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 2003, 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 8,700 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 1,100 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.

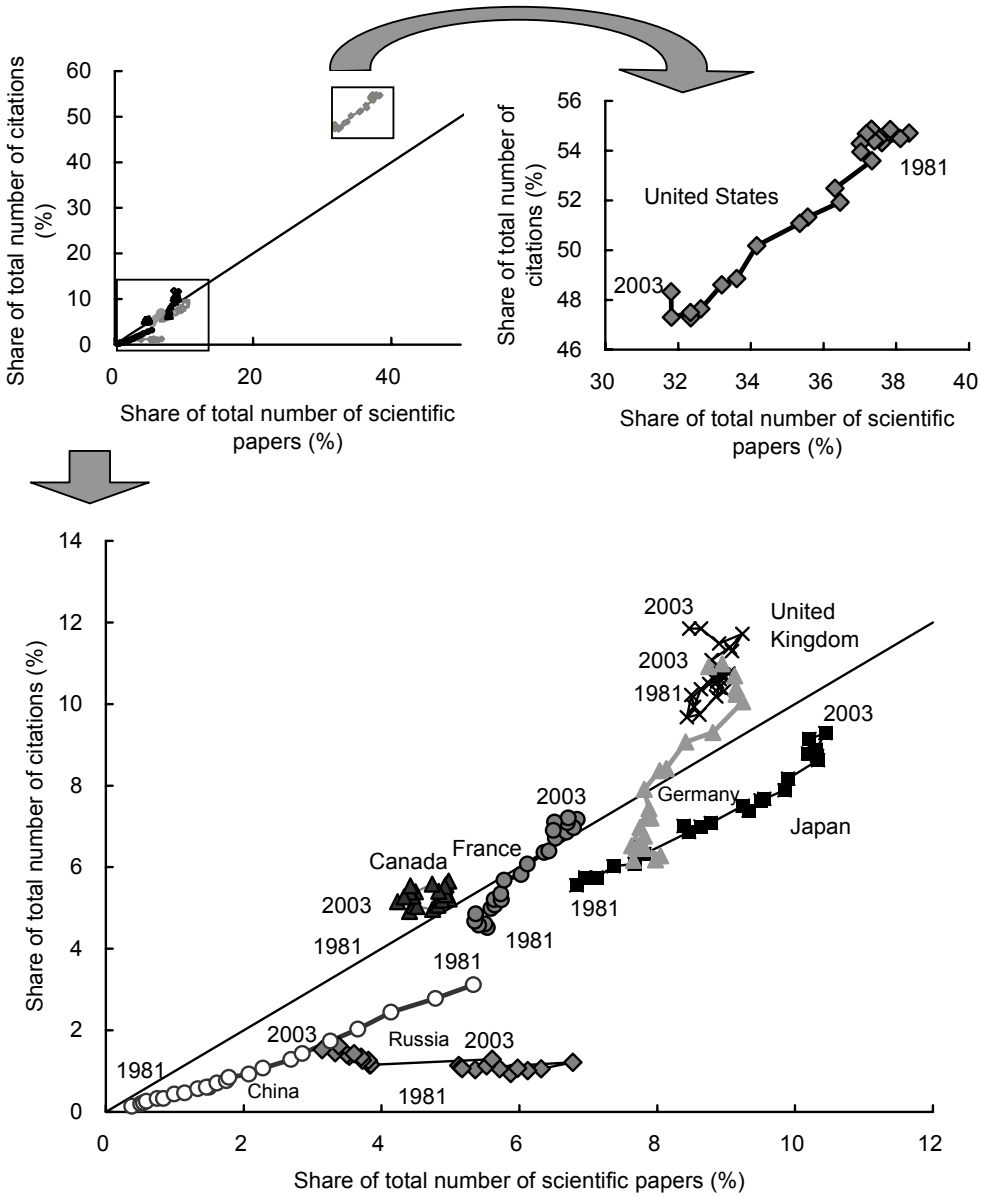

Figure 2-3-1 Relationship between the world total for scientific papers and for citations in scientific papers

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, 1981-2003" (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, Canada, and Germany (Figure 2-3-2).

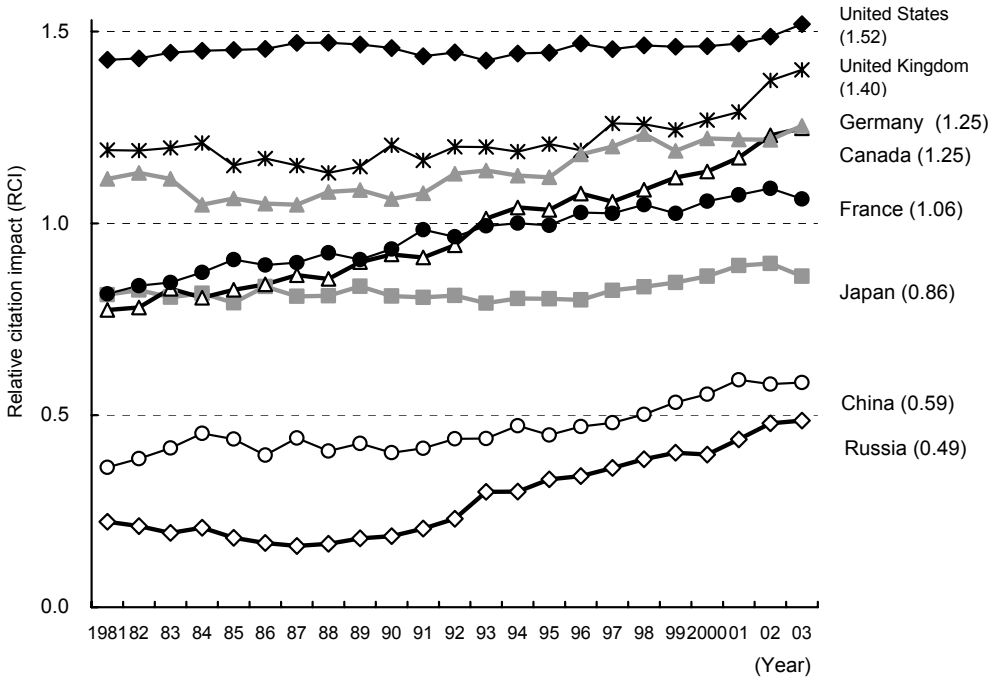

Figure 2-3-2 Trends in the relative citation impact for scientific papers in selected countries

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

For Japan's RCI by field, excepting materials 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
1	Material science	1.04
2	Immunology	1.00
3	Chemistry	0.98
4	Physics	0.96
5	Plant and animal science	0.94
6	Space science	0.94
7	Engineering	0.91
8	Agricultural science	0.88
9	Geosciences	0.88
10	Biology and biochemistry	0.87
11	Molecular biology and genetics	0.84
12	Clinical medicine	0.80
13	Mathematics	0.78
14	Pharmacology	0.75
15	Ecology / environment	0.73
16	Neuroscience and behavior	0.73
17	Microbiology	0.72
18	Computer science	0.52

Note: Data is for 1999-2003
Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (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 1999 to 2003 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.

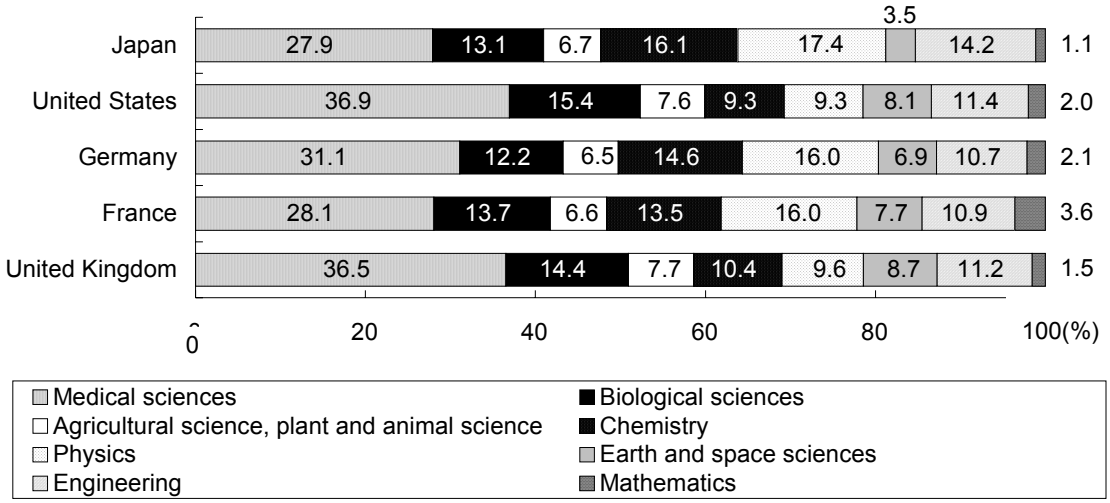

Figure 2-3-4 Number of scientific papers in selected countries, by field

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 1999 to 2003

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on “National Science Indicators, 1981-2003” (Thomson Scientific)

Figure 2-3-5 shows the share of Japan's scientific papers of all papers written worldwide, by field, for the years 1999 to 2003. Materials science, physics, and pharmacology are above Japan's average for all fields, demonstrating that Japan's research in these areas is relatively flourishing.

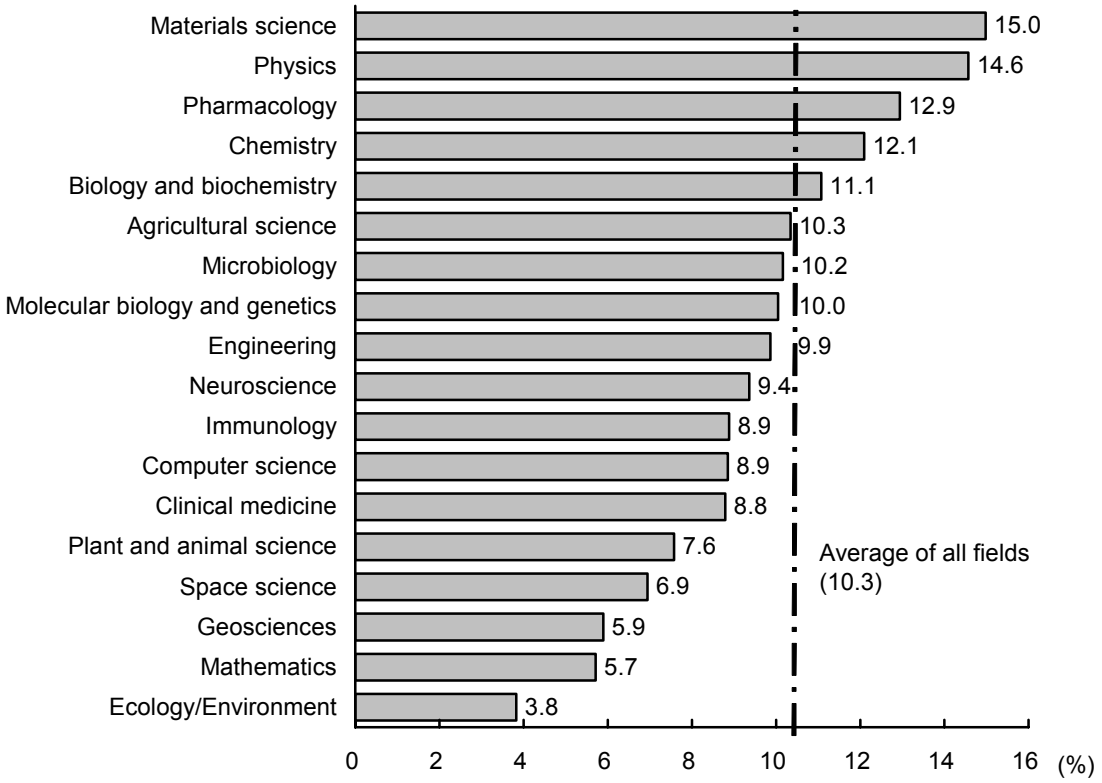

Figure 2-3-5 Japan's share of scientific papers, by field

Notes: 1. Figures are calculated from the aggregate values for 1999-2003.
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, 1981-2003" (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 clinical medicine is rising sharply.

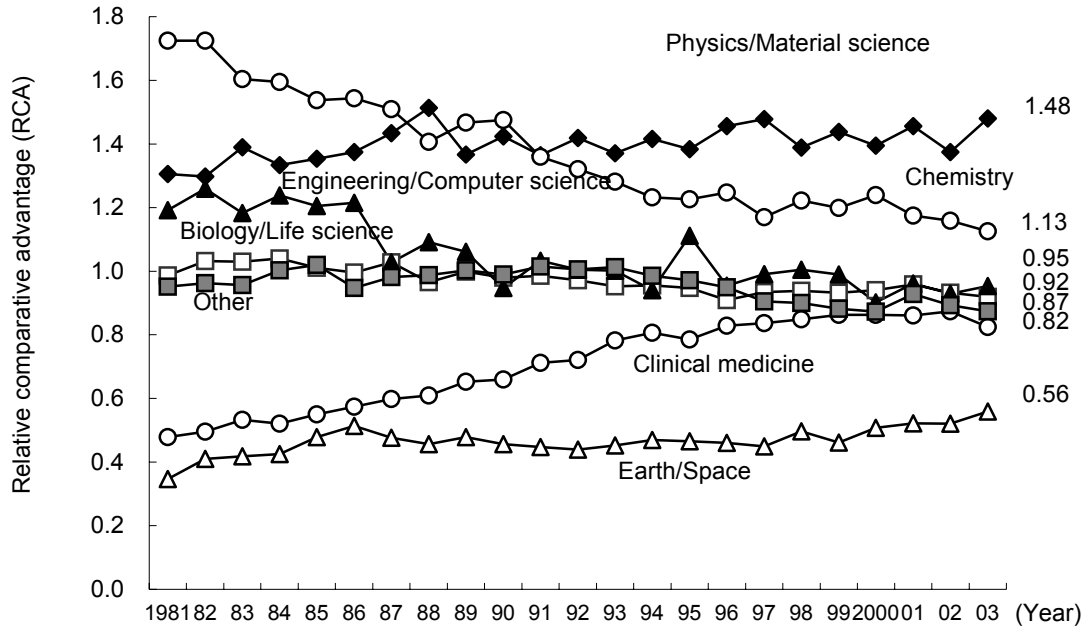

Figure 2-3-6 Trends in relative comparative advantage of scientific papers in Japan, by field

Source: Collected by the Ministry of Education, Culture, Sports, Science and Technology based on "National Science Indicators, 1981-2003" (Thomson Scientific)

2.3.2 Patents

Generally speaking, countries in which a large number of patents are applied for can be considered countries in which private corporations and other organizations carry out active R&D. Countries with a large number of patent applications in foreign countries can be viewed as taking aggressive strategies for the future establishment of foreign production centers or maintenance of markets. Moreover, countries with many patents granted are more likely to be countries with a large number of effective patents and inventions.

2.3.2.1 Patents in Selected Countries (Trends in Application and Registration)

As for the number of patent applications in major advanced nations (both applications filed domestically and in other countries, with those filed in other countries including patents filed as Patent Cooperation Treaty (PCT) applications[19] and European Patent Convention (EPC) applications[20]) Japan was ranked No.1 in the world through 1989. Since 1992, however, when the United States moved into the top ranking, the order has remained steady with the United States at the top, followed by Japan, Germany, the United Kingdom, and France. In particular, the increase in patent applications in the United States has been remarkably rapid since 1989 (Figure 2-3-7).

Meanwhile, the trend for the number of patents granted is modestly upward for most countries, with Japan and the United States emerging as particularly close rivals in recent years (Figure 2-3-8). There was a spike in Japan's patent grants in the year 1996, due to the introduction in that year of the patent post-grant objection system, which served to shorten the patent filing process.

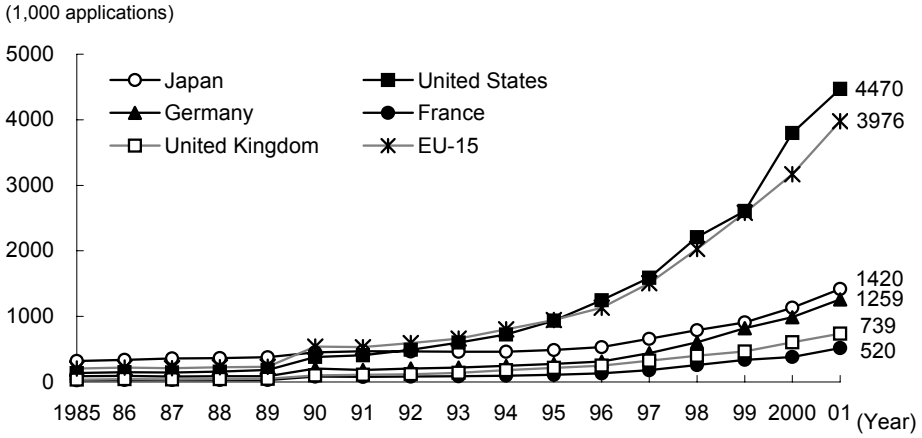

Figure 2-3-7 Trends in the number of patent applications in selected countries

Note: 1. Total number of patent applications made either inside or outside the country according to the patent applicants' nationality.
2. These data include designated countries under the Patent Cooperation Treaty (PCT) and the European Patent Convention (EPC).
3. The EU-15 consists of Belgium, Germany, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland, and Sweden.
Source: Japan Patent Office. "Patent Agency Yearbook", "Japan Patent Office Annual Report"
World Intellectual Property Organization (WIPO). "Industrial Property Statistics"

19 PCT Application: 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 126 as of February 8, 2005.

20 EPC Application: In 1977, the European Patent Convention (EPC) went into effect, and since June 1978, the European Patent Office (EPO) has been processing EPC applications. When a European patent is granted after an examination by the EPO, the patent has the same validity in the other EPC member countries designated by the applicant. The number of EPC member countries is 30 as of March 22, 2005.

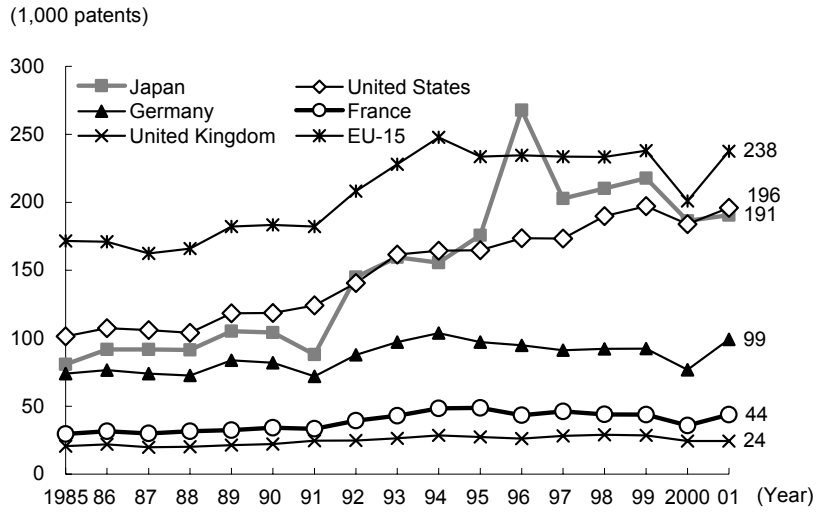

Figure 2-3-8 Trends in the number of patents granted by selected countries

Notes: The total number of patents granted either inside or outside the country according to the nationality of the persons holding the patent rights.
Source: Japan Patent Office. "Patent Agency Yearbook," "Japan Patent Office Annual Report"
WIPO. "Industrial Property Statistics"

In most major countries, the share of patent applications made by their own citizens that are made in other countries, and of patents granted by other countries to their citizens, is fairly high. In Japan, however, this ratio is relatively lower than elsewhere. In addition, the proportion of patent applications by non-Japanese researchers in Japan, and of patents granted to non-Japanese researchers in Japan, is much lower than in other major countries (Table 2-3-9).

Table 2-3-9 Number of patent applications (granted patents) in select countries (2002)

Nationality of applications	Country where patents were applied for							
	Japan	United States	Germany	France	United Kingdom	Other	Total	Applications in foreign countries (%)
Japan	388,390	66,578	32,150	25,140	29,773	904,977	1,447,008	73.2%
	109,375	33,223	7,705	6,464	7,142	26,357	190,266	42.5%
United States	47,750	190,907	85,615	50,485	86,995	4,087,656	4,549,408	95.8%
	6,020	87,606	8,876	8,412	9,968	74,642	195,524	55.2%
Germany	15,035	27,015	80,222	26,964	32,344	1,082,337	1,263,917	93.7%
	1,963	11,260	19,242	8,393	7,808	50,399	99,065	80.6%
France	5,393	9,213	11,744	21,790	11,604	463,029	522,773	95.8%
	785	4,041	2,829	11,010	2,703	22,318	43,686	74.8%
United Kingdom	6,168	11,855	13,479	7,879	34,500	670,239	744,120	95.4%
	479	3,965	1,402	1,375	3,975	13,095	24,291	83.6%
Other	33,885	70,089	69,188	42,864	69,490	—	—	—
	4,364	19,936	3,872	1,457	1,965	—	—	—
Total	496,621	375,657	292,398	175,122	264,706	—	—	—
	122,986	160,031	43,926	37,111	33,561	—	—	—
Percentage of foreign nationalities	21.8%	49.2%	72.6%	87.6%	87.0%	—	—	
	11.1%	45.3%	56.2%	70.3%	88.2%	—	—	

Notes: 1. Numbers in the upper row refer to patent applications, while number in the lower row refer to granted patents.
2. These data include designated countries under the Patent Cooperation Treaty (PCT) and the European Patent Convention (EPC).
Source: WIPO. "Industrial Property Statistics"

2.3.2.2 Japanese Patent Applications and Patents Granted in Foreign Countries

The United States holds the highest share of patent applications from Japanese applicants to foreign countries, while Europe holds the highest share of the different regions in the world (Figure 2-3-10 (1)).In the same way, the United States accounted for the largest share of patents granted to Japanese re- searchers in foreign countries, followed in order by Germany, the United Kingdom, South Korea, and France. Patents granted overseas tended to be concentrated in the major advanced nations (Figure 2-3-10(2)).

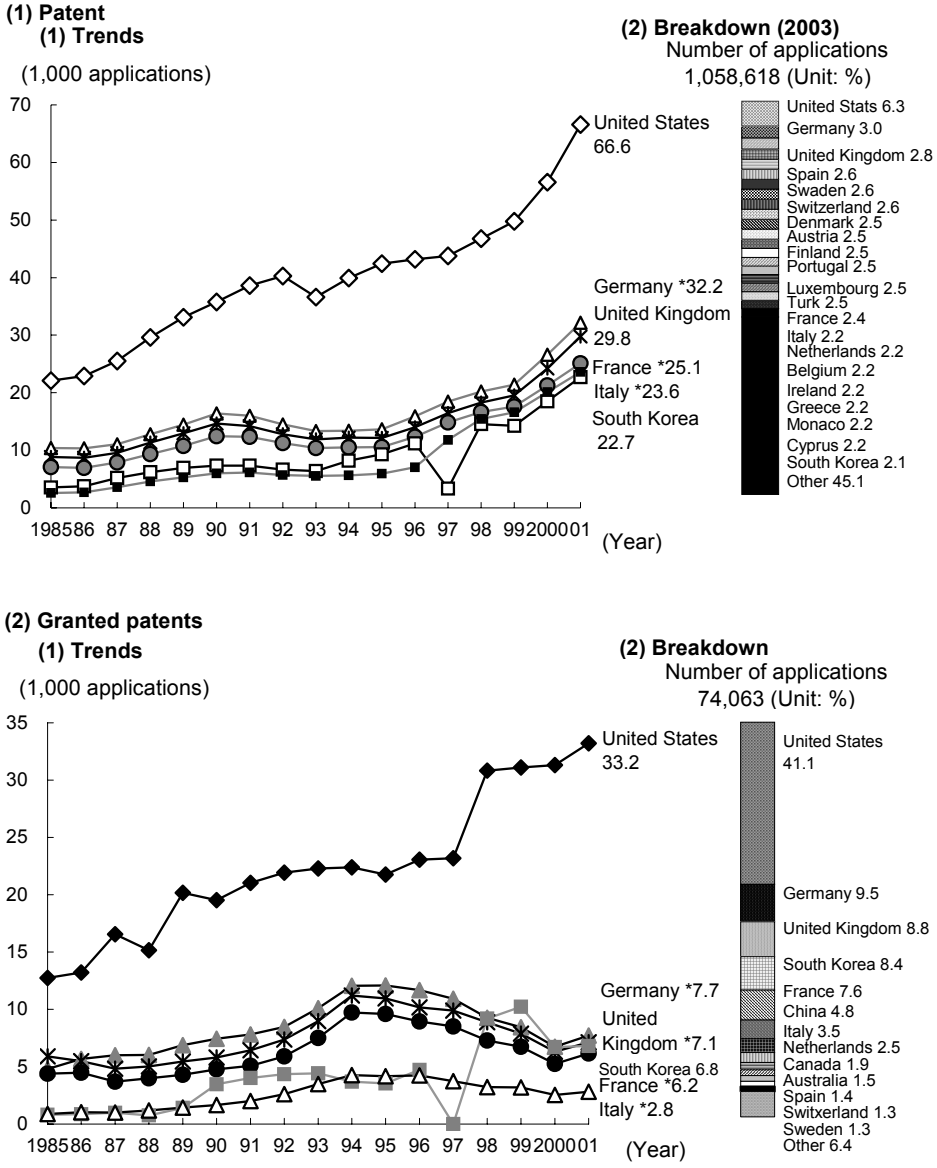

Figure 2-3-10 Number of patent applications and granted patents by Japanese researchers in foreign countries

Notes: 1. These data include designated countries under the PCT and the EPC.
2. "*" indicates EPC member countries.
Source: WIPO. "Industrial Property Statistics"

For the share of patent applications and patents granted held by Japanese in major countries, the numbers in South Korea were fairly high for some years but have recently been declining. The United States registered the highest proportion of Japanese patent applications and patents granted (Table 2-3-11).

Table 2-3-11 Changes in the ratio of Japanese researchers making applications and being granted patents in selected countries

Country \ Year	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
United States	18.9	20.3	21.8	21.5	19.1	19.0	18.0	19.3	18.5	17.8	16.9	17.1	17.7
	17.8	21.6	21.8	22.5	22.7	22.0	21.5	21.0	20.7	20.9	20.3	19.9	20.0
Germany	12.5	14.9	14.7	12.6	11.3	10.5	10.0	10.3	10.5	10.0	9.7	10.1	11.0
	14.4	17.4	18.1	18.2	19.4	20.9	21.4	21.1	19.9	17.9	17.1	16.2	16.0
France	12.6	15.2	15.6	13.7	12.7	12.2	11.8	12.6	13.2	12.8	12.7	13.3	14.4
	11.7	13.6	14.3	15.5	16.9	17.7	17.2	18.2	16.9	15.8	15.2	14.5	15.1
United Kingdom	12.6	15.0	14.9	12.9	11.8	11.3	10.5	10.8	11.1	10.4	10.2	10.4	11.2
	17.2	18.0	18.9	19.4	21.0	23.0	22.6	23.0	22.1	20.5	19.4	18.7	18.0
Netherlands	9.3	9.7	9.6	8.0	7.8	7.0	7.2	8.3	12.2	13.3	13.3	13.7	14.7
	9.9	10.5	10.8	11.7	12.3	12.9	13.9	13.6	11.8	11.0	10.3	9.8	9.7
Sweden	5.9	7.4	7.1	5.8	5.4	5.2	4.9	5.5	9.7	10.6	10.4	10.6	11.7
	6.3	6.7	7.2	7.7	8.8	8.9	9.4	9.1	7.9	6.9	6.6	6.5	7.0
Switzerland	6.4	7.3	6.7	5.7	5.4	5.2	5.0	5.5	9.7	10.8	10.6	10.8	11.6
	7.9	6.7	7.7	8.1	8.9	9.0	9.1	8.6	8.0	7.8	7.5	7.4	6.7
South Korea	30.1	23.4	20.3	16.6	13.6	13.5	9.6	9.8	2.6	12.0	10.7	10.7	11.9
	35.8	44.8	46.3	41.4	38.6	31.6	28.4	28.6	-	17.4	16.3	19.2	19.7
Canada	11.1	11.7	11.0	9.7	8.5	6.7	6.0	6.5	6.4	6.3	6.1	6.4	7.6
	10.9	12.7	13.1	13.9	14.4	17.5	18.7	21.7	19.0	15.7	15.0	14.7	12.8

Notes: 1. Numbers in the upper row refer to patent applications, while numbers in parentheses refer to granted patents.
2. These data include designated countries under the PCT and the EPC.
Source: WIPO. "Industrial Property Statistics"

2.3.2.3 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.

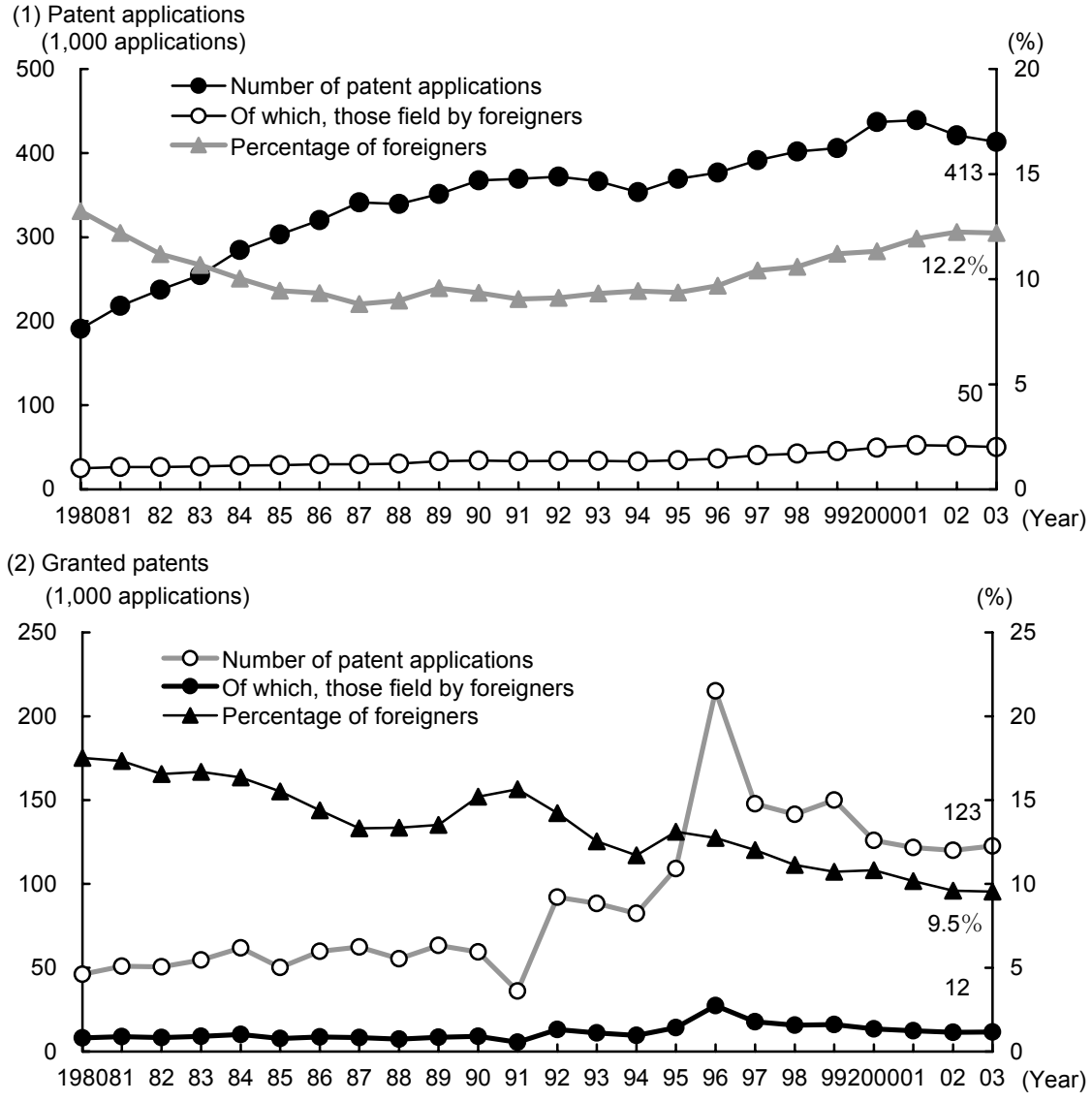

Figure 2-3-12 Trends in number of patent applications and granted patents in Japan

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

2.3.2.4 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 patent applications from the United States started to decrease recently, while those from other countries have been generally flat. The number of patents granted peaked in 1996 and has been declining since then (Figure 2-3-13).

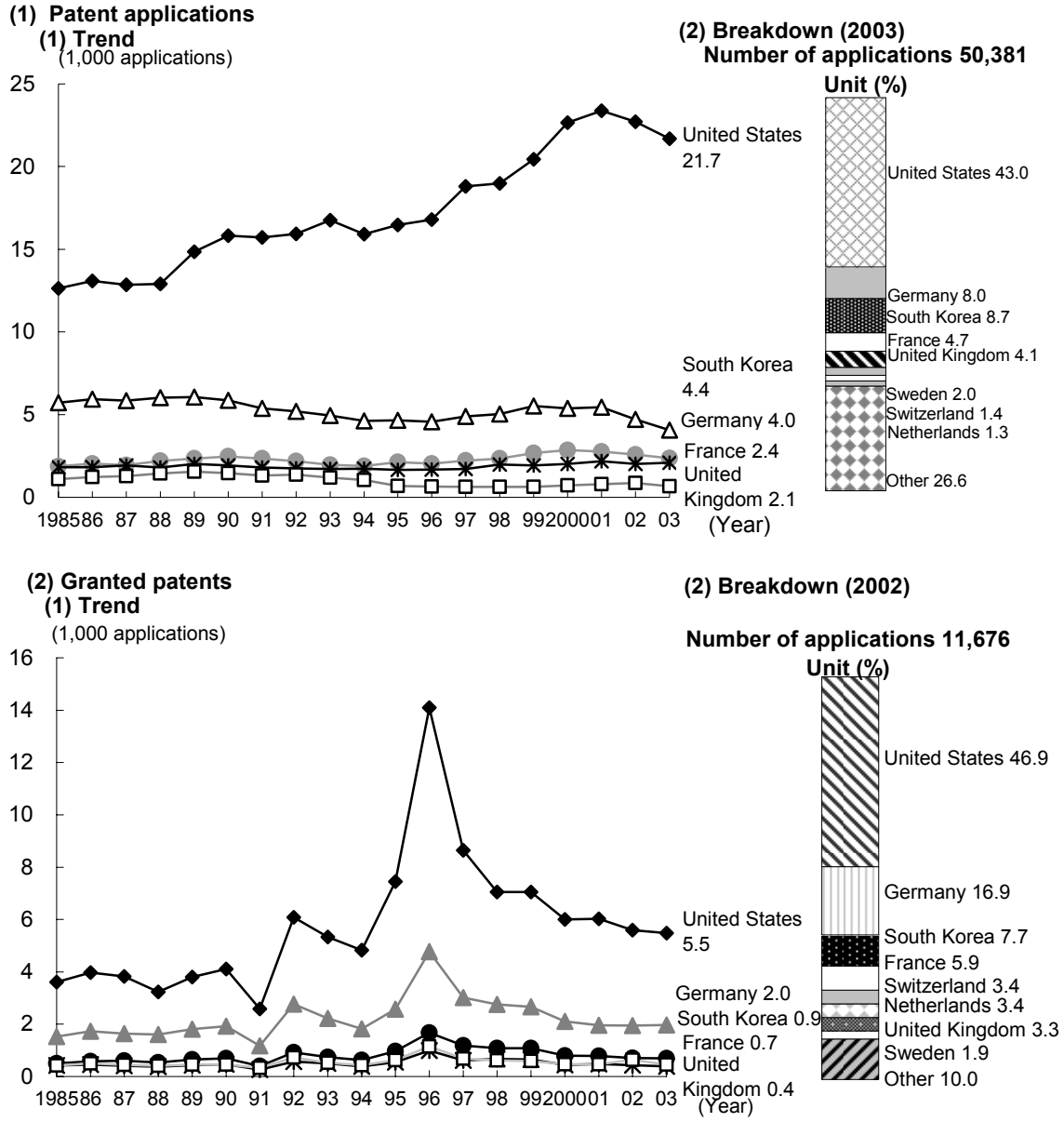

Figure 2-3-13 Number of patent applications and granted patents by nationality of foreign inventors

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

2.3.2.5 Patent Applications in Japan by Field

Patent applications by category[21] in 2002 showed no change in ranking from the previous year (Table 2-3-14)

Table 2-3-14 Number of patent applications by field of technology in Japan (2002)

Fields of technology	Number of applications	Composition rate (%)
Human necessities	40,723	10.7
Performing, operations, transportation	66,703	17.5
Chemistry, metallurgy, textiles	44,112	11.6
Fixed construction	15,088	4.0
Mechanical engineering	32,368	8.5
Physics	94,918	25.0
Electricity	86,430	22.7
Total	380,342	100

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

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.

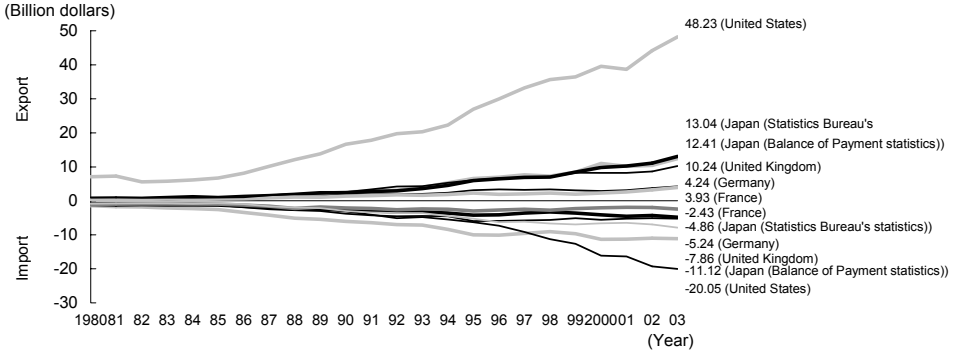

Figure 2-3-15 Trend in technology trade of selected countries

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, 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.

Sources: Japan - Bank of Japan. "Balance of Payments Monthly," Statistics Bureau. "Report on the Survey of Research and Development"
United States - Development of Commerce. "Survey of Current Business"
Germany - Deutsche Bundesbank. "Zahlungsbilanz-statistik"
France - Ministere de l'Economie, des Frances et de l'industrie/Banque de France. "La Balance des Paiements et la Position Exterieure de la France"
United Kingdom - Office for National Statistics. "Overseas Earnings from Royalities and Services" (1980-90), and "UK trade in Services" (1991-)

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 2-3-16). Elsewhere, France and the U.K. have moved into an excess of exports while Germany continues to show an excess of imports.

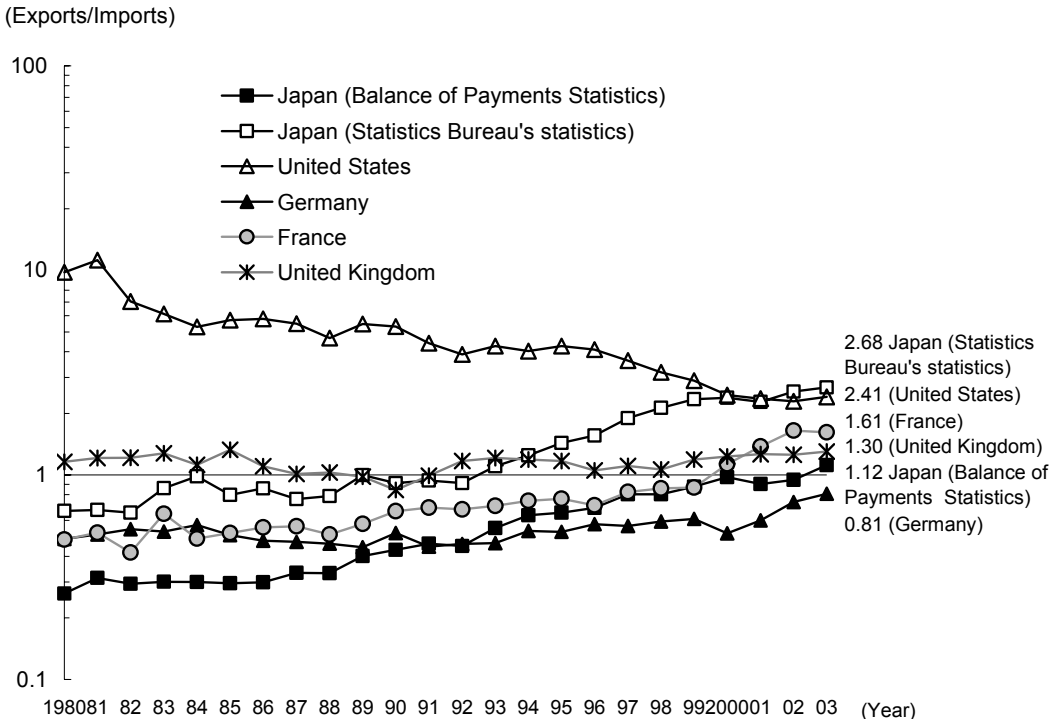

Figure 2-3-16 Trends in the technology trade balance of selected countries

Source: Same as in Figure 2-3-15

For the technology trade balance between major selected countries, the United States shows an increasingly strong excess of exports. In Japan, the Balance of Payments statistics and the Statistics Bureau's statistics reveal conflicting trends, with the former showing an excess of imports trend, and the latter showing an excess of exports trend (Table 2-3-17).

Table 2-3-17 Technology trade balance between selected countries by counterpart

Country (Year) \ Technology trade couterpart		Japan	United States	Germany	France	United Kingdom
Japan	(2002)	*	0.71	0.56	0.30	0.93
		*	1.73	1.27	0.44	2.95
	(2003)	*	0.75	0.54	0.34	1.22
		*	1.79	1.01	0.38	2.94
United States	(2002)	1.26	*	1.55	1.57	2.87
	(2003)	1.19	*	1.40	1.39	2.50
Germany	(2001)	0.86	0.44	*	0.43	0.46
	(2002)	1.43	0.74	*	0.54	0.44
France	(2002)	16.82	2.35	1.38	*	1.58
	(2003)	13.52	2.42	1.33	*	1.39
United Kingdom	(2002)	1.46	0.91	0.97	0.75	*
	(2003)	1.05	0.88	1.00	0.63	*

Note: 1. The trade balance is a ratio derived by dividing the total export value by the total import value.
2. Japan's data is divided into two rows, with the upper row showing the Bank of Japan Balance of Payments statistics (2002) values, and the lower row showing Statistics Bureau's statistics (FY2004) values.

Source: Germany - Federal Ministry of Education and Research. "Bundesbericht Forschung 2004"
Other countries - Same as in Figure 2-3-15.

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).

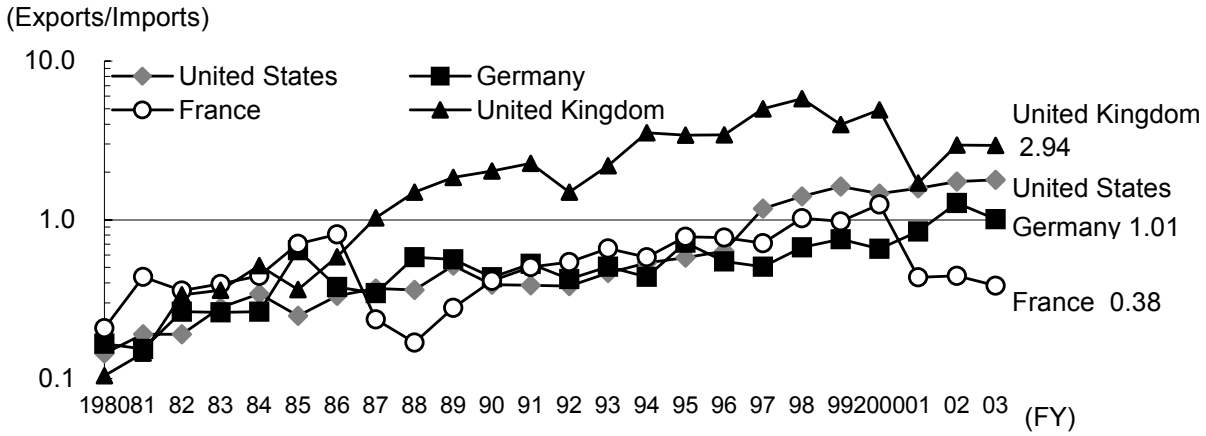

Figure 2-3-18 Trends in technology trade balance of Japan with other selected countries

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

A look at Japan's technology trade for FY2003 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 nearly half 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 2-3-19).

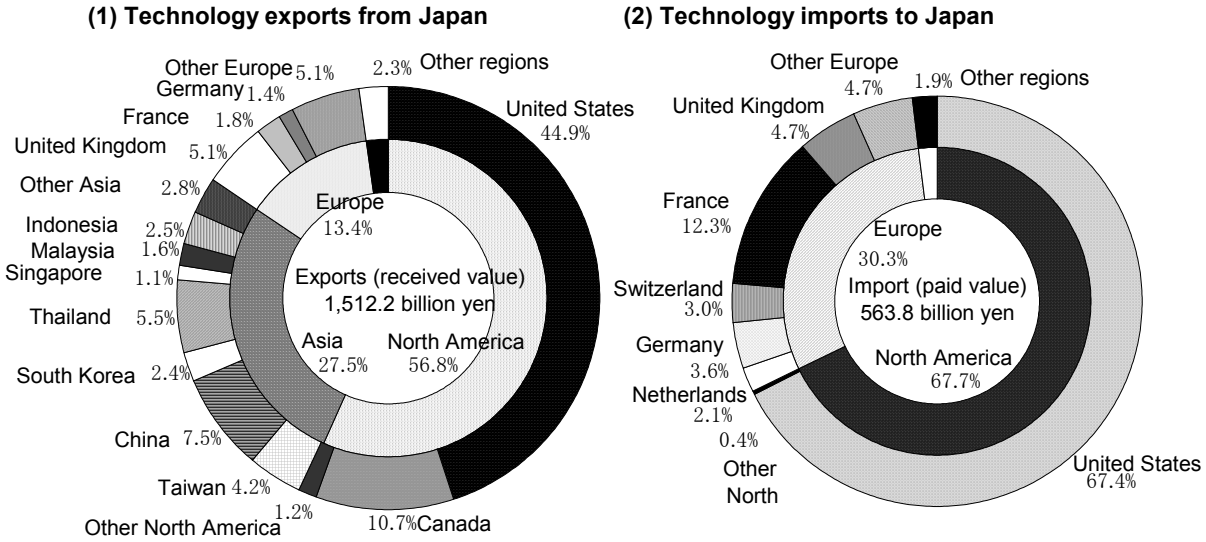

Figure 2-3-19 Composition of Japan's technology trade, by selected country and region (FY2003)

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

As late as FY1996, Japan had an excess of imports with Europe and North America, and an excess of exports with Asia. Starting in FY1997, however, Japan's technology trade balance shifted to an export surplus with all regions, and then to an import surplus with Europe in FY2001 (Figure 2-3-20).

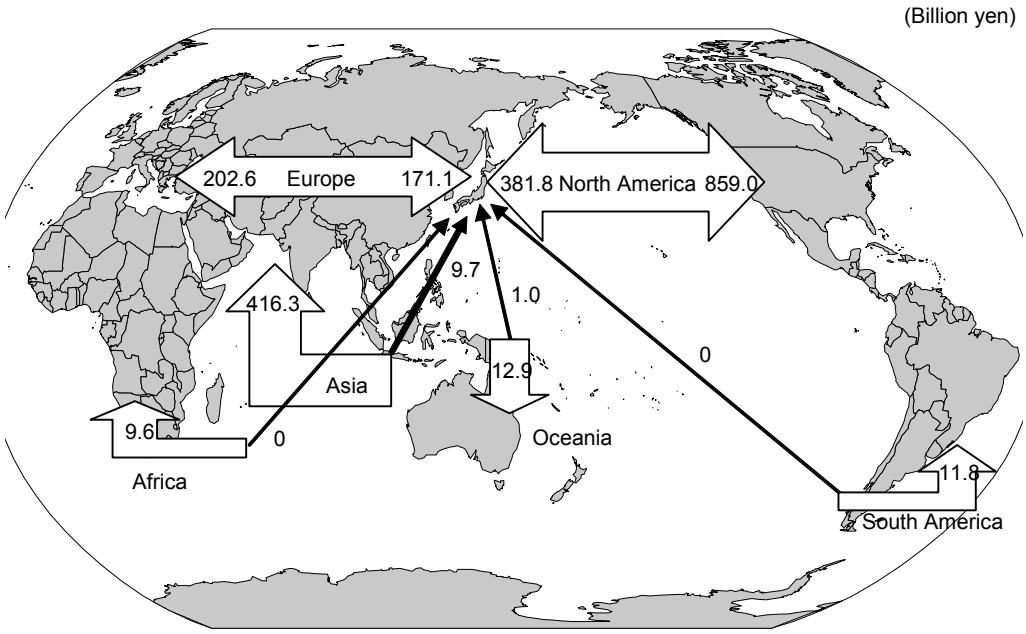

Figure 2-3-20 Technology trade by region (FY2003)

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 FY2003, 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 2-3-21).

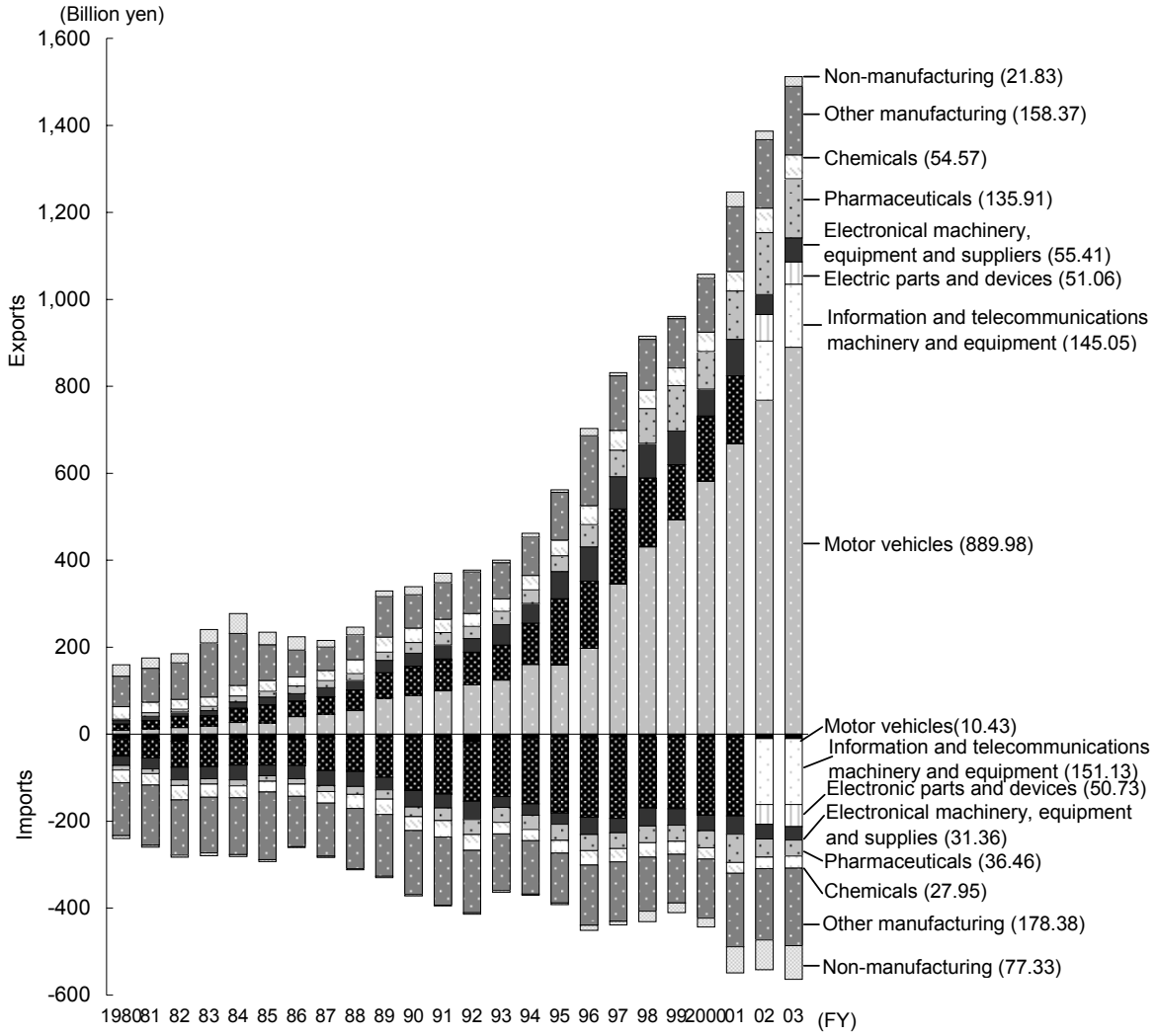

Figure 2-3-21 Trends in technology trade by industry sector

Note: 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 technology trade balance in the electrical parts and devices industry—a new category since FY2002—has shown an excess of exports, while the information and communications machinery industry has shown an excess of imports. The electrical machinery, equipment and supplies industry, which had once been tilted toward imports, has had an excess of exports since FY1993. While the drug and medicines industry has in recent years been in general balance, it tilted over to an excess of exports in FY1996, and has tended more in the direction of that trend since (Figure 2-3-22).

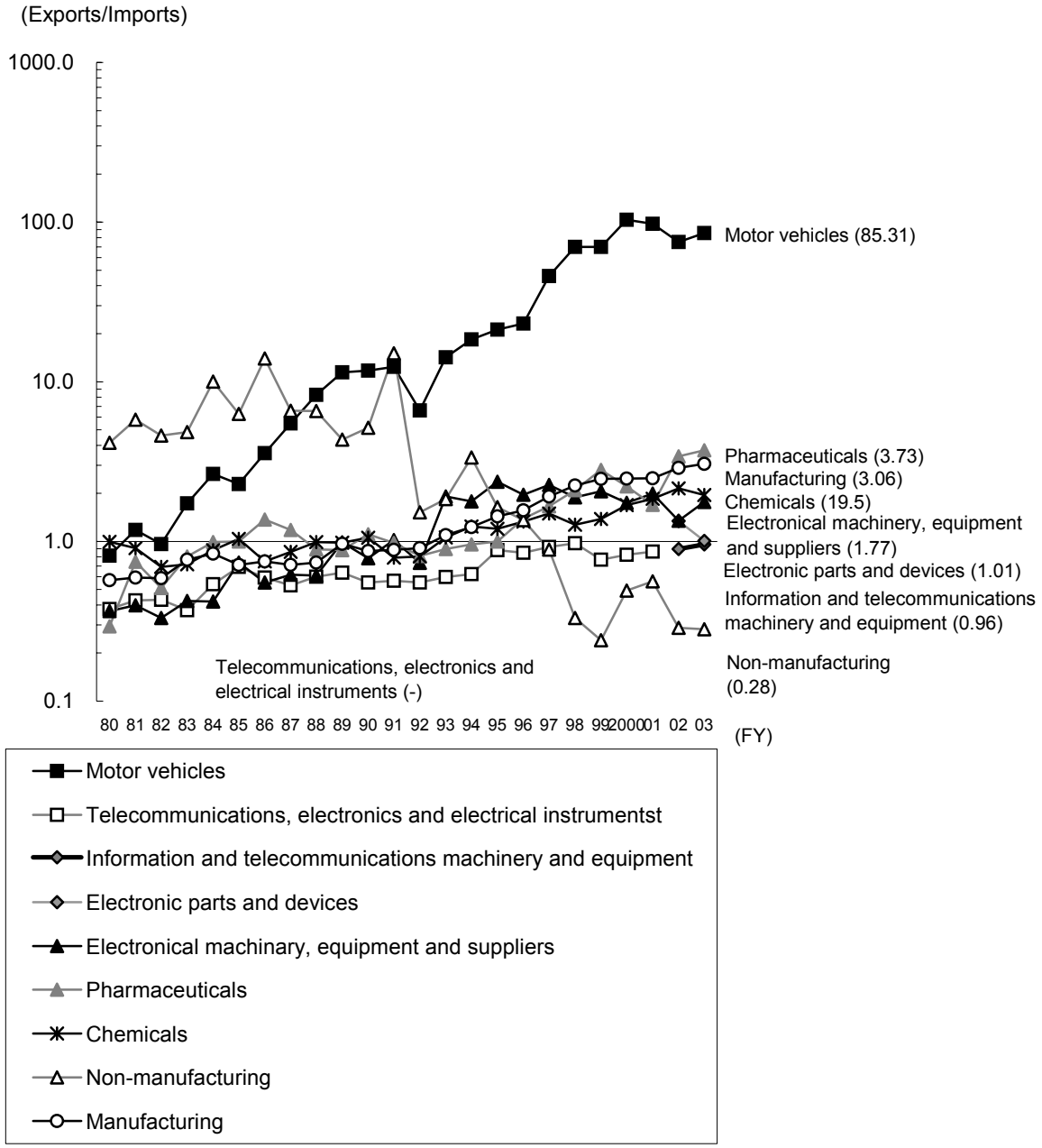

Figure 2-3-22 Trends in technology trade balance in major industry sectors

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 2-3-23).

Table 2-3-23 Technology trade balance of payments by trade partner country and region for major industrial categories in Japan (FY2003)

Motor vehicles (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
United States	462.6	5.4	457.2
United Kingdom	45.9	0.2	45.7
Thailand	52.8	0.0	52.8
Taiwan	28.9	-	28.9
China	22.4	0.0	22.4
South Korea	4.1	0.2	3.9
Other	273.2	4.6	268.6
Total	890.0	10.4	879.5

Information and telecommunications machinery and equipment (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
Taiwan	11.4	2.7	8.7
China	34.7	0.1	34.6
Malaysia	12.3	-	12.3
Singapore	5.4	0.0	5.4
South Korea	8.3	0.5	7.8
United Kingdom	2.4	2.9	-0.6
Netherlands	13.0	5.8	7.2
France	1.1	4.8	-3.6
United States	27.3	120.1	-92.8
Other	29.3	14.2	15.0
Total	145.1	151.1	-6.1

Pharmaceuticals (Billion yen)

Export and import	Technology Exports	Technology Imports	Exports-Imports
United States	88.6	11.8	76.8
France	6.0	1.4	4.5
United Kingdom	19.1	9.1	10.1
Netherlands	0.1	0.7	-0.6
Switzerland	2.1	3.5	-1.5
Germany	6.6	5.9	0.7
Sweden	0.1	0.8	-0.7
Other	13.3	3.2	10.2
Total	135.9	36.5	99.5

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 ex- ports 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 second only to the United States among OECD countries. This share had been declining. (Figure 2-3-24).

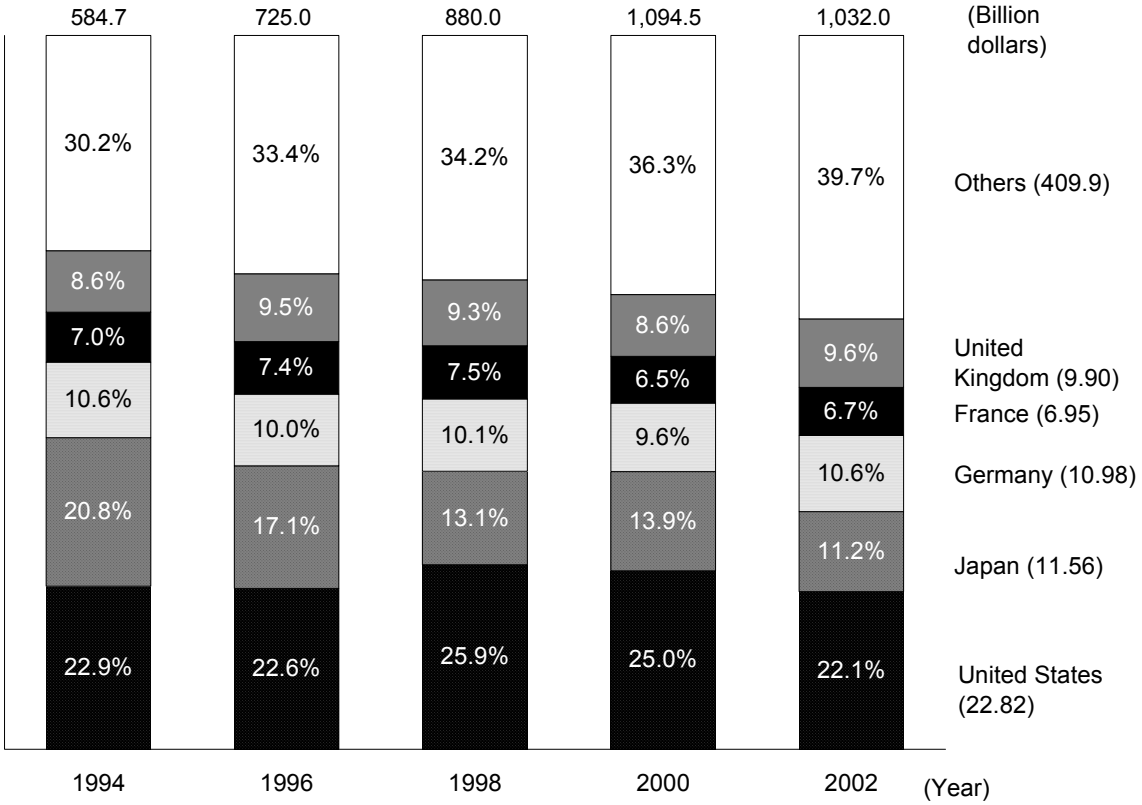

Figure 2-3-24 Export market shares for high-tech products by country in OECD countries

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.

With the exception of the United Kingdom and France, 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).

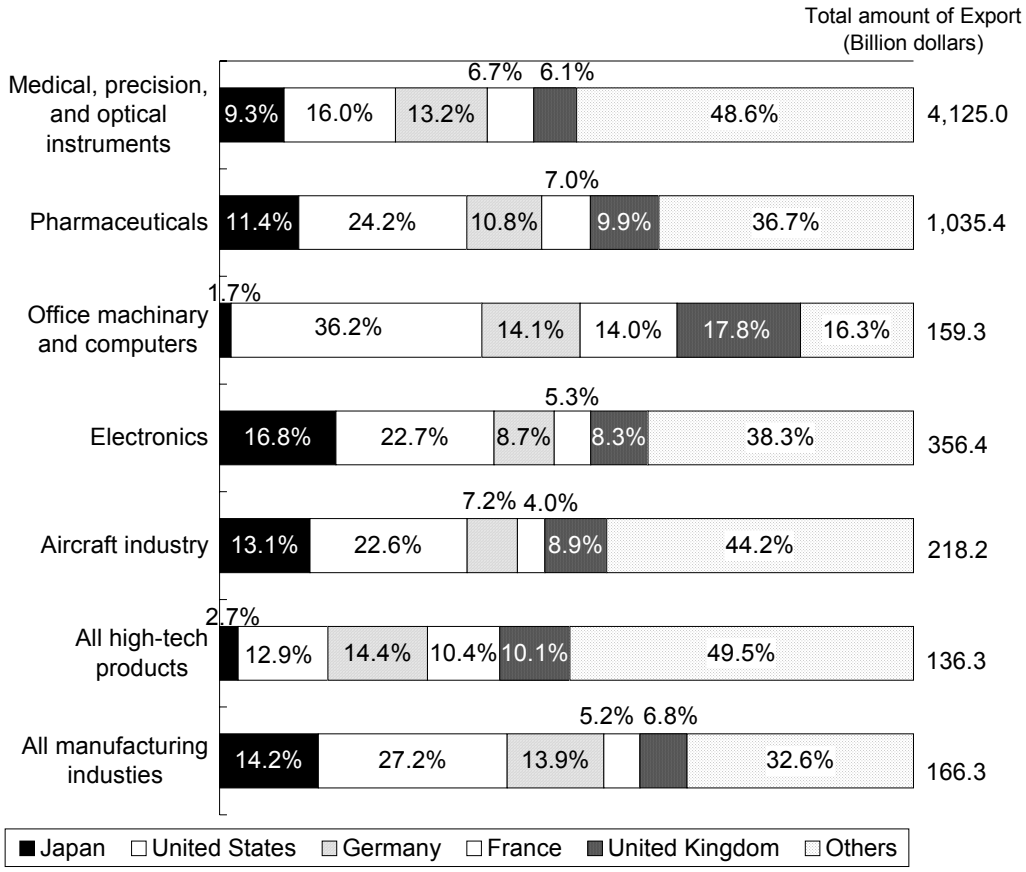

Figure 2-3-25 Share of high-tech products by country manufactured in OECD (2002)

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 2-3-26).

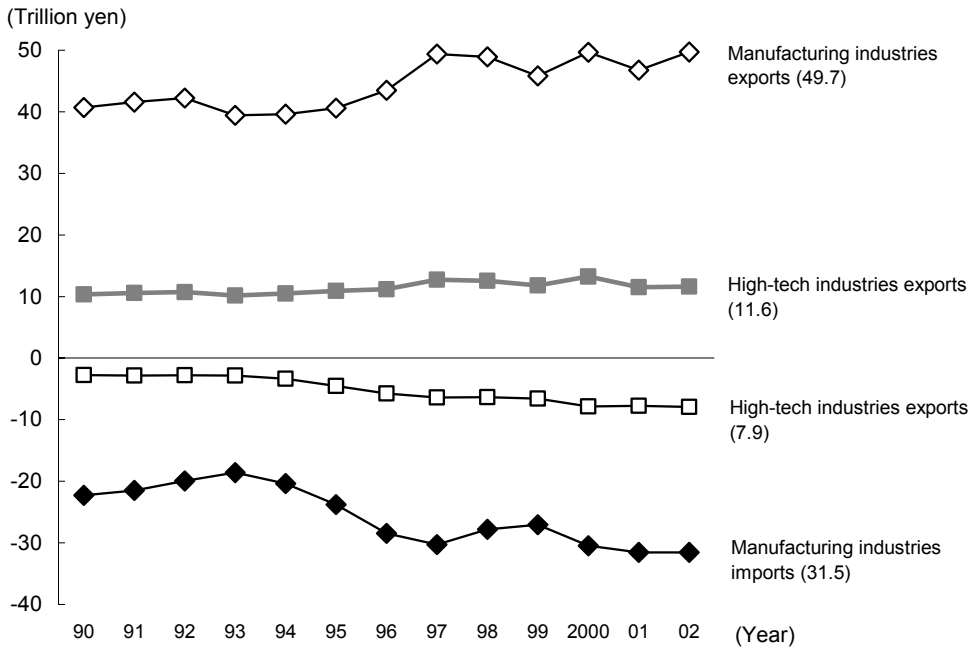

Figure 2-3-26 Trends in imports and exports, by value, for Japan's general manufacturing industry, and the high-tech industry

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

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).

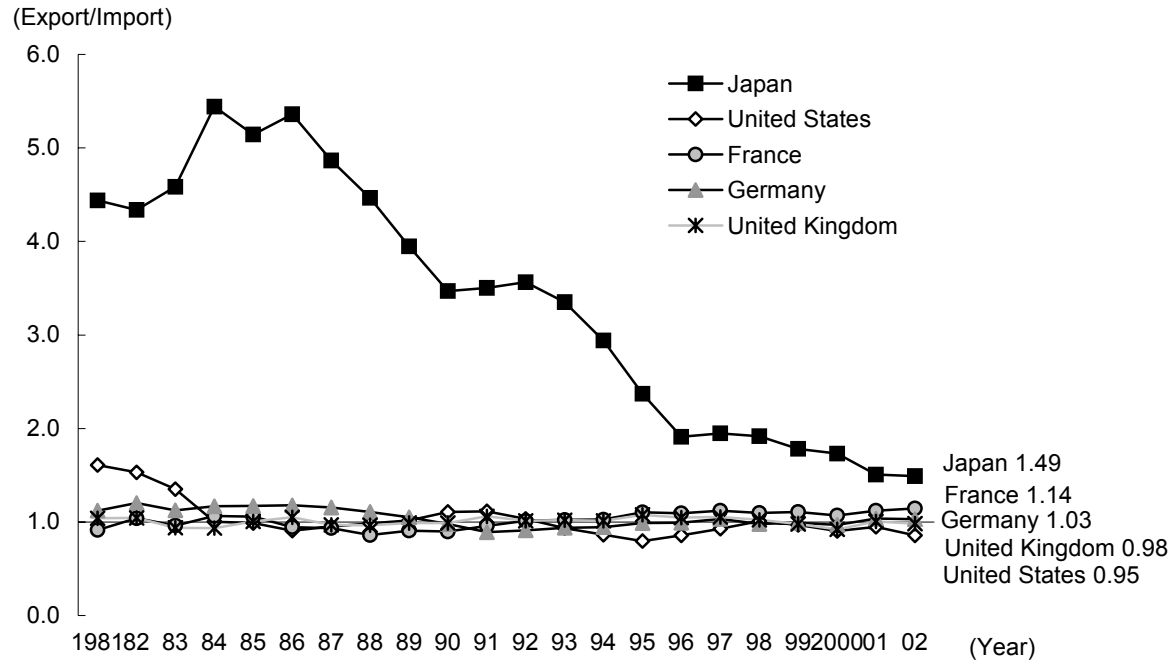

Figure 2-3-27 Trends in high-tech balance of payment ratios for selected countries

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 2002, by industry, was as shown in Table 2-3-28. The electronics industry showed a higher balance of payments ratio than the high-tech industry overall. The medical, precision, and optical equipment industries had about the same balance of payments ratio as the manufacturing industry as a whole. 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 (2002)

Export and import amounts / Industry	Exports (billion yen)	Imports (billion yen)	Trade balance
All manufacturing	49,700	31,533	1.58
All high-tech products	14,494	9,728	1.49
Electronics	7,678	3,550	2.16
Office Machinery & Computer Industry	3,222	2,768	1.16
Medical, precision, and optical equipment	2,857	1,822	1.57
Pharmaceuticals	479	822	0.58
Aerospace	258	766	0.34

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