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[15] compiled by the Institute for Scientific Information.

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 2002, 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, and has registered the second fastest rate of growth after China among the selected countries.

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 Ger-many 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).

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).

For Japan's RCI by field, materials science registers the highest RCI value. But no sector exceeds 1.0, and th results are generally low across fields (Table 2-3-3).

15 ISI database: About 8,500 journals are listed in the ISI database, of which about 5,500 are natural science journals, about 1,800 are social science journals, and about 1,200 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.

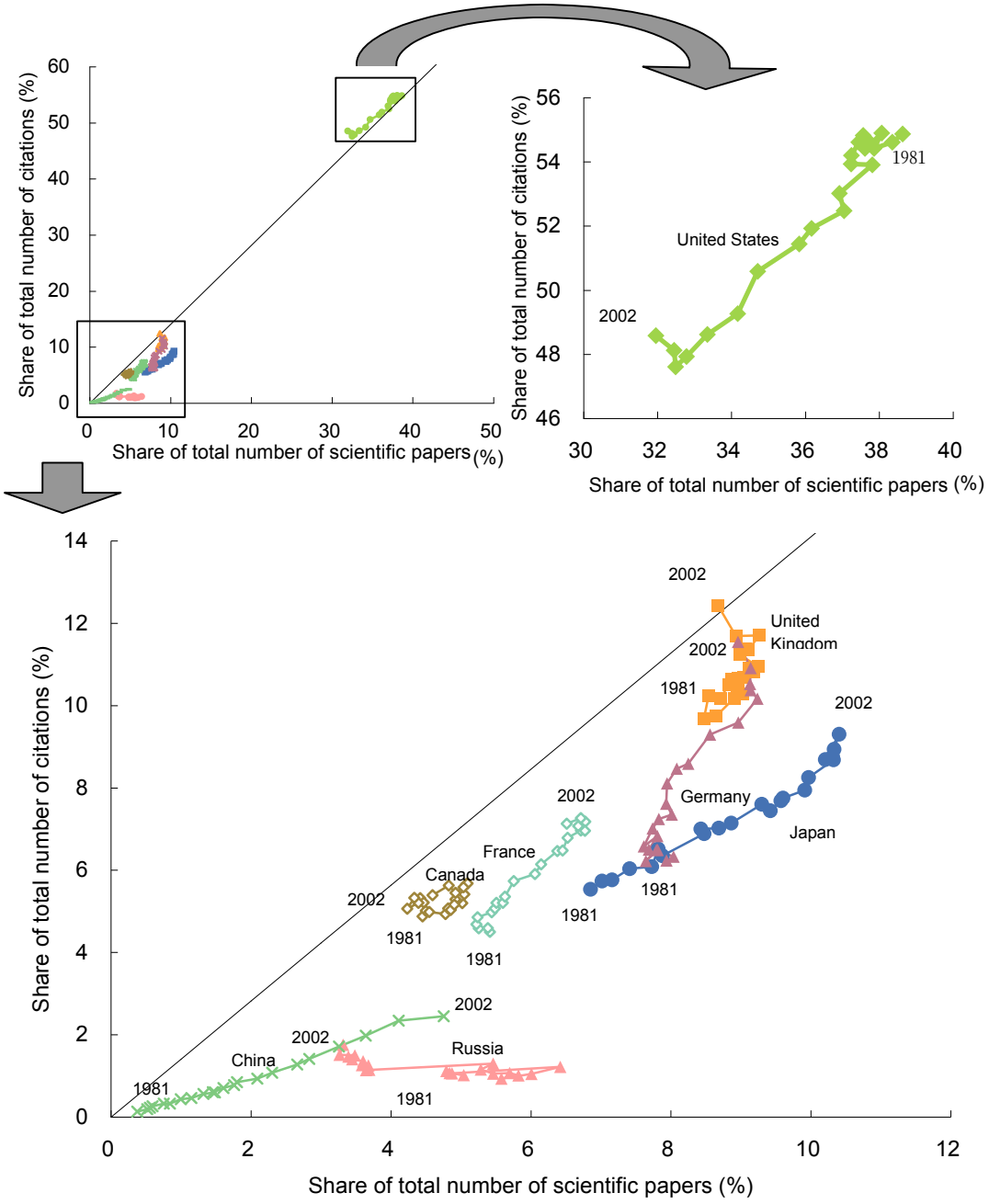

Figure 2-3-1 Relationship between the world total for scientific papers and for citations in scientific papers

Notes: 1. The figures for Russia include those for the Soviet Union.

2. The figures for Germany include those for the former East Germany.

3. The straight line drawn through the figures was derived from the least-squares method using the 2002 data of the seven countries.

Source: Institute for Scientific Information (ISI) "National Science Indicators 1981-2002"

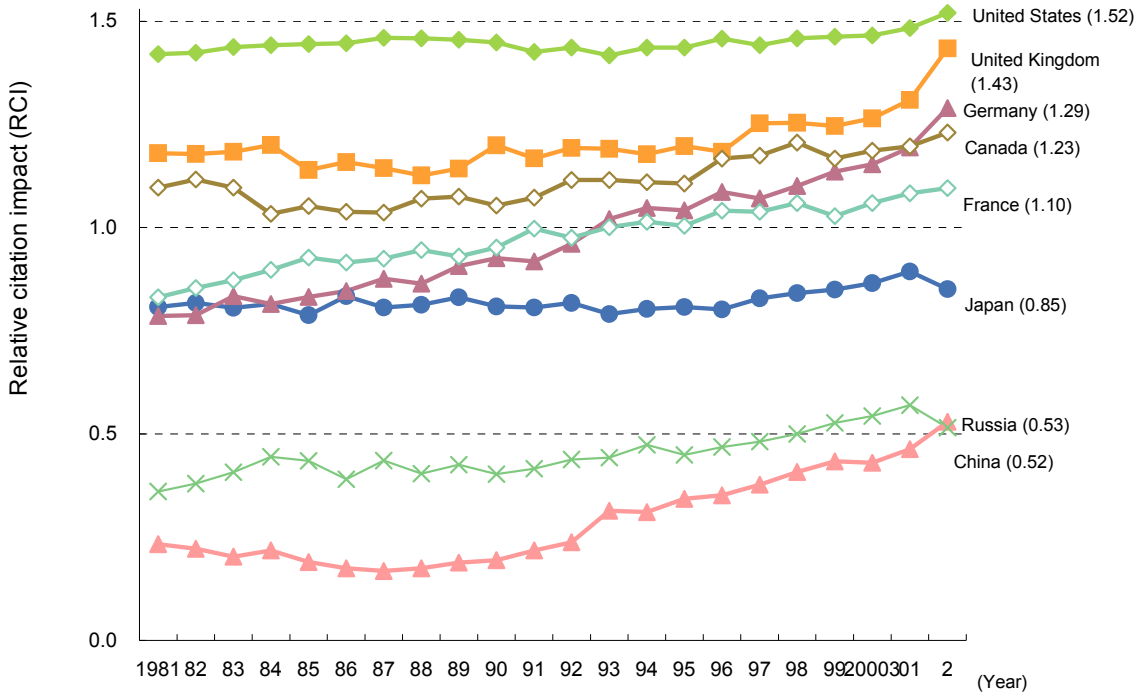

Figure 2-3-2 Trends in the relative citation impact for scientific papers in selected countries

Source: Institute for Scientific Information. "National Science Indicators, 1981-2002"

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

Rank	Research field	Relative citation impact
1	Material science	1.00
2	Chemistry	0.97
3	Physics	0.96
4	Plant and animal science	0.92
5	Agricultural science	0.90
6	Immunology	0.90
7	Space science	0.90
8	Engineering	0.87
9	Geosciences	0.86
10	Biology and biochemistry	0.84
11	Molecular biology and	0.83
12	Mathematics	0.80
13	Clinical medicine	0.79
14	Ecology / environment	0.75
15	Pharmacology	0.75
16	Neuroscience and behavior	0.73
17	Microbiology	0.69
18	Computer science	0.42

Note: Data is for 1998-2002

Source: Institute for Scientific Information. "National Science Indicators, 1981-2002"

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 1998 to 2002 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.

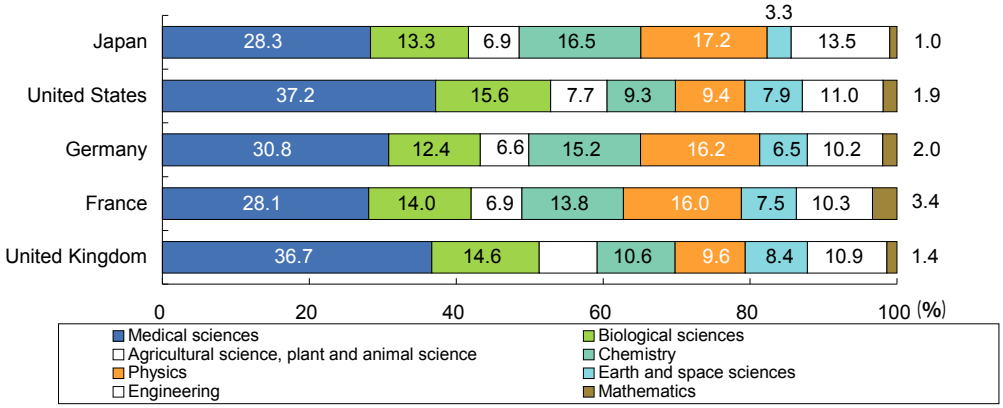

Figure 2-3-4 Number of scientific papers in selected countries, by field

Notes: 1. The composition of each field is as follows. Eighteen fields listed in the Institute for Scientific Information'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 1998 to 2002

Source: Institute for Scientific Information. "National Science Indicators, 1981-2002"

Figure 2-3-5 shows the share of Japan's scientific papers of all papers written worldwide, by field, for the years 1998 to 2002. Materials science, physics, and pharmacology are above Japan's average for all fields, demonstrating that Japan's research in these areas is relatively flourishing.

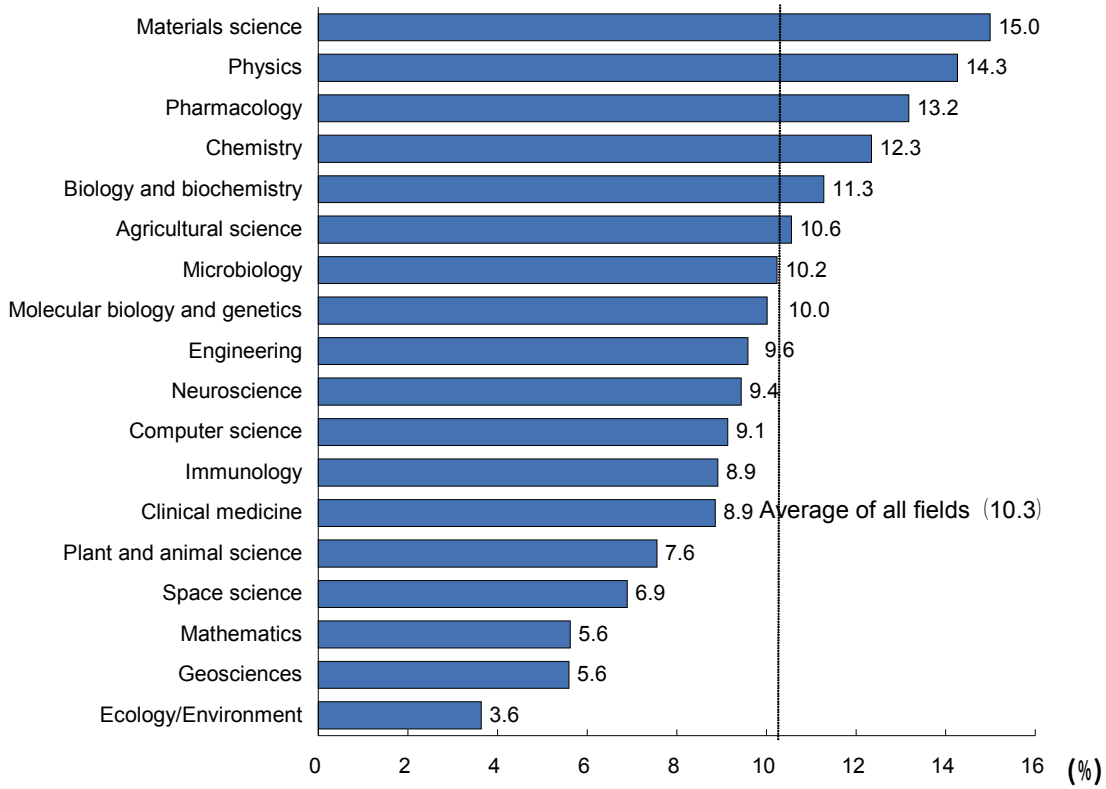

Figure 2-3-5 Japan's share of scientific papers, by field

Notes: 1. Figures are calculated from the aggregate values for 1998-2002.

2. Figures are Japan's share of all scientific papers in the world for each sector.

Source: Institute for Scientific Information. "National Science Indicators, 1981-2002"

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.

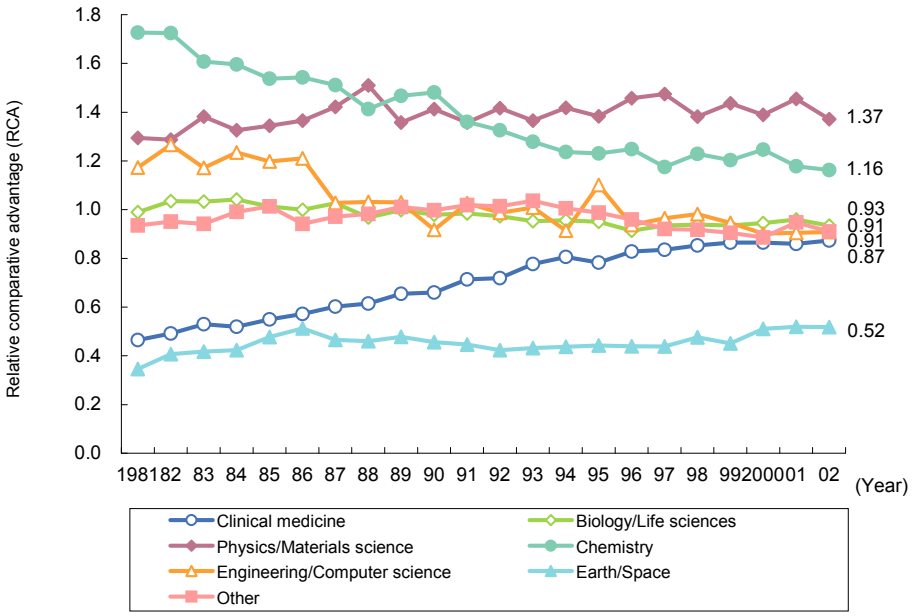

Figure 2-3-6 Trends in relative comparative advantage of scientific papers in Japan, by field

Source: "National science Indicators 1981-2002"

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[16] and European Patent Convention (EPC) applications[17], 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).

16 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 123 as of March 2, 2004.

17 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 28 as of April 1, 2004.

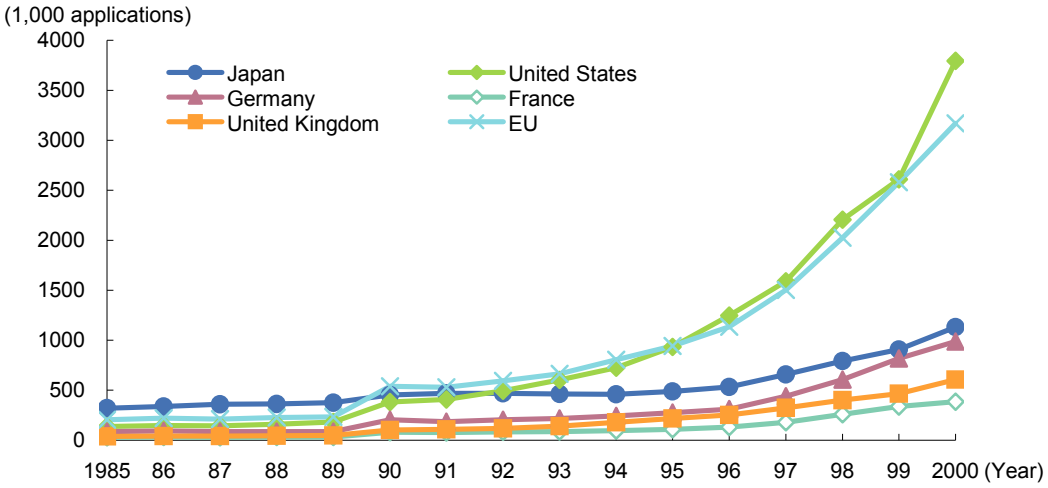

Figure 2-3-7 Trends in the number of patent applications in selected countries

Notes: 1. Total number of patent applications made either inside or outside the country according to the patent applicants' nationality
2. EU figures show the total for the current 15 member countries.
3. These data include designated countries under the Patent Cooperation Treaty (PCT) and the European Patent Convention (EPC).

Source: Japan Patent Office. "Patent Agency Yearbook", "Japan Patent Office Annual Report"
World Intellectual Property Organization (WIPO [18]). "Industrial Property Statistics"

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.

18 WIPO:World Intellectual Property Organization

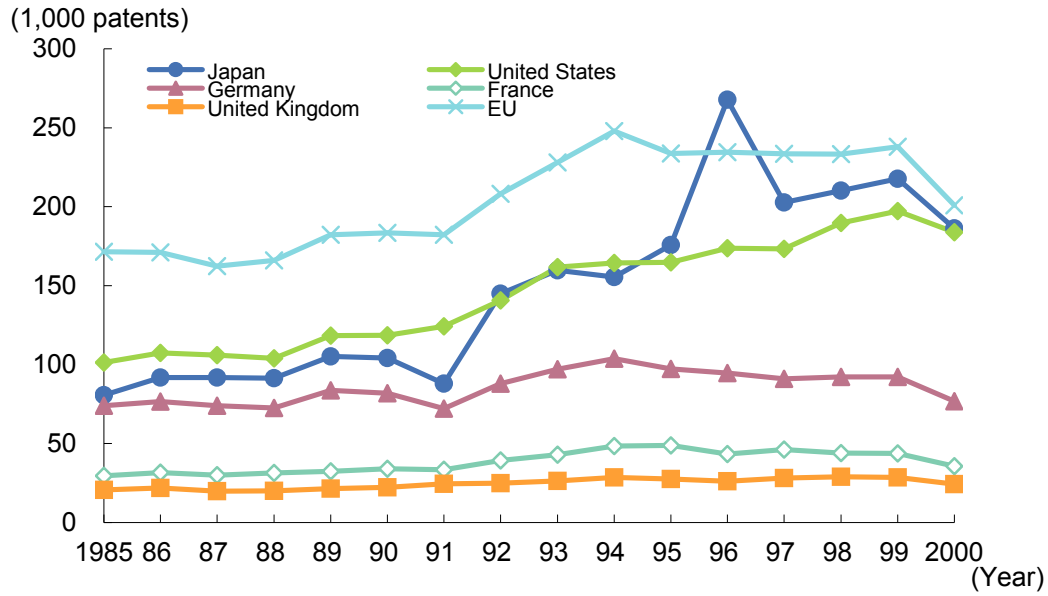

Figure 2-3-8 Trends in the number of patents granted by selected countries

Notes: 1. The total number of patents granted either inside or outside the country according to the nationality of the persons holding the patent rights.
2. EU figures show the total for the current 15 member countries.

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 selected countries (2000)

Nationality of applications	Country where patents were applied for							
	Japan	United States	Germany	France	United Kingdom	Other	Total	Applications in foreign countries (%)
Japan	388,879	56,586	26,621	21,268	24,219	615,238	1,132,811	65.7%
	112,269	31,296	6,723	5,262	6,302	24,480	186,332	39.7%
United States	45,920	175,582	78,559	48,765	79,990	3,366,778	3,795,594	95.4%
	6,007	85,071	7,787	7,387	8,825	68,863	183,940	53.8%
Germany	13,436	23,102	78,754	25,111	28,429	819,487	988,319	92.0%
	2,112	10,234	16,901	5,900	5,454	36,157	76,758	78.0%
France	4,664	7,862	10,032	21,471	9,770	329,494	383,293	94.4%
	793	3,819	2,167	10,303	2,067	16,612	35,761	71.2%
United Kingdom	5,517	10,286	11,922	7,241	33,658	536,727	605,351	94.4%
	449	3,667	1,410	1,386	4,170	13,339	24,421	82.9%
Other	27,788	58,355	56,662	36,322	57,157	—	—	—
	4,250	23,409	6,597	6,166	6,938	—	—	—
Total	486,204	331,773	262,550	160,178	233,223	—	—	—
	125,880	157,496	41,585	36,404	33,756	—	—	—
Percentage of foreign nationalities	20.0%	47.1%	70.0%	86.6%	85.6%	—	—	
	10.8%	46.0%	59.4%	71.7%	87.6%	—	—	

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"

Patent applications in foreign countries are particularly high in the United States, with applications apparently being placed in countries believed to offer the possibility of becoming production sites in the future, or where potential markets exist. U.S. patent applicants appear to be positioning intellectual property as important strategic assets, and to be aiming for international growth.

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 researchers in foreign countries, followed in order by South Korea, Germany, the United Kingdom, and France. While patents granted overseas tended to be concentrated in the major advanced nations, the number granted in South Korea has risen sharply in recent years (Figure 2-3-10(2)).

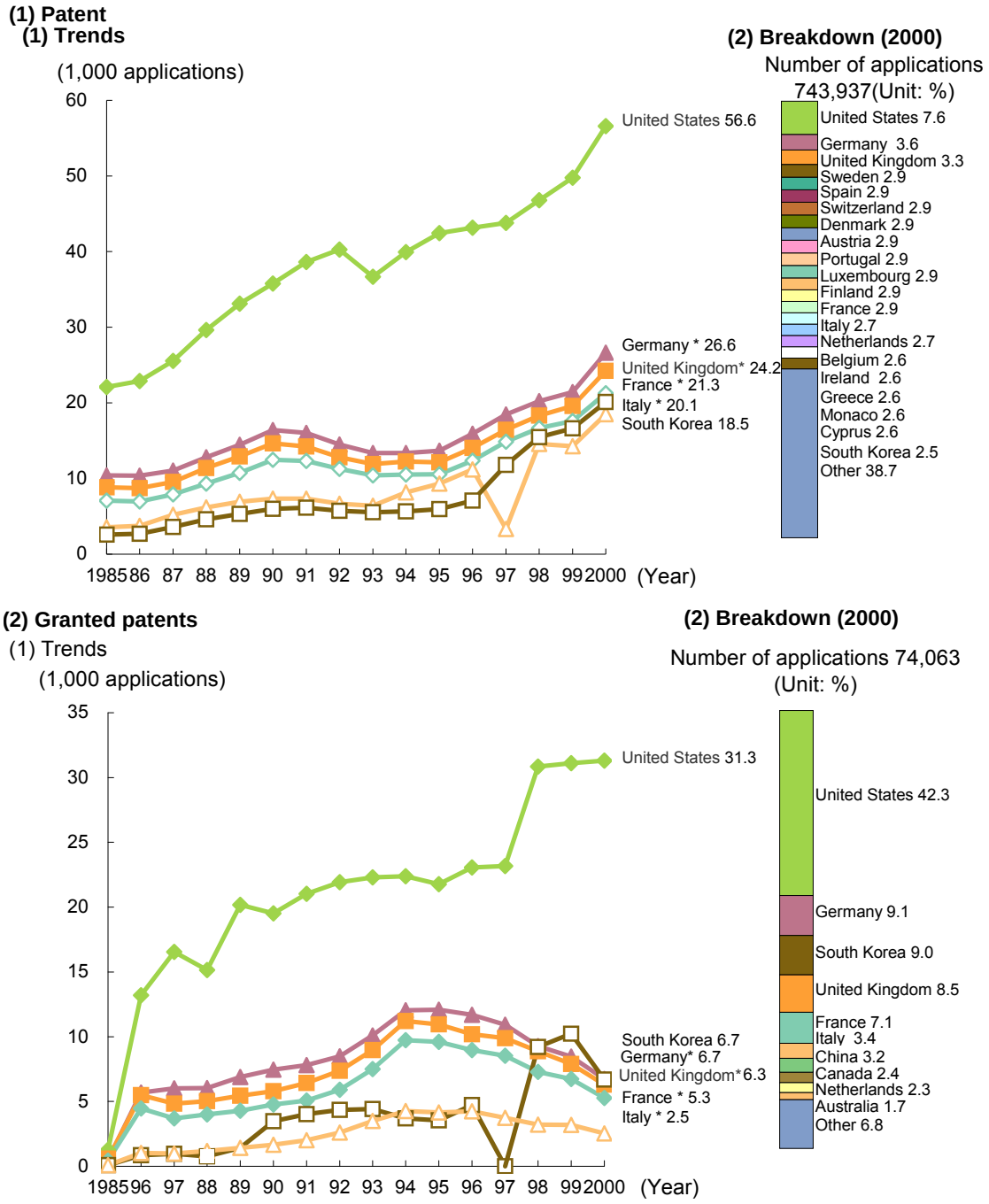

Figure 2-3-10 Number of patent applications and granted patents by Japanese researchers in foreign countries

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
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
	17.8	21.6	21.8	22.5	22.7	22.0	21.5	21.0	20.7	20.9	20.3	19.9
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
	14.4	17.4	18.1	18.2	19.4	20.9	21.4	21.1	19.9	17.9	17.1	16.2
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
	11.7	13.6	14.3	15.5	16.9	17.7	17.2	18.2	16.9	15.8	15.2	14.5
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
	17.2	18.0	18.9	19.4	21.0	23.0	22.6	23.0	22.1	20.5	19.4	18.7
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
	9.9	10.5	10.8	11.7	12.3	12.9	13.9	13.6	11.8	11.0	10.3	9.8
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
	6.3	6.7	7.2	7.7	8.8	8.9	9.4	9.1	7.9	6.9	6.6	6.5
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
	7.9	6.7	7.7	8.1	8.9	9.0	9.1	8.6	8.0	7.8	7.5	7.4
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
	35.8	44.8	46.3	41.4	38.6	31.6	28.4	28.6	-	17.4	16.3	19.2
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
	10.9	12.7	13.1	13.9	14.4	17.5	18.7	21.7	19.0	15.7	15.0	14.7

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.

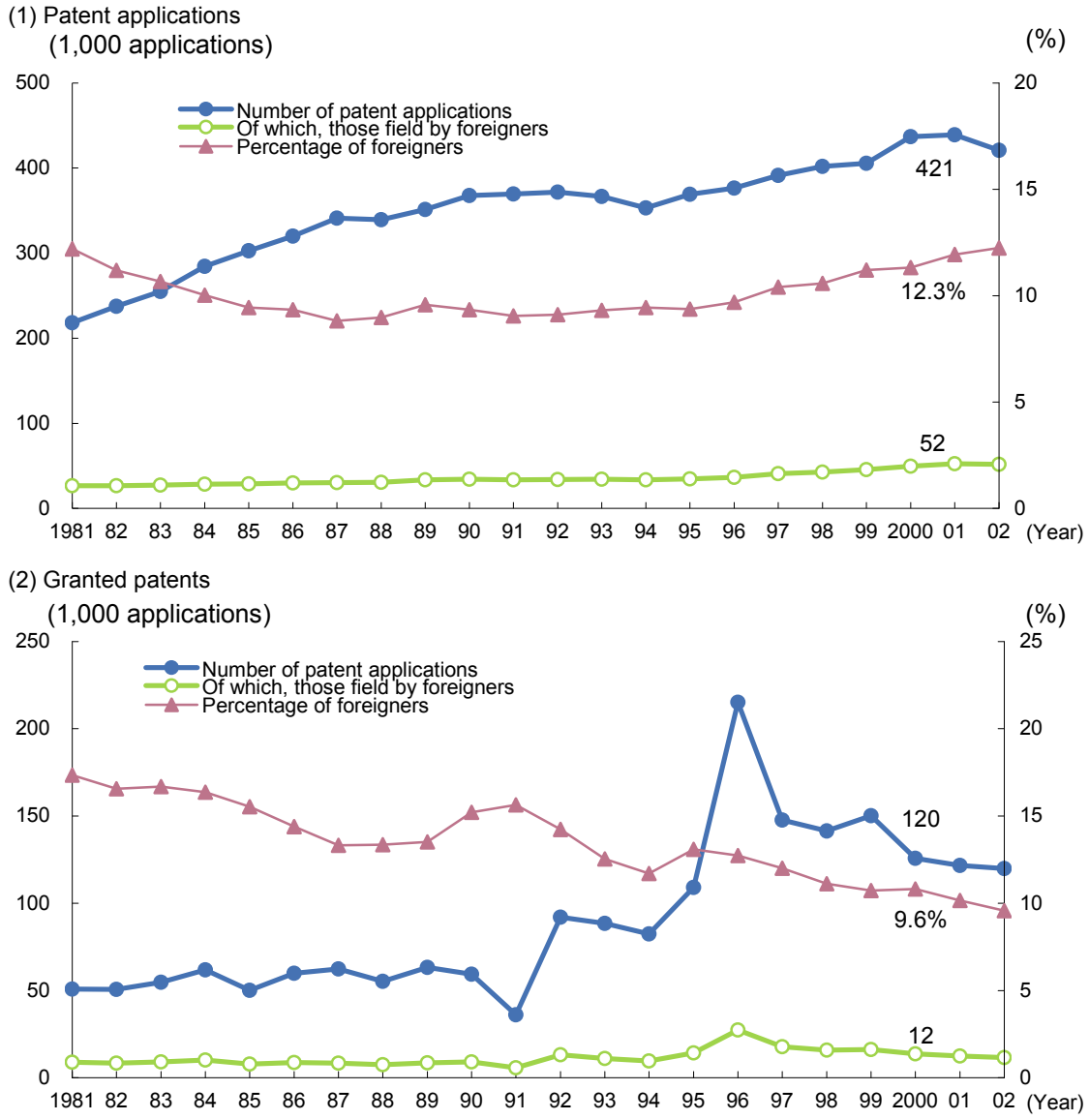

Figure 2-3-12 Trends in number of patent applications and granted patents in Japan

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 have been rising, 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).

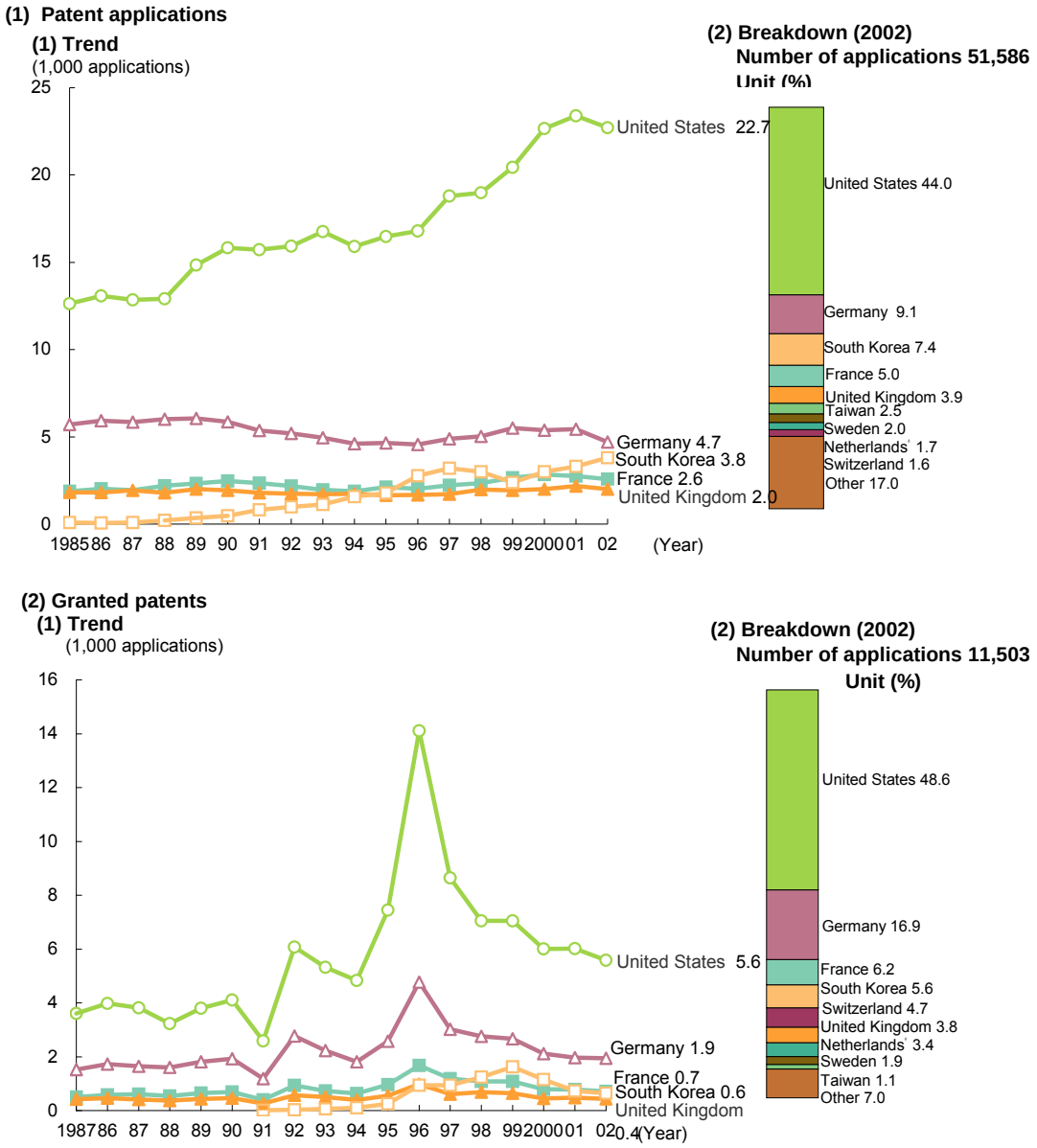

Figure 2-3-13 Number of patent applications and granted patents by nationality of foreign inventors

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[19] in 2000 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 (2001)

Fields of technology	Number of applications	Composition rate (%)
Human necessities	41,205	10.3
Performing, operations, transportation	69,996	17.5
Chemistry, metallurgy, textiles	45,962	11.5
Fixed construction	16,807	4.2
Mechanical engineering	33,178	8.3
Physics	103,110	25.8
Electricity	89,361	22.4
Total	399,619	100

Source: Japan Patent Office. "Japan Patent Office Annual Report 2003"

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.

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

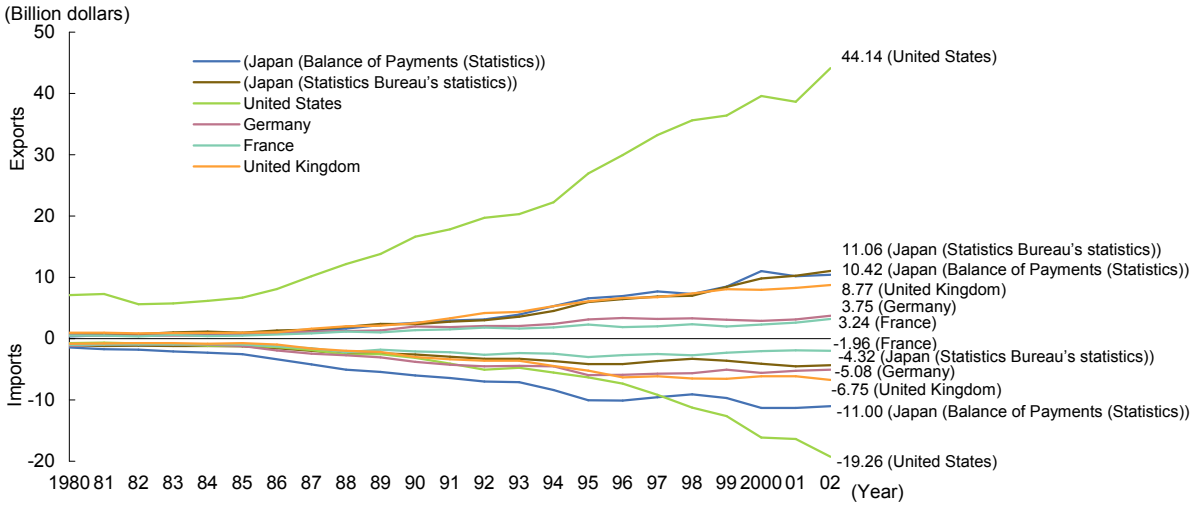

Figure 2-3-15 Trend in technology trade of selected countries

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 Indus tries 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 exchange 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-)

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.

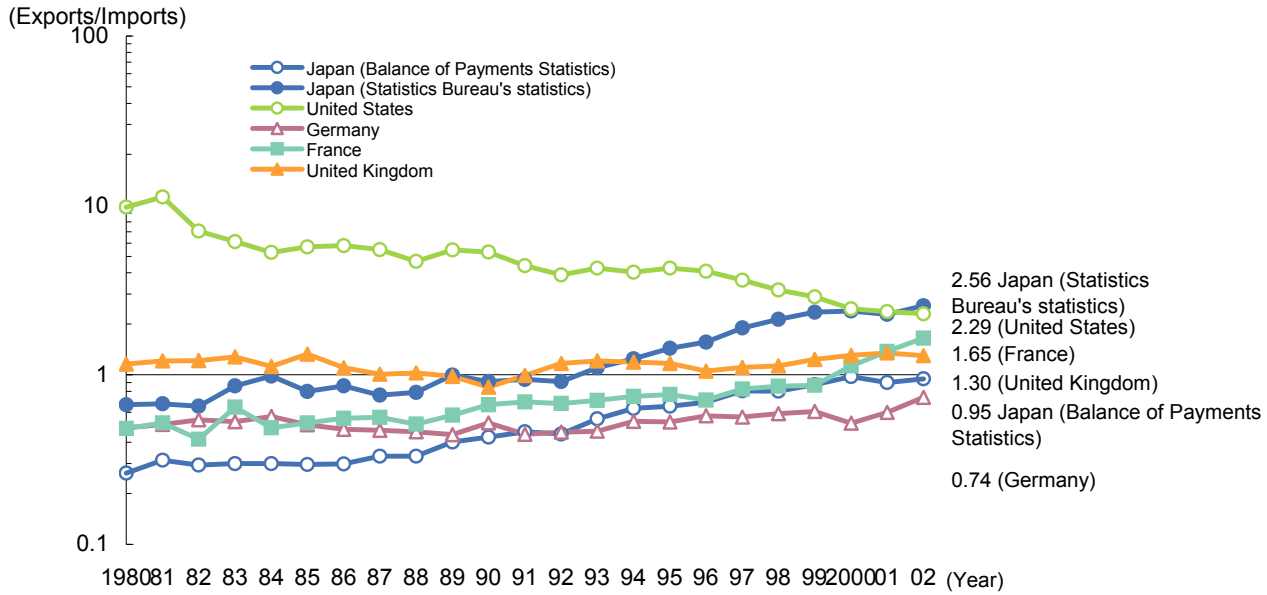

Figure 2-3-16 Trends in the technology trade balance of selected countries

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	(2001)	*	0.63	0.61	0.41	0.72
		*	1.58	0.84	0.43	1.70
	(2002)	*	0.71	0.56	0.30	0.93
		*	1.73	1.27	0.44	2.95
United States	(2001)	1.55	*	1.86	1.75	2.19
	(2002)	1.27	*	1.48	1.68	2.98
Germany	(2001)	0.86	0.44	*	0.43	0.46
	(2002)	1.43	0.74	*	0.54	0.44
France	(2001)	5.00	1.61	1.51	*	1.55
	(2002)	16.82	2.36	0.98	*	1.39
United Kingdom	(2001)	1.10	0.79	1.48	1.07	*
	(2002)	1.46	0.91	0.97	0.75	*

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).

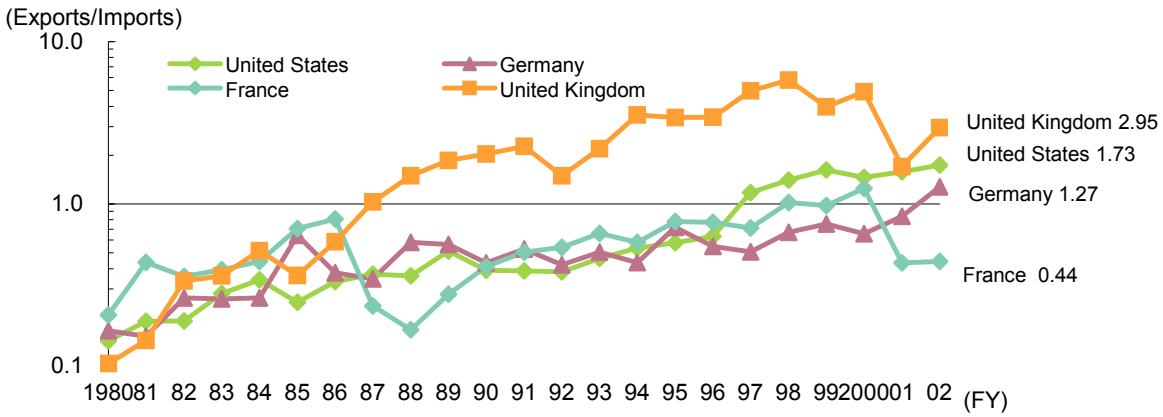

Figure 2-3-18　Trends in technology trade balance of Japan with other selected countries

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

（See Appendix 3. (13)）

A look at Japan's technology trade for FY2002 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).

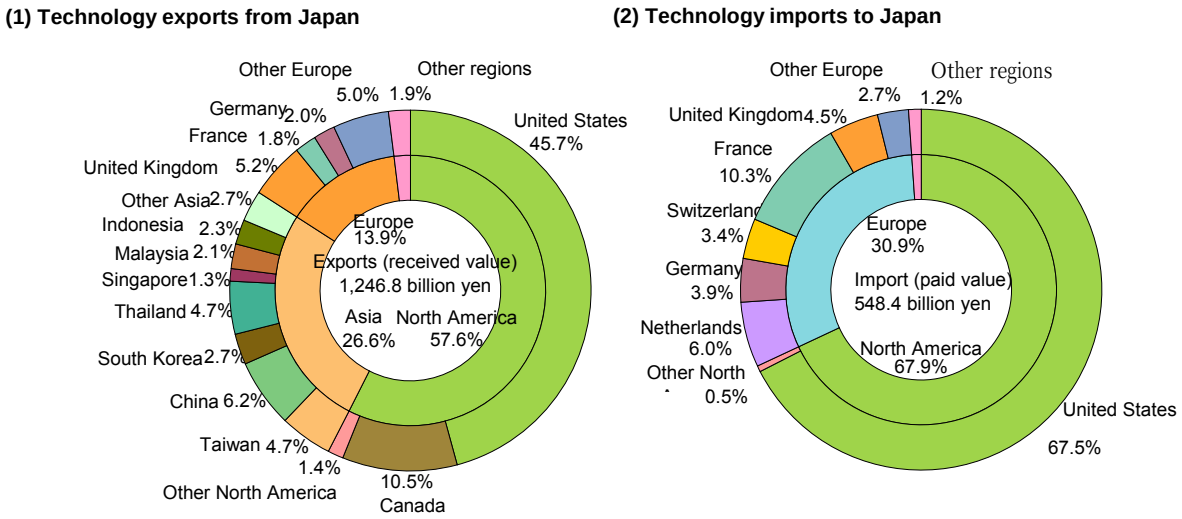

Figure 2-3-19 Composition of Japan's technology trade, by selected country and region (FY2002)

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).

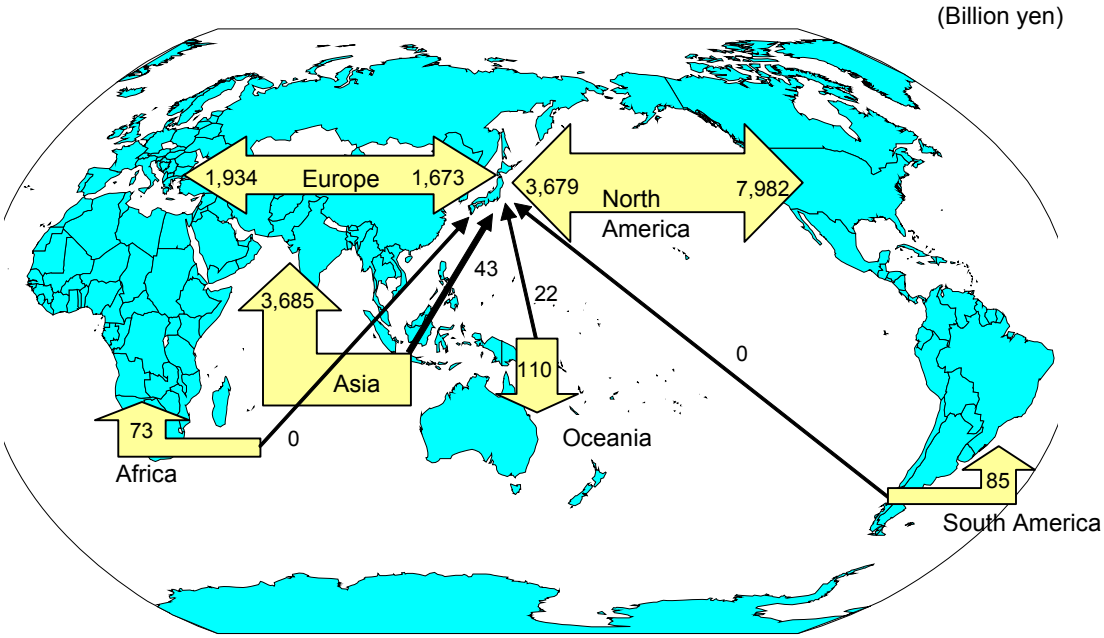

Figure 2-3-20 Technology trade by region (FY2002)

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 FY2002, 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).

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).

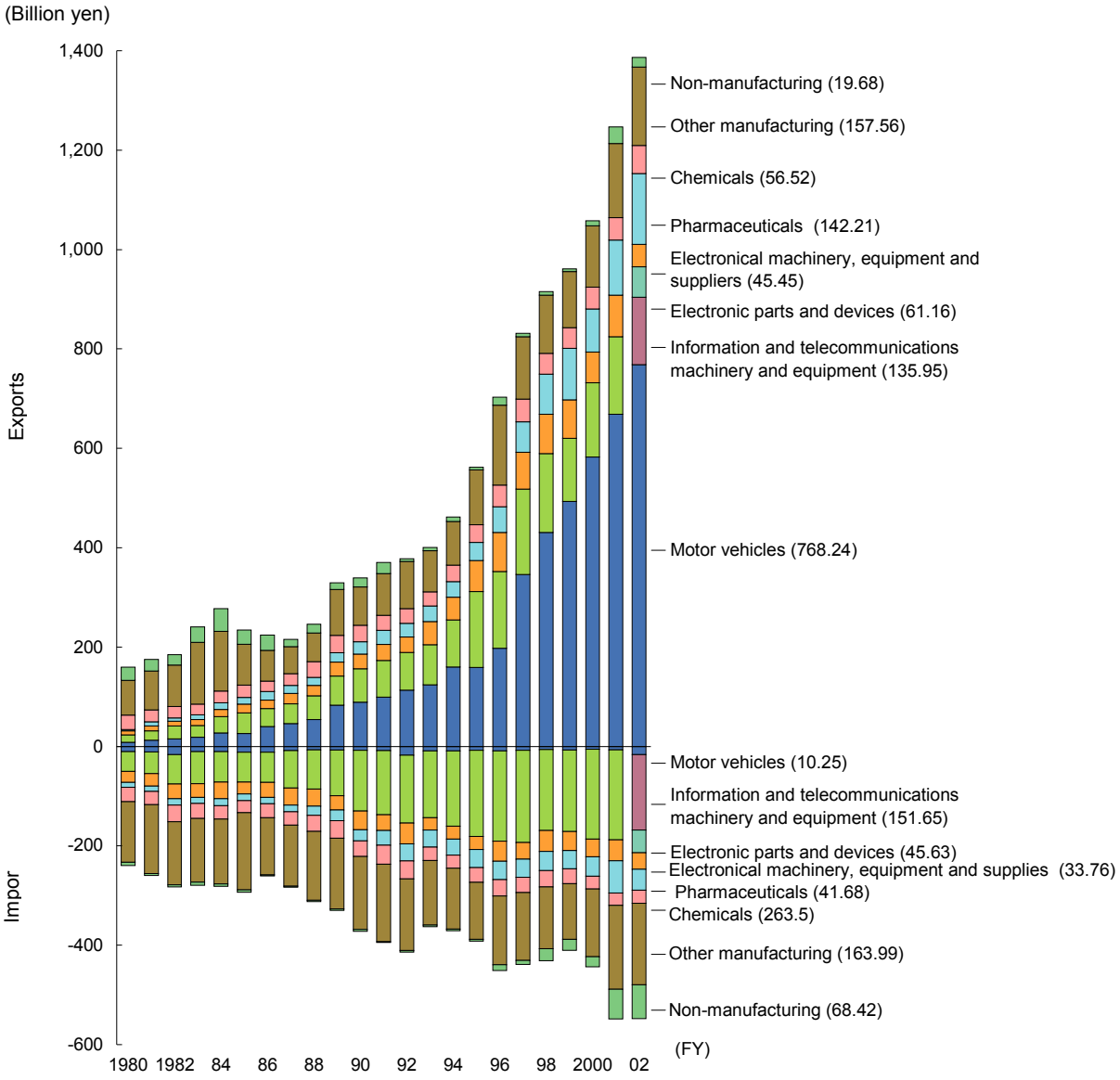

Figure 2-3-21 Trends in technology trade by industry sector

Note: The 2002 revision of industrial categories split "telecommunications, electronics and electrical instruments" into "Information and telecommunications machinery and equipment" and "Electronic parts and devices."

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

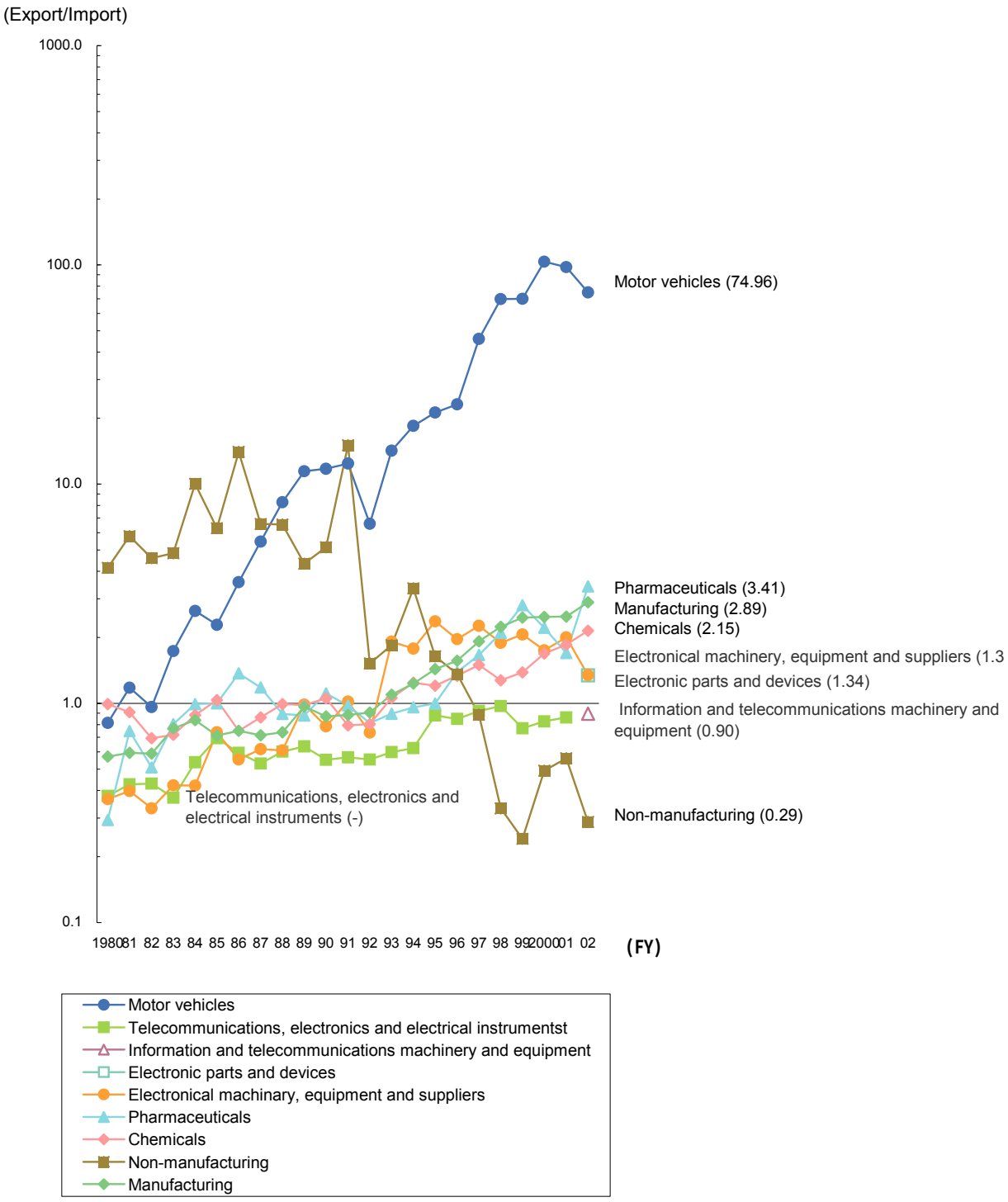

Figure 2-3-22 Trends in technology trade balance in major industry sectors

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 (FY2002)

Motor vehicles (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
United States	418.9	5.6	413.4
United Kingdom	42.4	0.8	41.6
Thailand	38.6	—	38.6
Taiwan	15.5	—	15.5
China	12.0	0.0	12.0
South Korea	6.0	0.2	5.7
Other	234.8	3.6	231.2
Total	768.2	10.2	758.0

Information and telecommunications machinery and equipment (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
Taiwan	16.5	0.2	16.3
China	29.5	0	29.5
Malaysia	13.7	—	137.0
Singapore	5.2	0.2	5.0
South Korea	5.0	0.2	4.8
United Kingdom	2.7	2.8	-0.1
Netherlands	11.0	13.4	-2.3
France	4.4	8.3	-4.0
United States	26.1	121.2	-95.1
Other	21.9	5.3	16.5
Total	136.0	151.6	-15.7

Pharmaceuticals (Billion yen)

Export and import amounts / Country and region	Technology Exports	Technology Imports	Exports-Imports
United States	92.2	11.5	80.8
France	6.0	1.5	4.5
United Kingdom	18.6	13.1	5.6
Netherlands	0.1	0.8	-0.7
Switzerland	4.3	3.9	0.4
Germany	6.9	8.0	-1.1
Sweden	0.0	0.9	-0.9
Other	14.1	2.1	12.0
Total	142.2	41.7	100.5

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

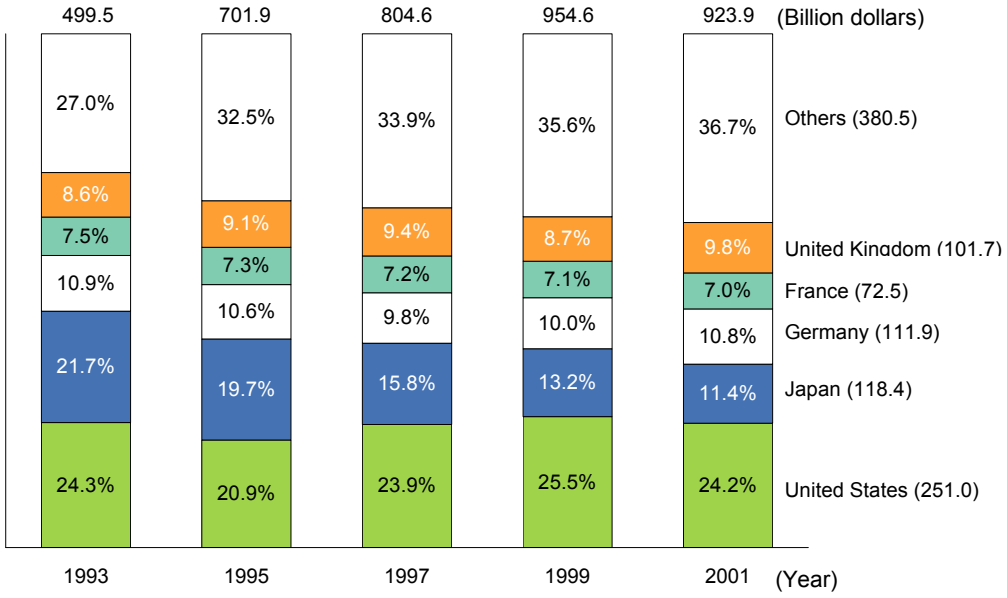

Figure 2-3-24 Export market shares for high-tech products by country in OECD countries

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

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.

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).

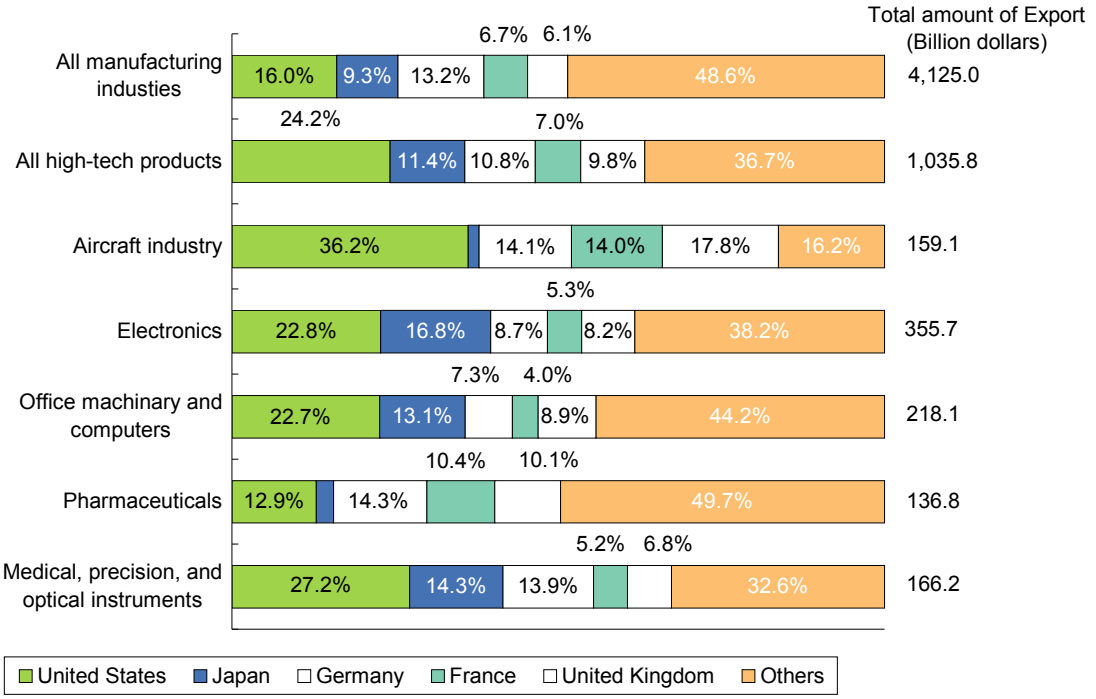

Figure 2-3-25 Share of high-tech products by country manufactured in OECD (2001)

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).

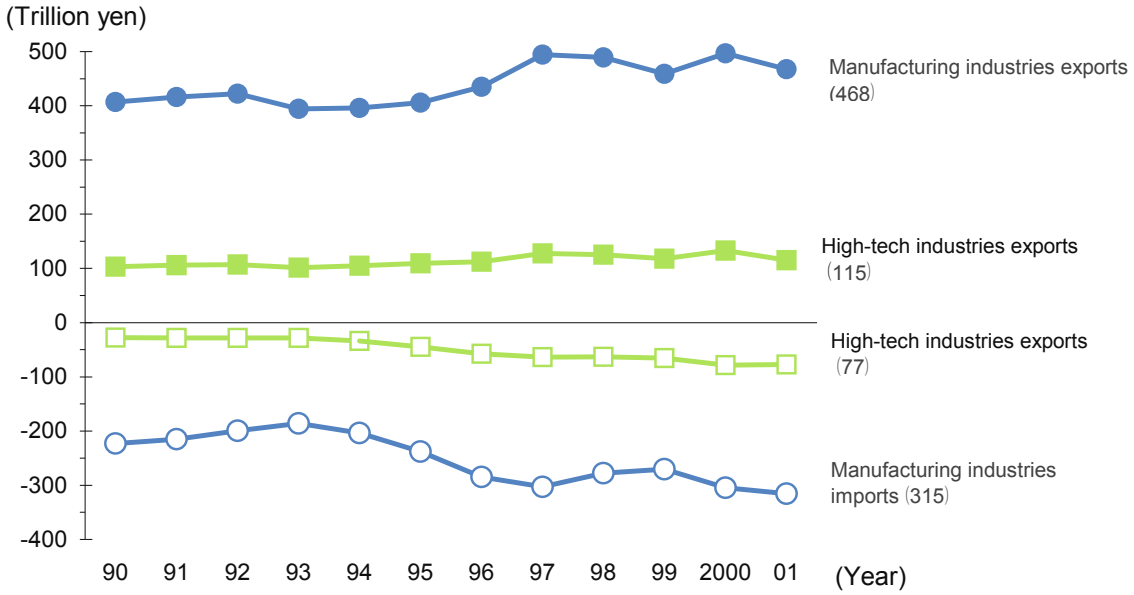

Figure 2-3-26 Trends in imports and exports, by value, for Japan's general manufacturing industry, and the high-tech industry

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).

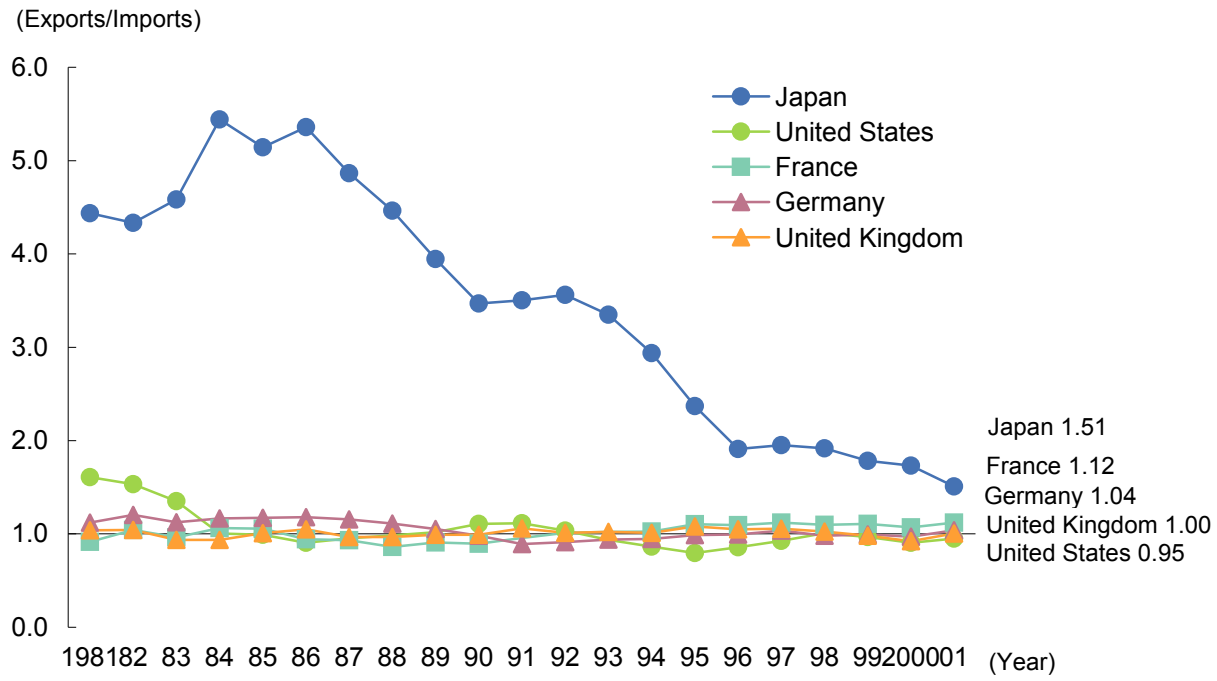

Figure 2-3-27 Trends in high-tech balance of payment ratios for selected countries

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 2001, 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 (2001)

Export and import amounts / Industry	Exports (billion yen)	Imports (billion yen)	Trade balance
All manufacturing	46,772	31,533	1.48
All high-tech products	14,386	9,544	1.51
Electronics	7,277	3,657	1.99
Office Machinery & Computer Industry	3,462	2,848	1.22
Medical, precision, and optical equipment	2,878	1,799	1.60
Pharmaceuticals	445	750	0.59
Aerospace	323	490	0.66

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