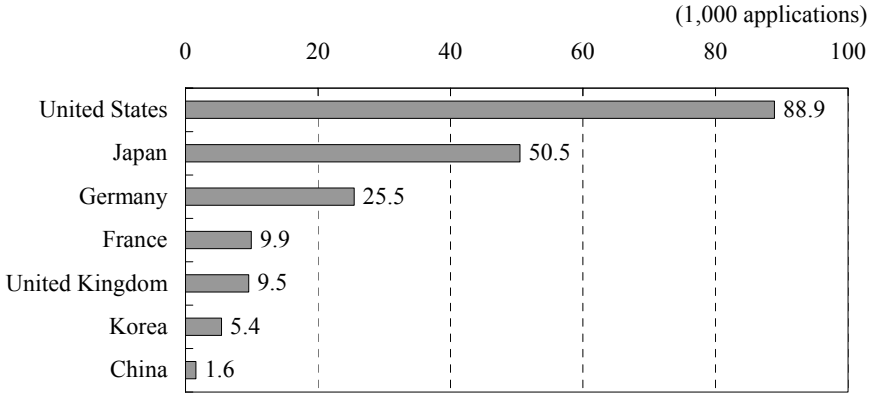
In the comparison of the number of patent applications in major countries (the total of the number of applications filed in the applicant's own country and overseas and the number of those that entered the national phase of each PCT member country by using PCT,[20] by nationality of applicant), Japan has been the top in the world, followed by the United States, South Korea, and China. South Korea and China especially have had remarkable

(1) Trends in the number of patent applications



Note: The total of the number of applications filed in the applicant's own country and overseas and the number of those that entered the national phase of each PCT member country by using PCT, by nationality of applicant.

(2) The number of patent applications that used PCT (2005)



Note: The total number of the patent applications that entered the national phase of each PCT member country by using PCT, by nationality of applicant.

Source: World Intellectual Property Organization (WIPO). "Industrial Property Statistics", Patent Applications by Origin (1995 to 2005)
WIPO website: http://www.wipo.int/ipstats/en/statistics/patents/ (searched on February 1, 2007)

Figure 2-3-7 Trends in the number of patent applications of selected countries

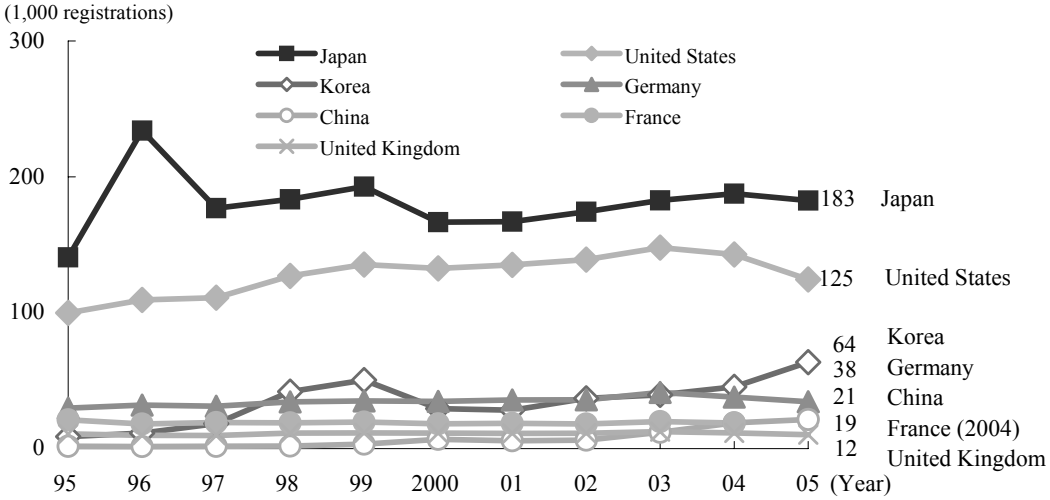
[20] In 1978, the Patent Cooperation Treaty (PCT) went into effect, by which it became possible for the applicant to apply for patents in more than one country (designated countries) at the same time, when he presents one application at one place. The number of PCT member countries is 137, as of March, 2007.

increases in recent years. On the other hand, with the number of patent applications that used PCT in 2005, the United States was the world's number one far, ahead of other countries, followed by Japan (Figure 2-3-7).

Also with the number of patent registrations (the total of the number of applications filed in the applicant's own country and overseas and the number of those that were granted after entering the national phase of each PCT member country by using PCT, by nationality of applicant), Japan has been the top in the world, followed by the United States, South Korea, and Germany. The number of patent registrations in Japan in 1996 temporarily increased. This was because the grant process speeded up due to the introduction of the Post-Grant Opposition System. As for the number of patent registrations that used PCT in 2005, the United States was the world's number one and was overwhelming other countries, with Japan following as the second (Figure 2-3-8).

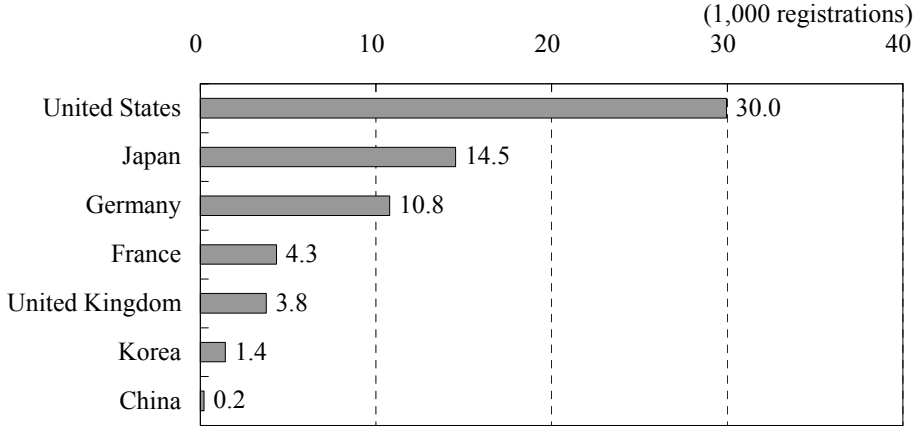
With the number of patent applications and registrations in major countries by nationality, the percentage of the patent applications and registrations in Japan of foreigners is smaller in comparison with those in other major countries (Table 2-3-9).

(1) Trends in the number of patent registrations



Note: The total of the number of applications filed in the applicant's own country and overseas and the number of those that were granted after entering the national phase of each PCT member country by using PCT, by nationality of applicant.

(2) The number of the patent registrations using PCT (2005)



Note: The total number of the patents granted after entering the national phase of each PCT member country by using PCT, by nationality of applicant.
Source: WIPO. "Industrial Property Statistics", Patent Granted by Origin (1995 to 2005)
WIPO website: http://www.wipo.int/ipstats/en/statistics/patents/ (searched on February 1, 2007)

Figure 2-3-8 Trends in the number of patent registrations in selected countries

Table 2-3-9 The number of patent applications and registrations in selected countries by nationality (2004)

Nationalities \ Country in which patent was filed	Japan	Untied States	Germany	France	United Kingdom	EPO
Japan	368,416	64,812	3,407	600	939	20,583
	112,527	35,348	1,558	467	1,101	10,441
United States	22,995	189,536	2,702	440	4,362	32,621
	5,256	84,271	687	375	2,954	14,202
Germany	7,394	19,824	48,448	876	573	-
	1,856	10,779	12,925	670	490	-
France	3,144	6,813	280	14,230	169	-
	680	3,380	141	9,371	161	-
United Kingdom	1,840	7,792	100	37	19,178	-
	408	3,450	55	54	3,780	-
EPO	-	-	-	-	-	61,196
	-	-	-	-	-	31,458
Others	19,292	68,166	4,297	1,107	4,733	62,505
	3,465	27,063	1,295	904	2,055	27,272
Total	423,081	356,943	59,234	17,290	29,954	123,701
	124,192	164,291	16,661	11,841	10,541	58,730
Percentage of Patent Applications and Registrations of Foreigners	12.9%	46.9%	18.2%	17.7%	36.0%	50.5%
	9.4%	48.7%	22.4%	20.9%	64.1%	46.4%

Notes: 1. The upper column is the number of patent applications and the lower column is that of patent registrations.
2. The number of patent applications includes the number of those that entered the national phase of each PCT member country by using PCT. The number of patent registrations includes those granted after entering the national phase of each PCT member country by using PCT.

Source: WIPO. "Industrial Property Statistics"
Patent Applications by Office (1985 to 2005), Patent Applications by Origin (1995 to 2005)
Patent Granted by Office (1985 to 2005), Patent Granted by Origin (1995 to 2005)
http://www.wipo.int/ipstats/en/statistics/patents/ (searched on February 1, 2007)

2.3.2.2 Number of Patent Applications and Registrations Abroad of Japanese Nationals

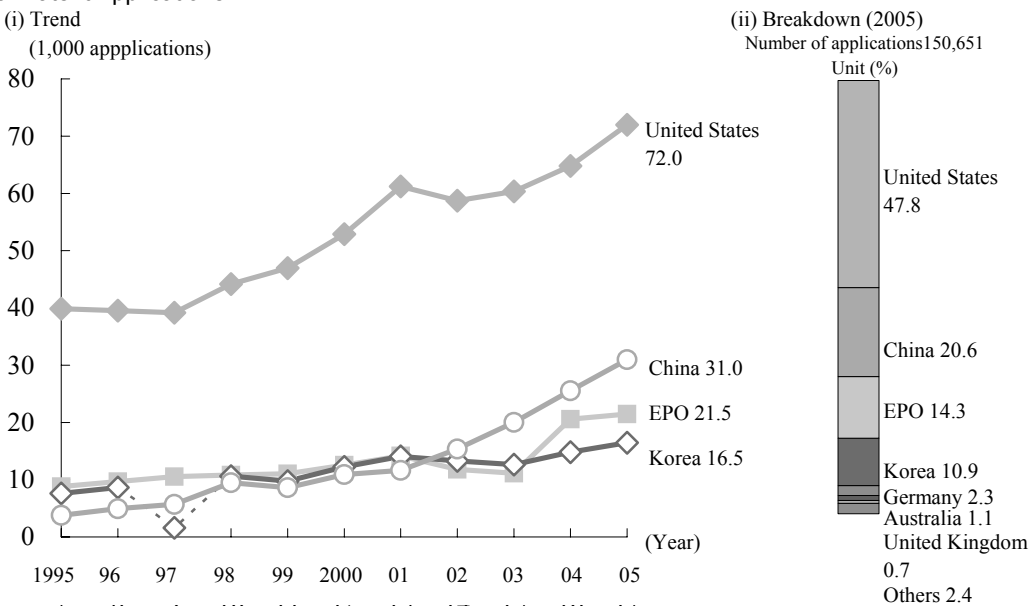
As the countries for Japanese nationals to file patent applications abroad, the rate of the United States is the highest, followed by China, Europe (EPO), and South Korea. Recently, the number of applications in China has been sharply increasing. The trends of patent registrations also show that the rate in the United States is the highest, followed by China, South Korea, and Europe (Figure 2-3-10).

The shares of Japanese nationals in the number of patent applications and registrations in major countries tend to be large in the United States, China, and EPO (Table 2-3-11).

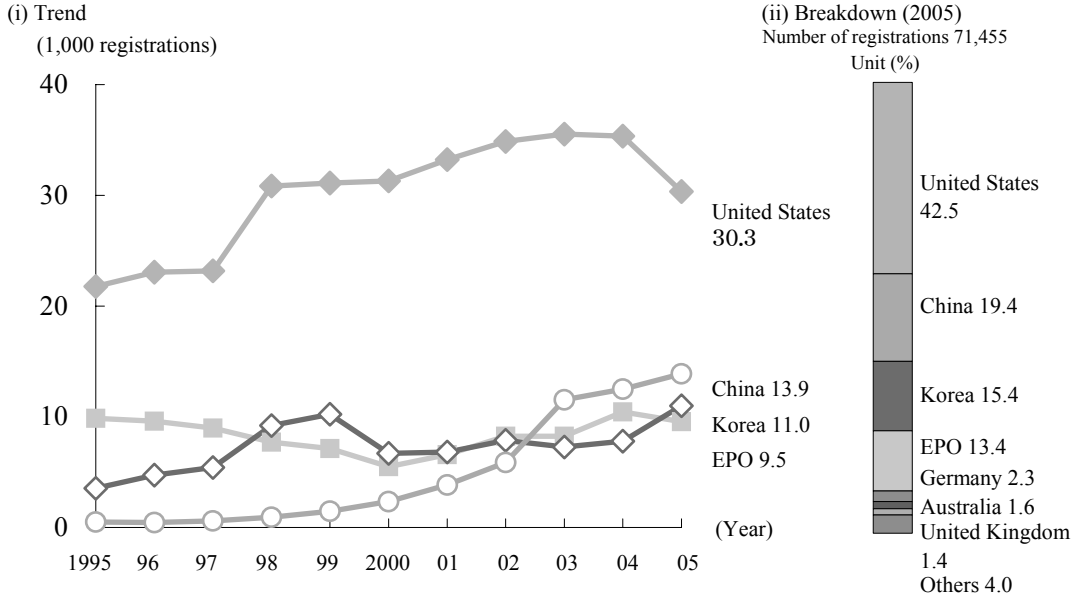
2.3.2.3 Trends in Patent Applications and Registrations in Japan

The number of patent applications in Japan has been rising, and the share of non-Japanese applicants also has had a mild upward trend recently. The number of patent registrations in Japan has been relatively flat in recent years while the share of those by non-Japanese has decreased. Note that the sharp increase seen between 1995 and 1996 was mainly due to the Post-Grant Opposition System, which speeded up the grant process (Figure 2-3-12).

(1) Number of Patent Applications



(2) Number of Patent Registrations



Notes: 1. The number of patent applications includes the number of those that entered the national phase of each PCT member country by using PCT. The number of patent registrations includes those granted after entering the national phase of each PCT member country by using PCT.
2. The number of patent applications to South Korea in 1997 (dotted line in the graph) is small, since the referred information below does not include the data on the non-residents' applications to South Korea.

Source: WIPO. "Industrial Property Statistics"
Patent Applications by Office (1985 to 2005), Patent Applications by Origin (1995 to 2005)
Patent Granted by Office (1985 to 2005), Patent Granted by Origin (1995 to 2005)
http://www.wipo.int/ipstats/en/statistics/patents/ (searched on February 1, 2007)

Figure 2-3-10 Trends in the number of patent applications and registrations abroad of Japanese nationals

Table 2-3-11 Changes in the share of Japanese nationals in the numer of patent applications and registrations in selected countries

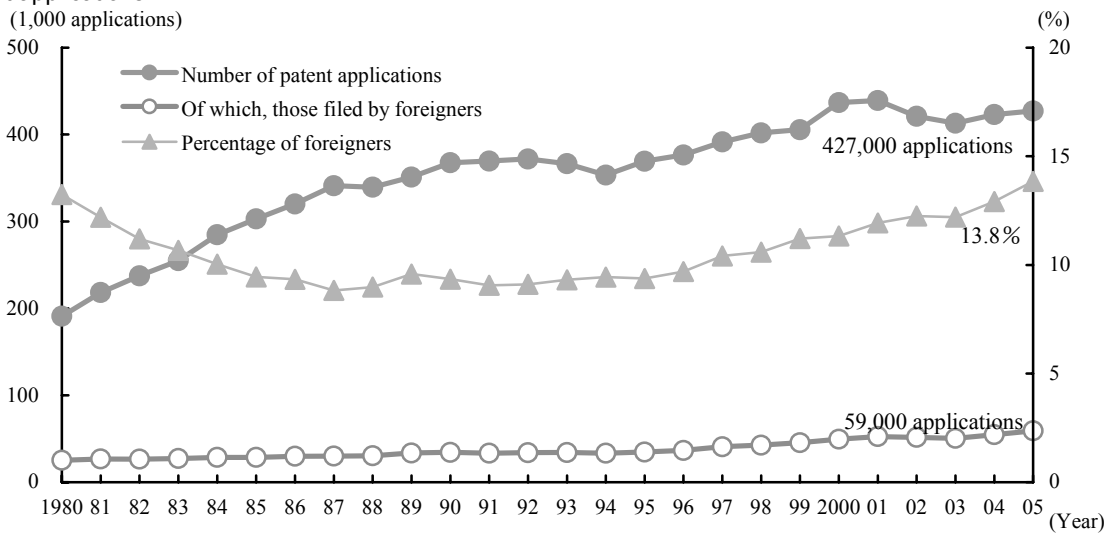
Unit (%)

Year / Countries	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
United States	17.5	18.6	17.8	18.6	17.7	17.9	18.8	17.6	17.6	18.2	18.4
	21.5	21.0	20.7	20.9	20.3	19.9	20.0	21.3	21.0	21.5	21.1
Germany	5.4	5.3	5.7	5.4	5.2	5.8	5.9	5.8	5.7	5.8	5.7
	14.7	13.6	12.9	10.8	9.5	8.9	8.7	8.9	9.2	9.4	9.8
France	2.8	3.4	3.7	3.7	3.4	3.7	4.0	3.6	3.5	3.5	-
	5.4	3.9	3.8	4.1	3.7	3.4	3.2	0.3	3.2	3.9	-
United Kingdom	5.3	5.5	5.6	4.7	4.3	4.4	4.1	3.7	3.3	3.1	3.7
	17.1	16.7	18.7	18.4	16.0	14.4	13.7	12.3	11.3	10.4	9.9
Canada	6.0	6.0	5.5	4.9	3.8	3.6	3.9	3.2	2.3	-	-
	18.7	21.7	19.0	15.7	15.0	14.7	12.8	17.7	11.8	10.8	-
Australia	4.3	4.6	4.8	5.0	4.1	3.6	3.1	2.3	2.5	5.4	5.5
	11.0	10.8	10.0	9.5	9.1	9.1	8.8	9.8	9.1	9.8	10.3
EPO	14.5	15.1	14.5	13.2	12.4	12.5	12.9	11.2	9.5	16.6	16.7
	23.7	24.0	22.7	21.0	20.2	20.0	19.0	17.4	15.2	17.8	17.9
Korea	9.7	9.6	1.7	14.1	12.1	12.0	13.5	12.5	10.6	10.6	10.2
	28.4	28.6	22.1	17.4	16.3	19.2	19.7	17.5	16.4	14.9	15.0
China	20.2	21.8	22.9	20.0	17.2	16.1	18.3	19.1	19.0	19.6	17.9
	14.4	15.0	17.0	19.6	19.2	17.5	23.6	27.6	23.4	25.3	26.0

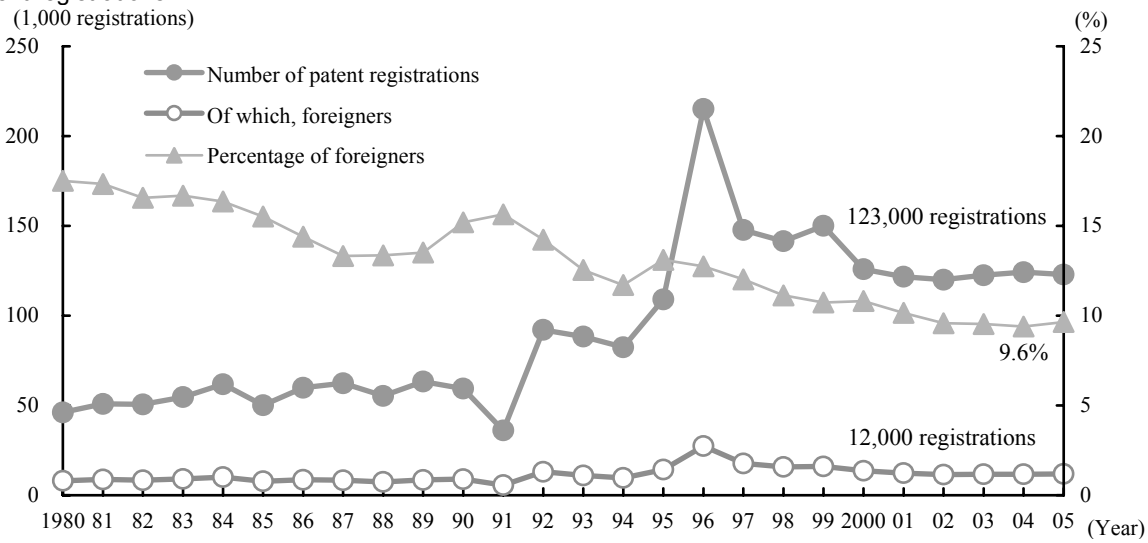
Notes: 1. The upper column is the rate in the number of patent applications and the lower column is that of patent registrations.
2. The number of patent applications includes the number of those that entered the national phase of each PCT member country by using PCT. The number of patent registrations includes those granted after entering the national phase of each PCT member country by using PCT.

Source: WIPO. "Industrial Property Statistics"
Patent Applications by Office (1985 to 2005), Patent Applications by Origin (1995 to 2005)
Patent Granted by Office (1985 to 2005), Patent Granted by Origin (1995 to 2005)
http://www.wipo.int/ipstats/en/statistics/patents/ (searched on February 1, 2007)

(1) Patent applications



(2) Patent registrations

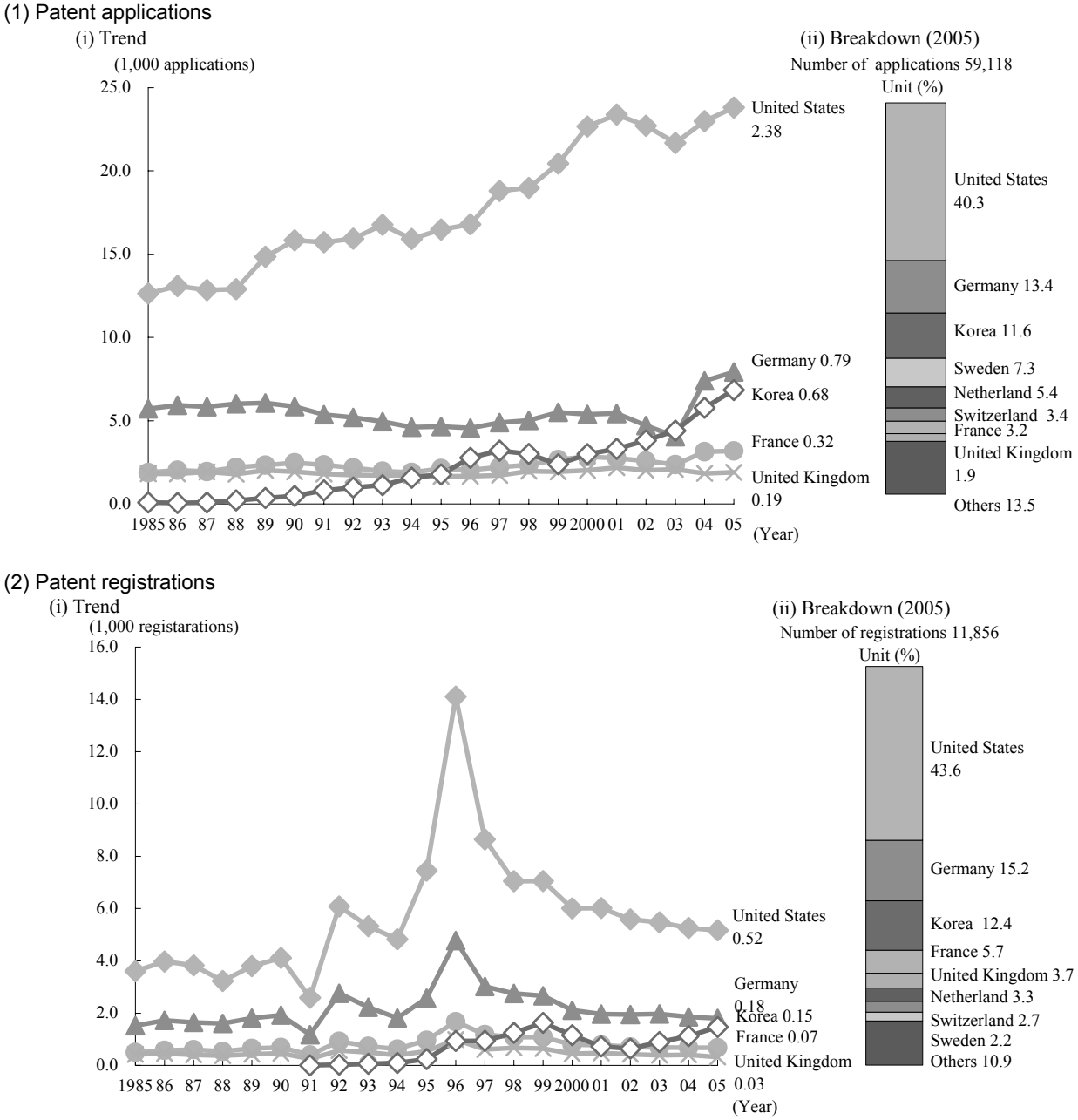


Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "Patent Agency Yearbook" and "Japan Patent Office Annual Report" (Japan Patent Office).

Figure 2-3-12 Trends in number of patent applications and granted patents in Japan

2.3.2.4 Foreign Patent Applications and Registrations in Japan

A look at the number of patent applications to Japan by non-Japanese by nationality reveals that patent applications from the United States returned to increase recently, in addition to the upward trend shown by Germany and South Korea. The number of patent registrations peaked in 1996 and has been declining since then, while those by South Korea has been slightly increasing in recent years (Figure 2-3-13).



Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "Patent Agency Yearbook" and "Japan Patent Office Annual Report" (Japan Patent Office)

Figure 2-3-13 Number of patent applications and registrations by nationality of foreign inventors

2.3.2.5 Patent Applications in Japan by Category

Patent applications by category[21] in 2004 showed no change in ranking from the previous year, i.e. the first was "Physics" and the second was "Electricity" (Table 2-3-14).

Table 2-3-14 Number of patent applications by category in Japan (2004)

Category	Number of applications	Composition rate (%)
Human necessities	47,456	11.5
Performing, operations, transportation	68,936	16.7
Chemistry, metallurgy, textiles	49,037	11.8
Fixed construction	13,808	3.3
Mechanical engineering	34,718	8.4
Physics	139,337	33.7
Electricity	96,623	23.3
Total	414,005	100

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "Statistical Table by Category" in Chapter 2 (4) of "Japan Patent Office Annual Report 2006 - Statistical Data" (Japan Patent Office)

[21] 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 2-3-15). 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.

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.

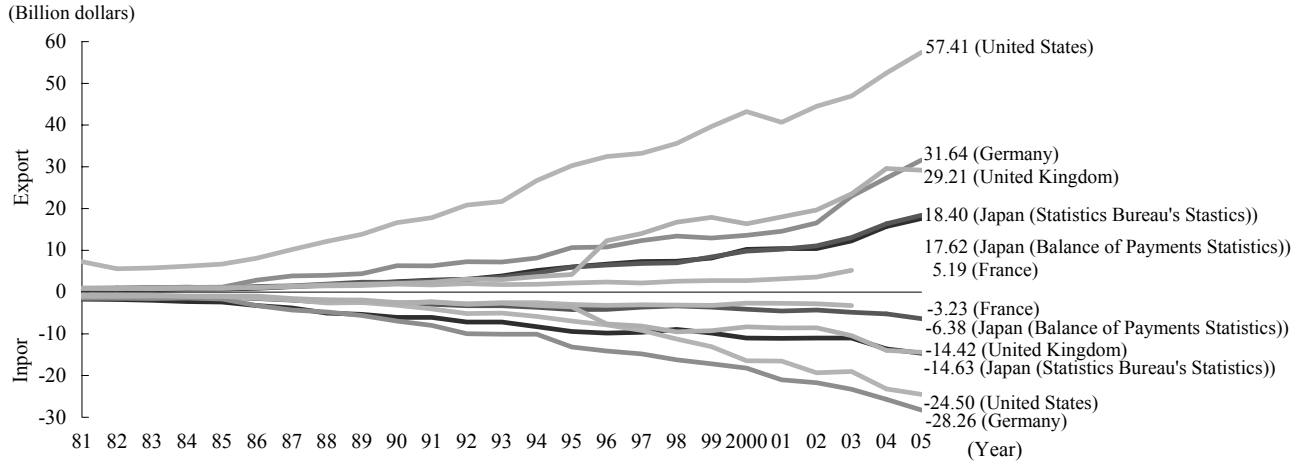


Figure 2-3-15 Trend in technology trade of selected countries

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 and industrial designs. Furthermore, the Balance of Payments Monthly does not include technology trade cases where foreign exchange 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"

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 2-3-16). Elsewhere, France and the U.K. have moved into an excess of exports, and Germany is going to shift to an excess of exports.

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 2-3-17).

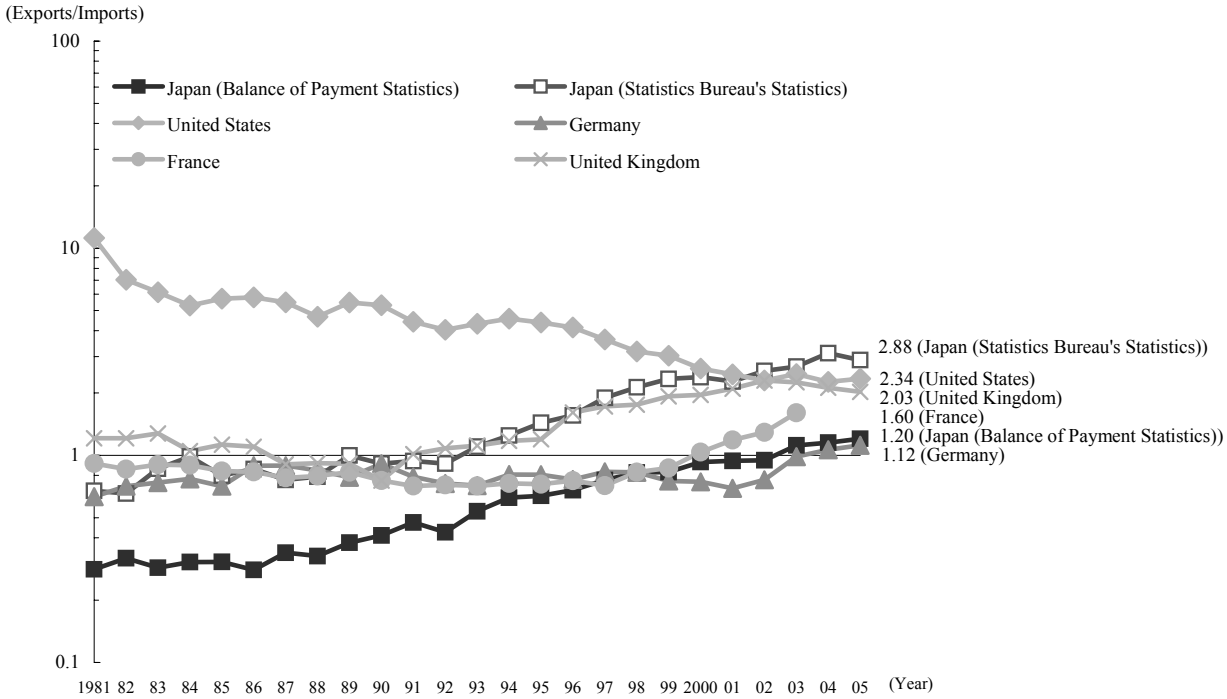


Figure 2-3-16 Trends in the technology trade balance of selected countries

Source: Same as in Figure 2-3-15

Table 2-3-17 Japan's technology trade balance with individual selected countries

Techonology trade couterpart		United States	Germany	France	United Kingdom
(2004)	Balance of Payment Statistics	0.77	0.36	0.46	1.66
	Statistics Bureau's Statistics	1.89	1.40	0.71	4.08
(2005)	Balance of Payment Statistics	0.75	0.46	0.75	1.53
	Statistics Bureau's Statistics	1.69	1.13	1.42	3.15

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 2-3-18).

A look at Japan's technology trade for fiscal 2005 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 three-fourths of all technology imports, while imports from Europe were distributed relatively evenly from all major European countries (Figure 2-3-19).

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. The situation was the same in 2005 (Figure 2-3-20).

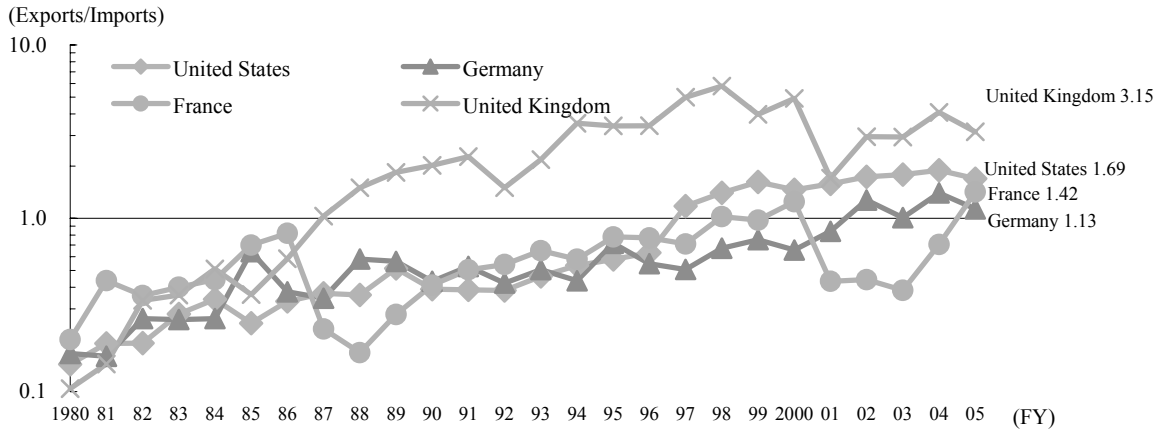


Figure 2-3-18 Trends in technology trade balance of Japan with other selected countries

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))

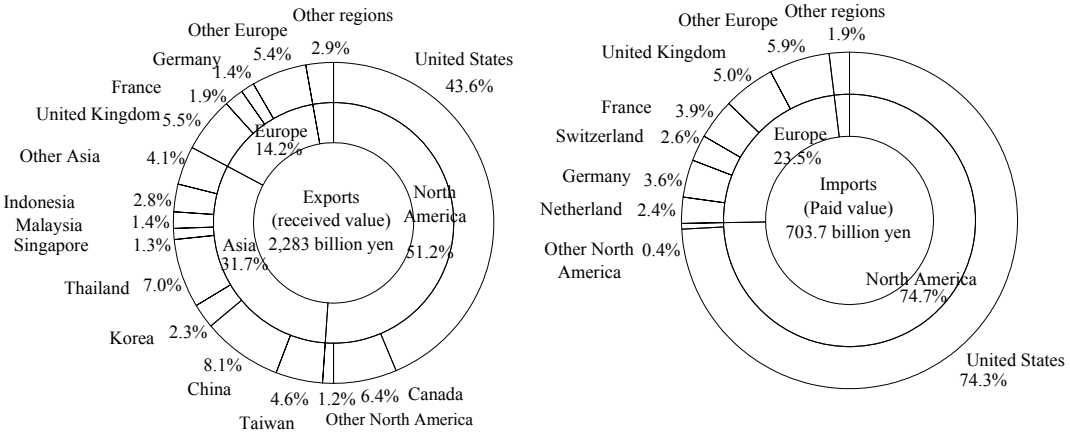


Figure 2-3-19 Composition of Japan's technology trade by selected country and region (FY2005)

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

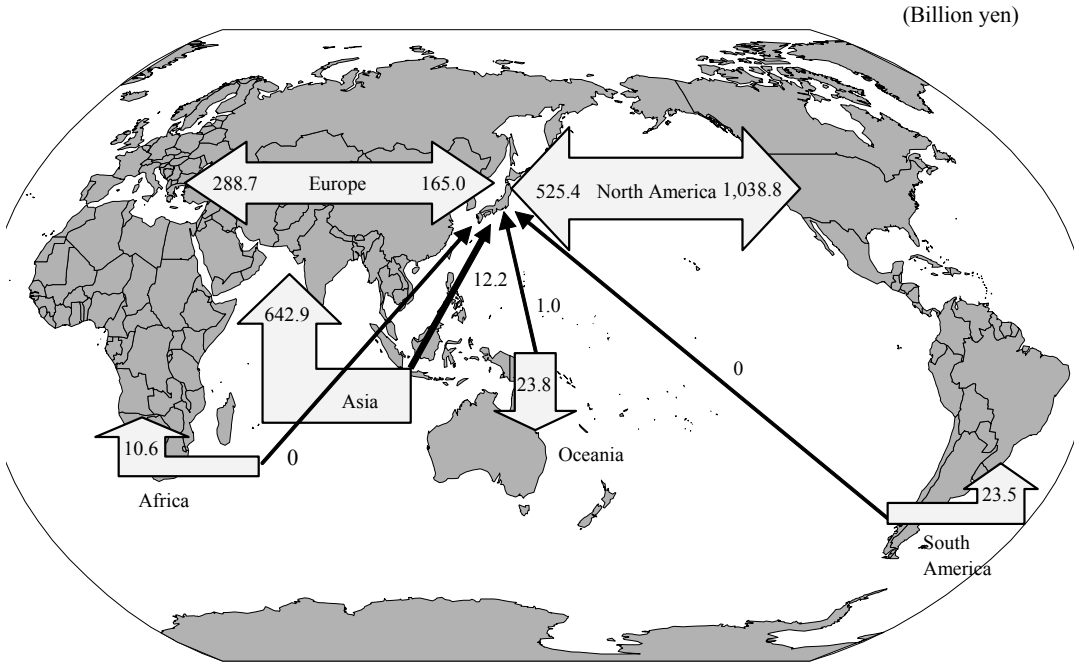


Figure 2-3-20 Technology trade by region (FY2005)

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 2005, we find that the motor vehicles industry was the top in technology exports by value, followed by the information and telecommunications machinery industry, the pharmaceutical industry, the general machinery industry, the electrical machinery industry, and the chemical industry.

As for the technology imports by value, the top is the information and telecommunications machinery industry, followed by the general machinery industry, the electronic parts and devices industry, the chemical industry, and the pharmaceutical industry (Figure 2-3-21).

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 pharmaceutical 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 2-3-22).

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 pharmaceutical industry trades overwhelmingly with Europe and the United States, and holds an overall export surplus (Table 2-3-23).

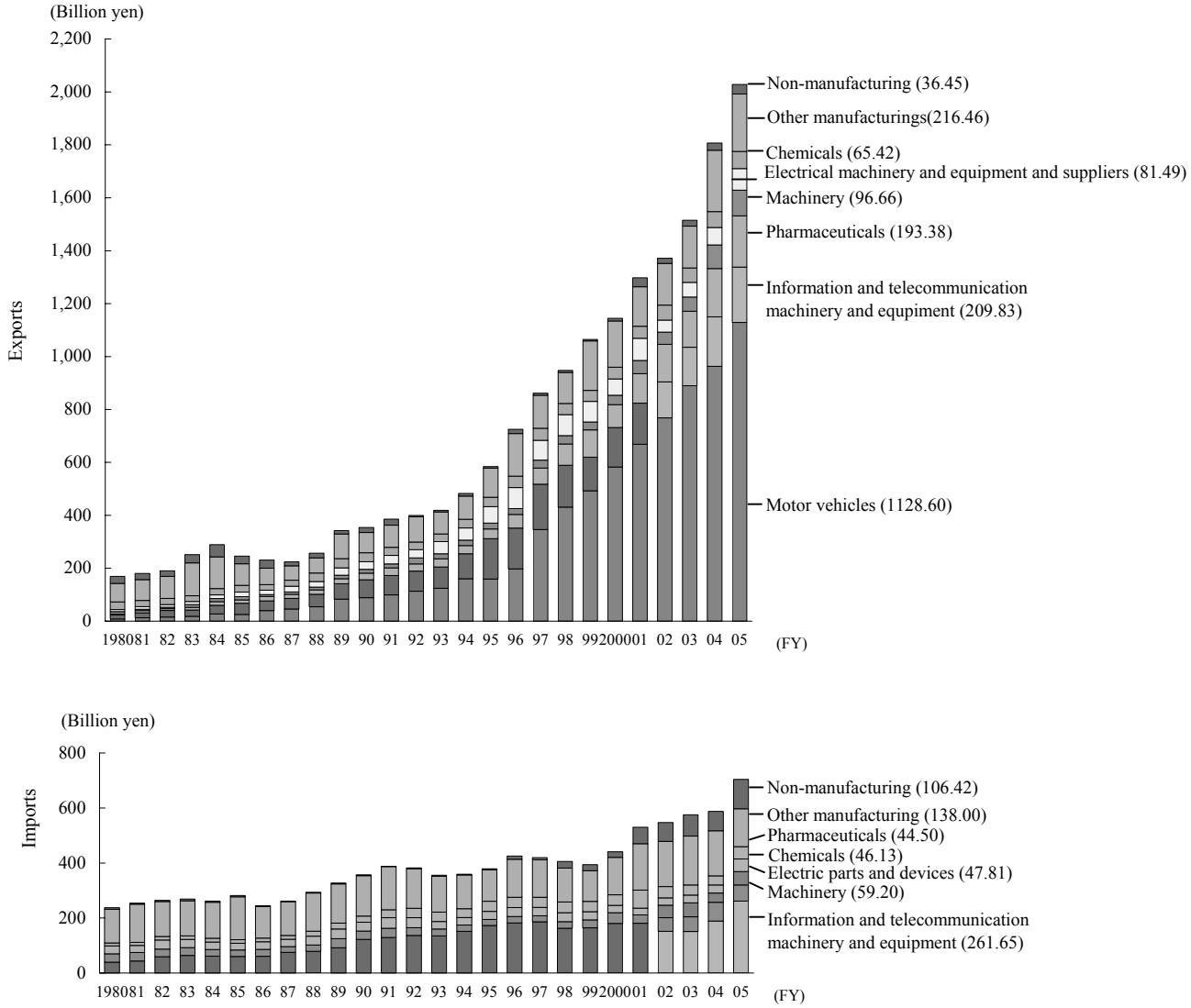


Figure 2-3-21 Trends in technology trade by industry sector

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 Developmen

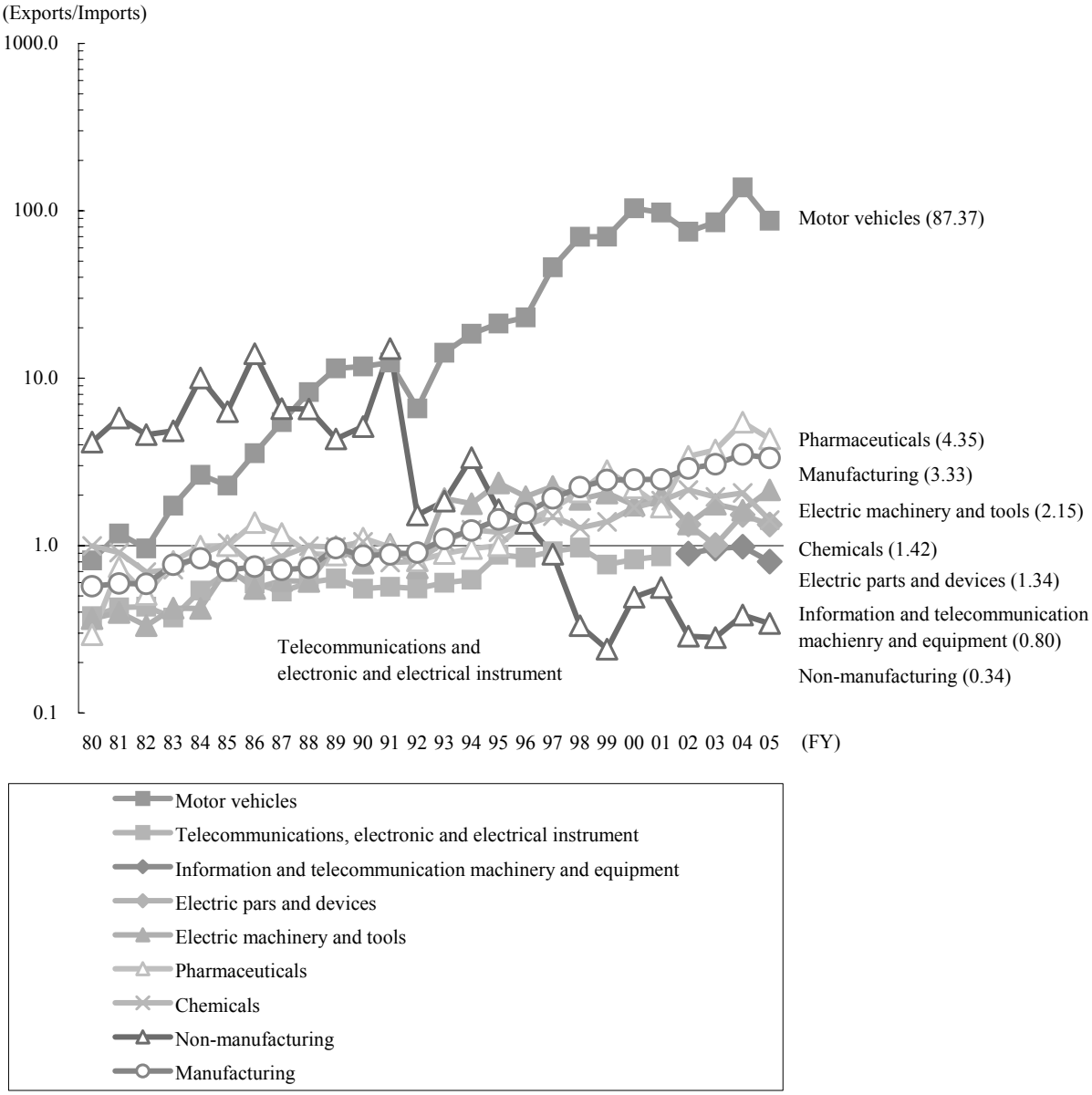


Figure 2-3-22 Trends in technology trade balance in major industry sectors

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

Table 2-3-23 Technology trade balance of payments by trade partner country and region for major industrial categories in Japan (FY2005)

Motor vehicle (Billion yen)

Country and regions \ Exports and imports amount	Techonolgy export	Technology imports	Exports-imports
United States	579.8	7.0	572.8
Thailand	93.1	0.0	93.1
United Kingdom	55.8	1.1	54.7
China	39.3	0.0	39.3
Indonesia	37.1	-	-
India	23.2	0.0	23.2
Australia	21.7	0.0	21.7
Taiwan	17.8	-	-
Korea	5.8	0.2	5.6
Others	254.9	4.5	250.4
Total	1128.6	12.9	1115.7

Information and telecommunication machinery and equipment (Billion yen)

Country and regions \ Exports and imports amount	Techonolgy export	Technology imports	Exports-imports
United States	53.2	211.0	-157.8
China	51.8	1.5	50.3
Taiwan	20.9	1.2	19.8
Singapore	14.3	0.3	14.0
Malaysia	11.4	0.0	11.4
Netherland	10.3	8.1	2.3
Germany	8.3	4.8	3.5
France	6.4	5.3	1.1
Korea	4.1	0.2	3.9
Untied Kingdom	1.9	12.8	-10.9
Sweden	0.0	12.1	-12.1
Others	27.3	4.5	22.8
Total	209.8	261.6	-51.8

Pharmaceuticals (Billion yen)

Country and regions \ Exports and imports amount	Techonolgy export	Technology imports	Exports-imports
United States	120.4	17.1	103.3
Untied Kingdom	38.4	10.3	28.1
Germany	8.8	7.3	1.5
France	7.3	1.1	6.2
Switzerland	2.8	6.5	-3.7
Italy	3.1	0.1	3.1
Korea	1.4	0.5	0.9
Finland	1.1	0.1	1.0
Others	10.0	1.5	8.5
Total	193.4	44.5	148.9

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[22] 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 2-3-24).

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 2-3-25).

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 2-3-26).

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 2-3-27).

Figure 2-3-24 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"

[22] 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.

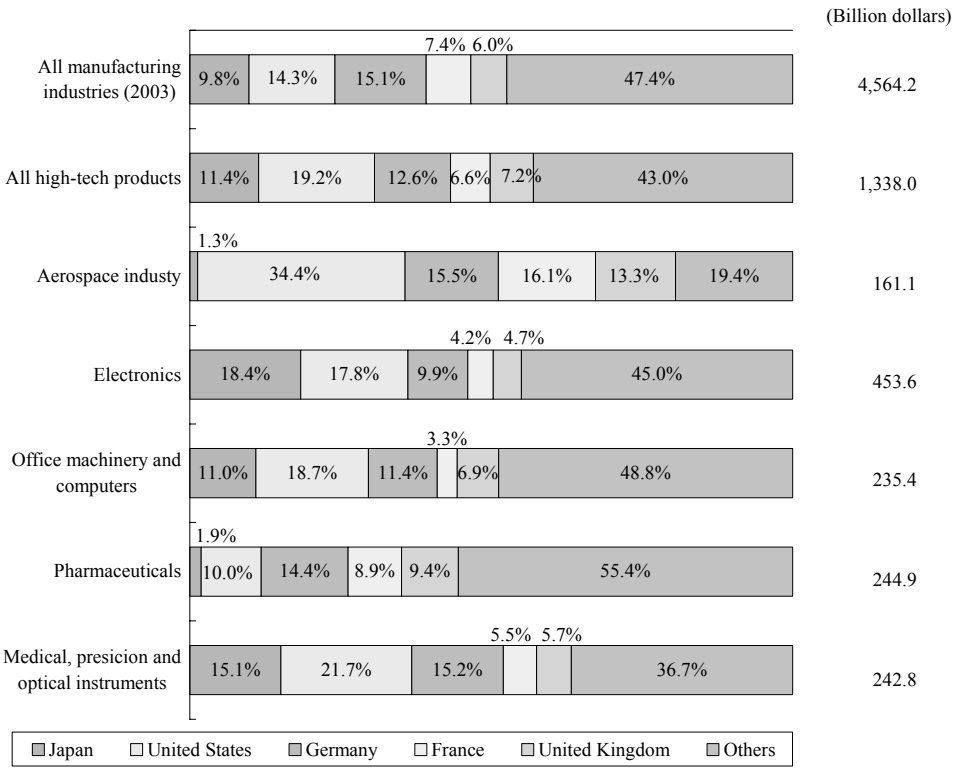


Figure 2-3-25 Share of high-tech products by country manufactured in OECD (2004)

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

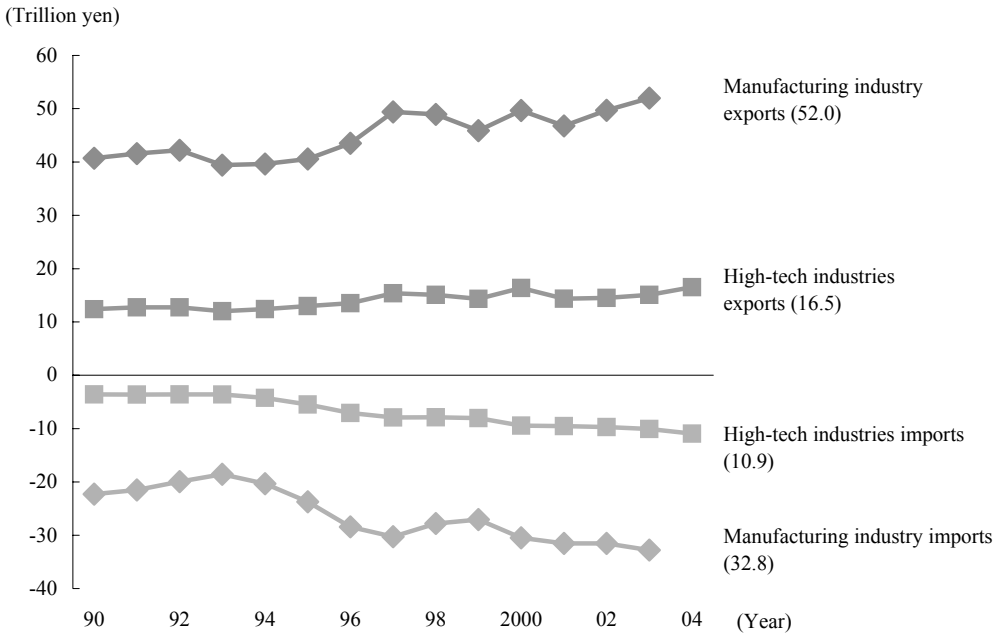


Figure 2-3-26 Trends in imports and exports, by value, for Japan's general manufacturing industry, and the high-tech industry

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

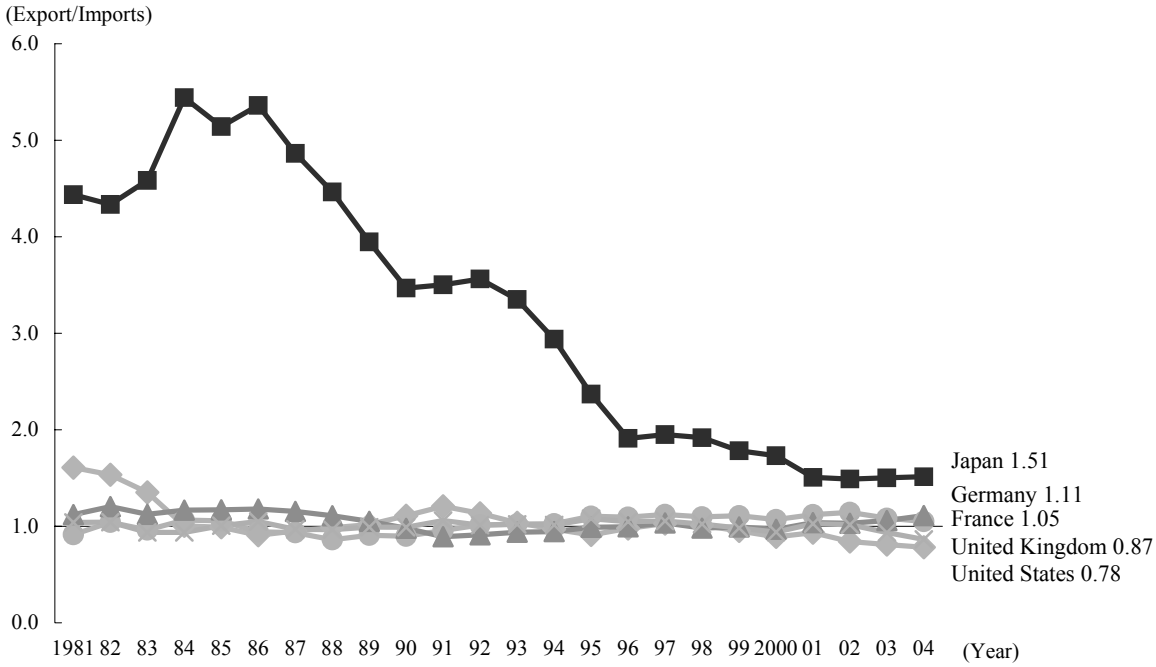


Figure 2-3-27 Trends in high-tech balance of payment ratios for selected countries

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 2004, by industry, was as shown in Table 2-3-28. 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 2-3-28 Balance of payments for Japan's high-tech trade by industry (2004)

Industries \ Exports and imports amounts	Exports (billion yen)	Imports (billion yen)	Trade balance
All manufacturing (2003)	51,988	32,777	1.59
All high-tech industries	16,527	10,921	1.51
Electronics	9,030	4,217	2.14
Office machinery and computer industry	2,795	2,932	0.95
Medical, precision and optical equipment	3,972	2,114	1.88
Pharmaceuticals	500	912	0.55
Aerospace	230	746	0.31

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