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Digest of Japanese Science and Technology

Indicators 2022

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Japanese Science and Technology Indicators 2022 (ABSTRACT)

"Science and Technology Indicators" is a fundamental resource for understanding Japanese science and technology activities based on objective and quantitative data. It classifies science and technology activities into five categories such as R&D Expenditure; R&D Personnel; Higher Education and S&T personnel; Output of R&D; and Science, Technology, and Innovation, and shows the state of Japanese science and technology activities with approximately 170 indicators. The report is published annually and offers the latest results of analyses of scientific publications and patent applications conducted by the NISTEP.

This edition of "Science and Technology Indicators 2022" includes new indicators such as "Status of university-launched venture companies." In addition, columns included "International comparison of research activities focusing on corresponding authors," "Partner countries/regions in imports/exports of high R&D intensive industries," and "Public trust in science and technology."

Overviewing the latest Japan's situation from "Science and Technology Indicators 2022," the R&D expenditure and the number of researchers in Japan are the third-largest in major countries (Japan, the U.S., Germany, France, the U.K., China, and Korea). Furthermore, Japan remains the world's first place in the patent family (patent applications to more than two countries).

The rank of Japan in the number of scientific publications (fractional counting method) in the world has changed from 4th to 5th, and the rank in the number of top 10% highly cited publications changed from 10th to 12th. The rank in the number of the top 1% highly cited publications changed from 9th to 10th. China surpassed the U.S. for the first time and ranked first in the world in the top 1% highly cited publications.

The number of new doctoral degree recipients in Japan peaked in FY2006 and has been on a slight downward trend ever since. On the other hand, in Korea, China, and the U.S., the number of new doctoral degree recipients has more than doubled compared to FY2000 (FY 2005 in China) and the latest year.

1. Japan's trends in key indicators

Trends for Japan in key indicators are as follows. Japan's ranking is generally the same as in the previous edition of the report, except for drops in the rankings for the number of papers and highly cited papers. Although Japan ranks third behind the U.S. and China in about half of the indicators listed, it shows smaller growth than the other selected countries in many cases as described later.

[Summary Chart 1] Japan's trends in key indicators

Indicators	Changes in Japan's ranking	Japan's figures	Note
R&D expenditure	No. 3→No. 3	17.6T yen	No. 1: U.S., No. 2: China
Business enterprises	No. 3→No. 3	13.9T yen	No. 1: U.S., No. 2: China
Universities and colleges	No. 4→No. 4	2.1T yen	No. 1: U.S., No. 2: China, No. 3: Germany
Public organizations	No. 4→No. 4	1.5T yen	No. 1: China, No. 2: U.S., No. 3: Germany
Number of Researchers	No. 3→No. 3	690K	No. 1: China, No. 2: U.S.
Business enterprises	No. 3→No. 3	515K	No. 1: China, No. 2: U.S.
Universities and colleges	No. 3→No. 3	136K	No. 1: China, No. 2: U.K.
Public organizations	No. 3→No. 3	30K	No. 1: China, No. 2: Germany
Number of scientific papers (fractional counting)	No. 4→No. 5	68K	No. 1: China, No. 2: U.S., No. 3: Germany, No. 4: India
Number of adjusted top 10% scientific papers (fractional counting)	No. 10→No. 12	4K	No. 1: China, No. 2: U.S., No. 3: U.K., No. 4: Germany, No. 5: Italy, No. 6: Australia, No. 7: India, No. 8: Canada, No. 9: France, No. 10: Spain, No. 11: Korea
Number of adjusted top 1% scientific papers (fractional counting)	No. 9→No. 10	0.3K	No. 1: China, No. 2: U.S., No. 3: U.K., No. 4: Germany, No. 5: Australia, No. 6: Italy, No. 7: Canada, No. 8: France, No. 9: India
Number of patent families	No. 1→No. 1	64K	
The trade balance ratios for high R&D intensive industries	No. 6→No. 6	0.7	No. 1: Korea, No. 2: China, No. 3: Germany, No. 4: France, No. 5: U.K.
The trade balance ratios for medium-high R&D intensive industries	No. 1→No. 1	2.6	
Number of cross-border trademark applications (Number of classes)	No.6→No.5	119K	No. 1: China, No. 2: U.S., No. 3: Germany, No. 4: U.K.

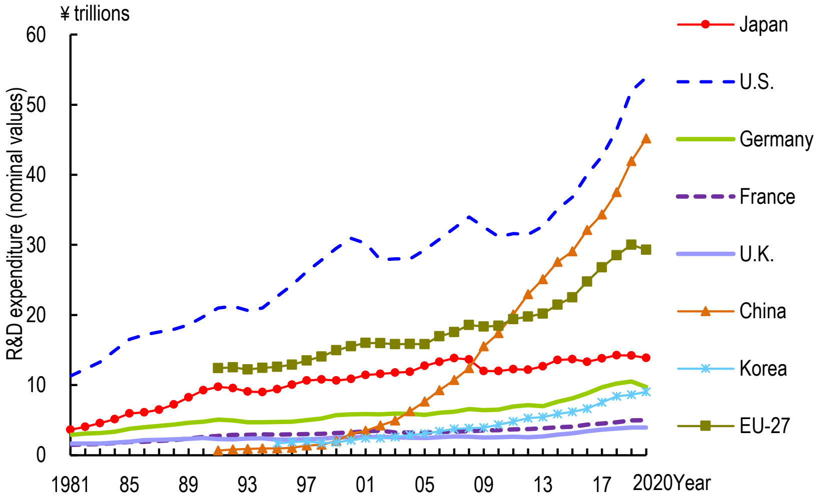
Note:
1) The "Changes in Japan's rankings" compares the latest year and the previous year. The "Japan's figures" is for the latest year.
2) Except for the number of papers and adjusted top 10% papers, the rankings are within the following selected countries: Japan, the U.S., Germany, France, the U.K., China, and Korea.
3) As for the number of researchers, the U.S. is excluded from the rankings in "universities and colleges" and "public organizations" as data have not been published for "universities and colleges" since 2000 and for "public organizations" since 2003. The overall number of researchers in the U.S. is an estimated figure.

(1) The growth of R&D expenditure in Japan's “business enterprises” and “universities and colleges” sectors is smaller compared to the other selected countries.

The U.S. has the largest R&D expenditures in the sectors of “business enterprises” and “universities and colleges” among the selected countries. Both sectors have seen strong growth since the 2010s. China is also increasing its R&D expenditures. Japan ranks third among the selected countries in the “business enterprises” sector, but its growth has been moderate over the same period. In the sector of “universities and colleges”, Japan's R&D expenditure has remained almost flat since the 2000s, surpassed by China and Germany, which have grown rapidly since the 2010s.

[Summary Chart 2] Nominal values of R&D expenditure by “business enterprises” and “universities and colleges” (based on OECD purchase power parities data)

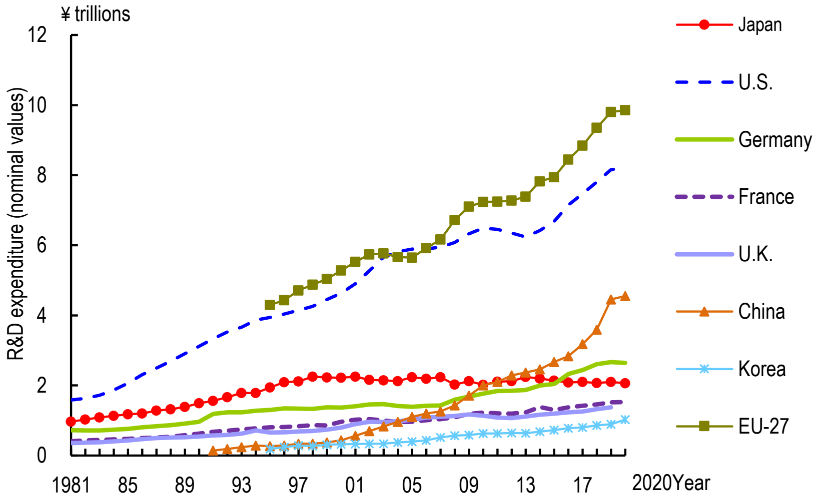
(A) Business enterprises



Reference: Chart 1-3-3(A), Japanese Science and Technology Indicators 2022 (in Japanese)

(B) Universities and colleges

Attention to international comparison

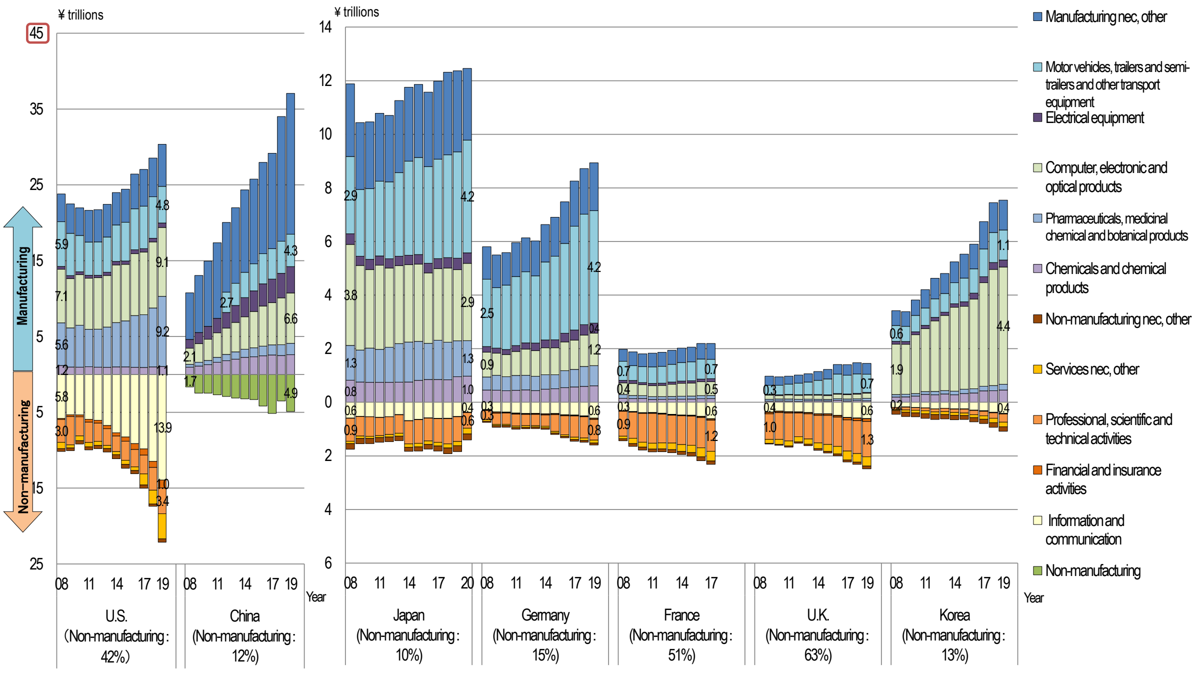


Reference: Chart 1-3-11(A), Japanese Science and Technology Indicators 2022 (in Japanese)

(2) In Japan, China, Korea and Germany, the R&D expenditures in the manufacturing industry are much larger than those in the non-manufacturing industry. In the U.S., those in the non-manufacturing industry also have a sizeable share, although smaller than the manufacturing industry.

Regarding the business enterprises' R&D expenditures by industry in the most recent year, the following industries have undertaken large-scale expenditures in the respective countries: the "information and communication industry" in the U.S., the "motor vehicles, trailers and semi-trailers and other transport equipment industry" in Japan and Germany, the "professional, scientific and technical activities industry" in France and the U.K., and the "computer, electronic and optical products industry" in China and Korea. Note that R&D expenditures in the "information and communication industry" in the U.S. (13.9 trillion yen in 2019) are about the same as that of the entire business enterprises sector in Japan (13.9 trillion yen in 2020).

[Summary Chart 3] Business enterprises' R&D expenditure by industry in the selected countries



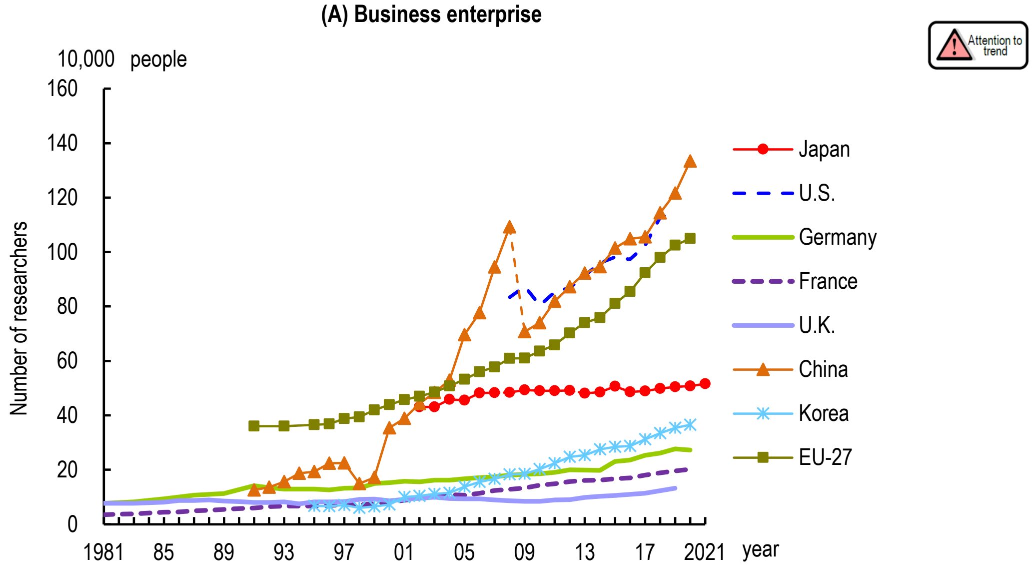
Note:
Figures in parentheses indicate the percentage of the non-manufacturing industry for the latest year in each country.
Reference: Chart 1-3-6, Japanese Science and Technology Indicators 2022(in Japanese)

(3) The growth of the number of researchers in Japan's “business enterprises” and “universities and colleges” sectors is smaller than that in other selected countries.

China has the largest number of researchers in the “business enterprises” and “universities and colleges” sectors among the selected countries. In the “business enterprises” sector, the U.S. and China are closely matched, with both countries showing rapid growth. The number of researchers in the “business enterprises” sector in Japan remained almost flat from the late 2000s, but has increased slightly since 2017. The number of Korean researchers in the “business enterprises” sector has also been increasing over a long time. In the “universities and colleges” sector, Germany has seen an increase since the mid-2000s. Japan's growth has been moderate and has recently leveled off.

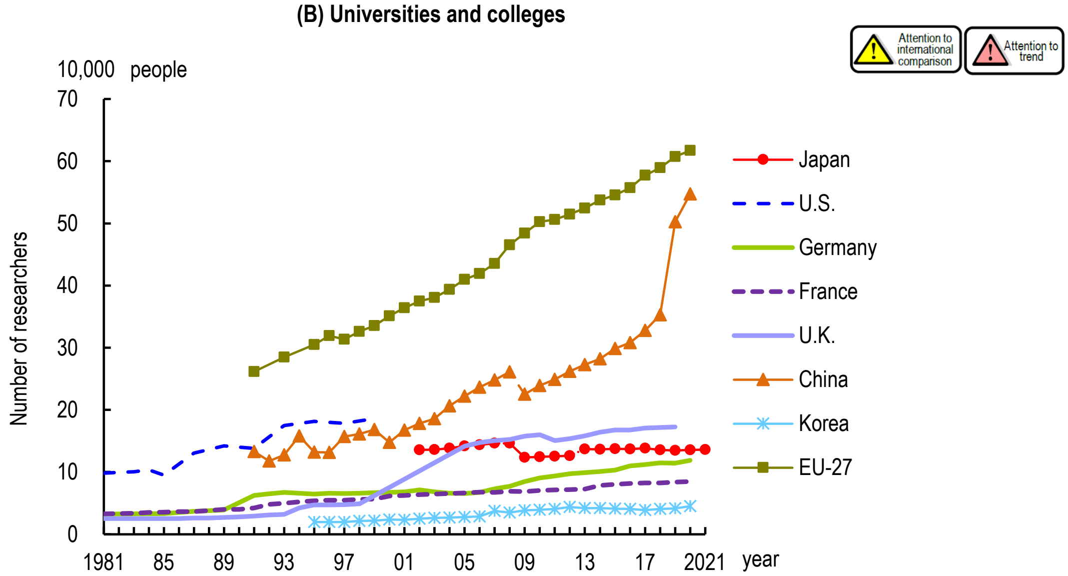
[Summary Chart 4] Trends in the number of researchers in “business enterprise” and “universities and colleges”

(A) Business enterprise



Reference: Chart 2-2-4, Japanese Science and Technology Indicators 2022 (in Japanese)

(B) Universities and colleges

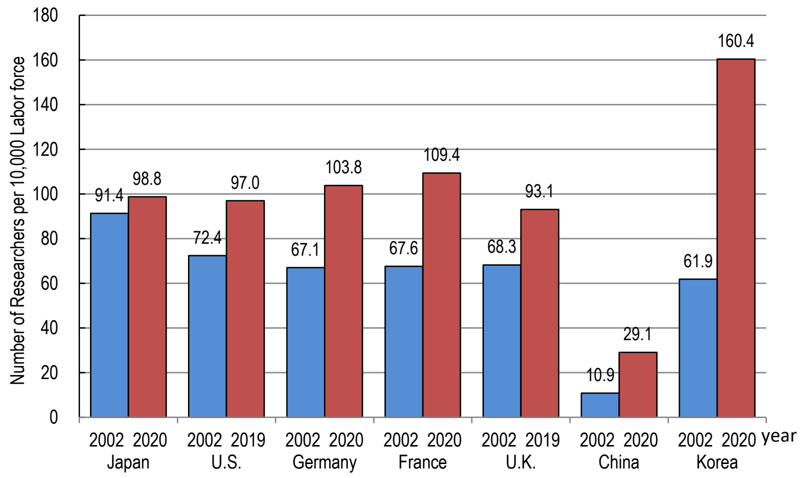


Reference: Chart 2-2-10, Japanese Science and Technology Indicators 2022 (in Japanese)

(4) Japan ranks fourth in the number of researchers per 10,000 people in the labor force in 2020, after ranking first among the selected countries in 2002.

In 2020, the number of researchers per 10,000 people in the labor force, in descending order, is 160.4, 109.4, 103.8, 98.8, 97.0(2019), 93.1(2019), and 29.1 in Korea, France, Germany, Japan, the U.S., the U.K., and China, respectively. Japan had the largest number of researchers per 10,000 people in the labor force among the selected countries in the early 2000s, but in recent years it has fallen to fourth place.

[Summary Chart 5] Changes in the number of researchers per 10,000 people in the labor force in the selected countries

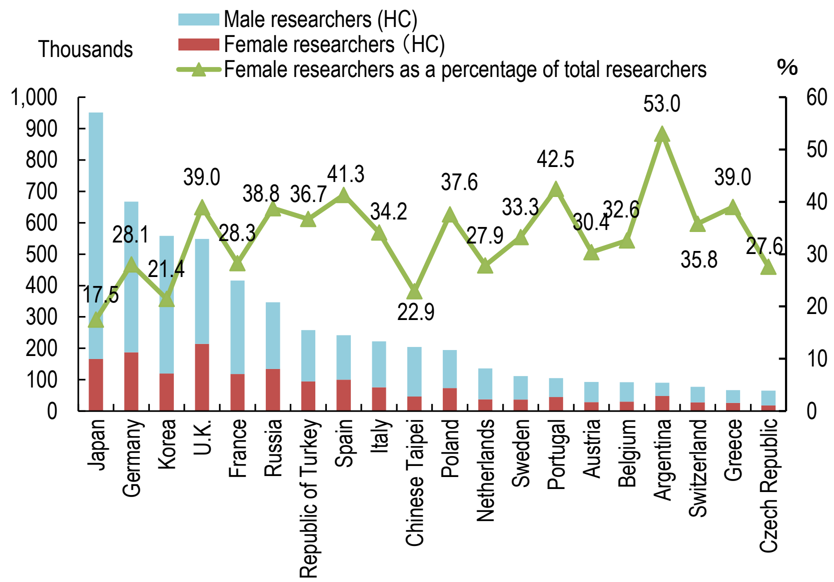


Reference: Chart 2-1-5, Japanese Science and Technology Indicators 2022 (in Japanese)

(5) The percentage of female researchers in Japan is the lowest among the selected countries and regions.

The percentage of female researchers to all researchers in Japan is 17.5% in 2021. Although the percentage is the lowest among selected countries and regions, the number is the third largest after the U.K. and Germany.

【Summary Chart 6】 Number of researchers by gender and the percentage of female researchers (Head count)

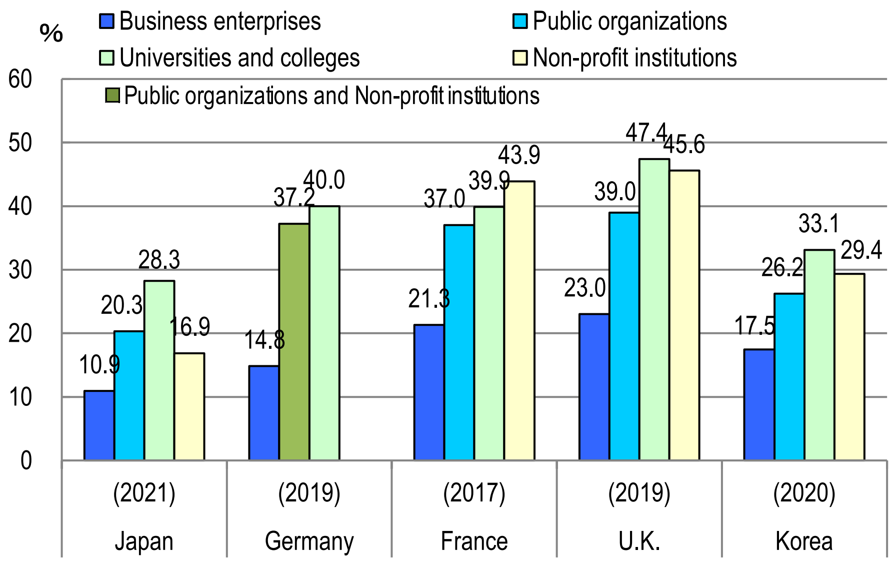


Reference: Chart 2-1-10, Japanese Science and Technology Indicators 2022 (in Japanese)

(6) Although the percentage of female researchers in Japan is lower than that in other selected countries, the percentage of women among newly hired researchers has been increasing.

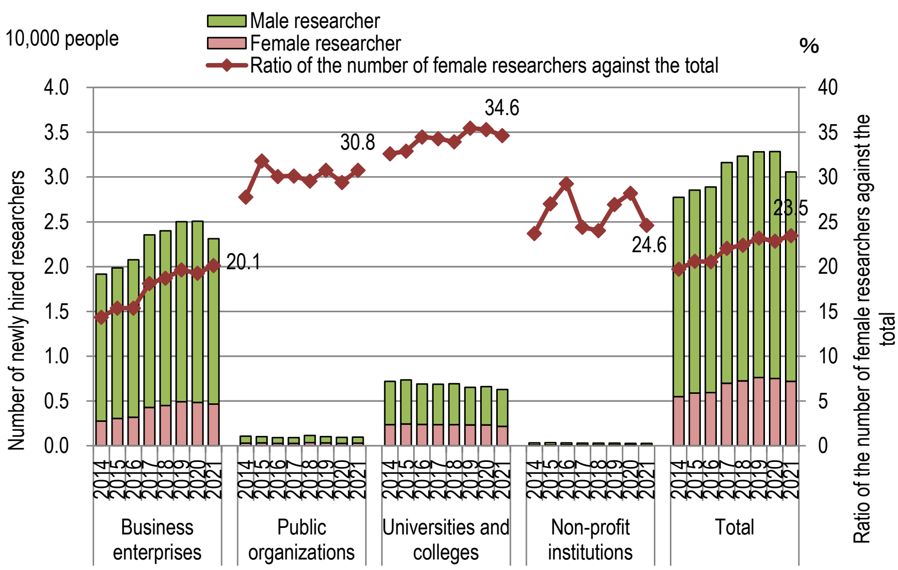
The percentage of women among all researchers is the lowest in "business enterprises" in all the selected countries. The percentage of female researchers in Japan is the lowest in each sector compared to the other countries. In Japan, the percentage of newly hired female researchers tends to be higher than the percentage of women among all researchers regardless of the sector.

[Summary Chart 7] Shares of female researchers of the selected countries by sector



Reference: Chart 2-1-11, Japanese Science and Technology Indicators 2022 (in Japanese)

[Summary Chart 8] Newly hired researchers by gender in Japan



Reference: Chart 2-1-18(A), Japanese Science and Technology Indicators 2022 (in Japanese)

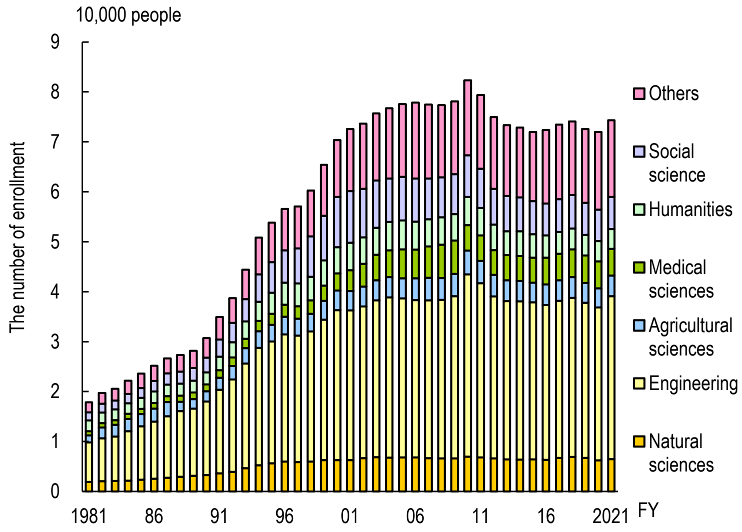
2. Students and graduate students: situations in Japan and selected countries

(1) Enrollment in Japanese graduate school doctoral programs peaked in FY2003 and has been on a long-term declining trend.

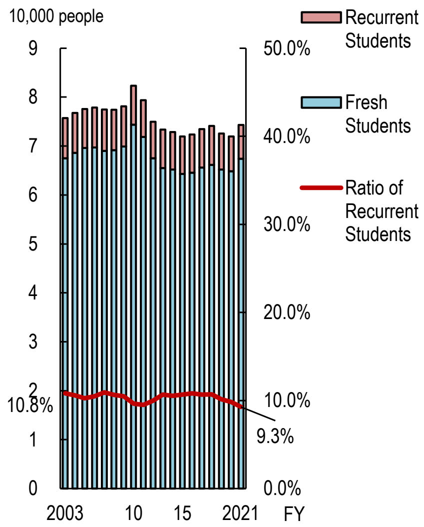
The enrollment in Japanese graduate school master's programs peaked in FY2010 and has declined since then. Although there has been a long-term downward trend, it increased by 3.3% year-on-year to 74,000 in FY2021. The number of recurrent students enrolled in master's programs has remained at about 10% of the total, beginning to decrease slightly in FY2019. The enrollment in graduate school doctoral programs has been on a long-term downtrend since its peak in FY2003, totaling 15,000 in FY2021. Among them, the number of recurrent students enrolled in doctoral programs increased for a long time, but has been decreasing since FY2018, totaling 6,000 in FY2021. This number accounted for 41.7% of the total in FY2021, about double the percentage in FY2003. Looking at the composition by major, there has been a long-term increase in the number of students enrolled in “Others” in both the master's and doctoral programs. Compared to FY2000, enrollment in the master's programs has decreased in “Humanities” and “Social Science,” and in the doctoral programs in all majors except “Medical Sciences” and “Others.”

[Summary Chart 9] The number of new enrollments in graduate schools (master's programs)

(A) Changes in the number of new enrollments in graduate schools by major subject (master's programs)



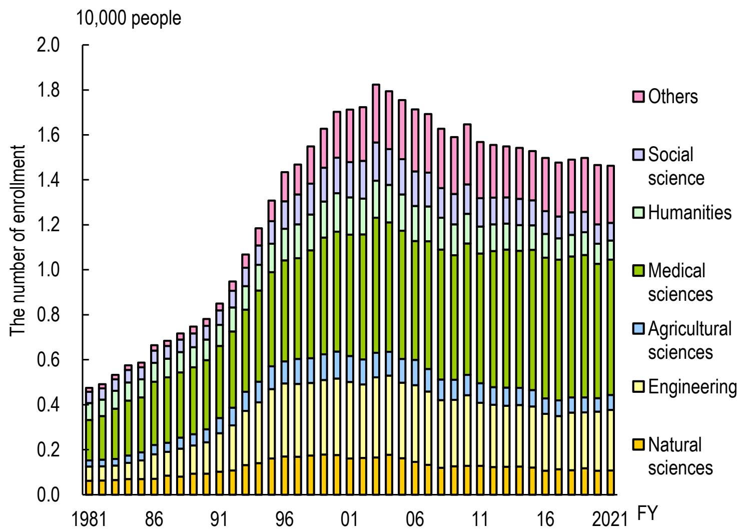
(B) Changes in the number of recurrent students newly enrolled in graduate schools (master's programs)



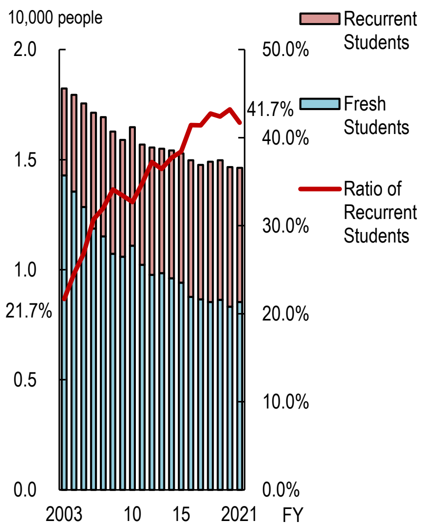
Reference: Chart 3-2-3, Japanese Science and Technology Indicators 2022 (in Japanese)

[Summary Chart 10] The number of new enrollments in graduate schools (doctoral programs)

(A) Changes in the number of new enrollments in graduate schools by major subject (doctoral programs)



(B) Changes in the number of recurrent students newly enrolled in graduate schools (doctoral programs)



Reference: Chart 3-2-4, Japanese Science and Technology Indicators 2022 (in Japanese)
Note.
"Others" in chart (A) are "Education," "Arts," "Merchant Marine," and "Domestic Science," as well as "Others," which indicates "Others" in the "Departmental Classification Table" of the "Report on School Basic Survey" Actual major study fields' names included in this category often use words such as "Environment," "Human," "Information," "International," and so on.

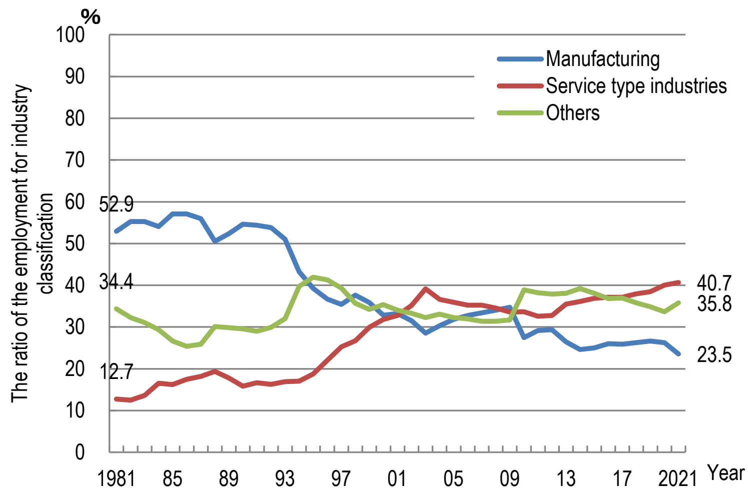
(2) As for natural sciences and engineering students, many of those who graduated from undergraduate programs find employment in the service type industries. In contrast, the majority of those who completed master's degree programs work in the manufacturing industry.

Looking at the employers of undergraduate graduates in natural sciences and engineering by industry, the percentage employed in the manufacturing industry was in the 50% range in the 1980s, but has declined over time to 23.5% in 2021. Now, the service type industries have taken over from the manufacturing industry, employing 40.7% of undergraduate graduates in natural sciences and engineering in 2021, about triple the percentage in 1981.

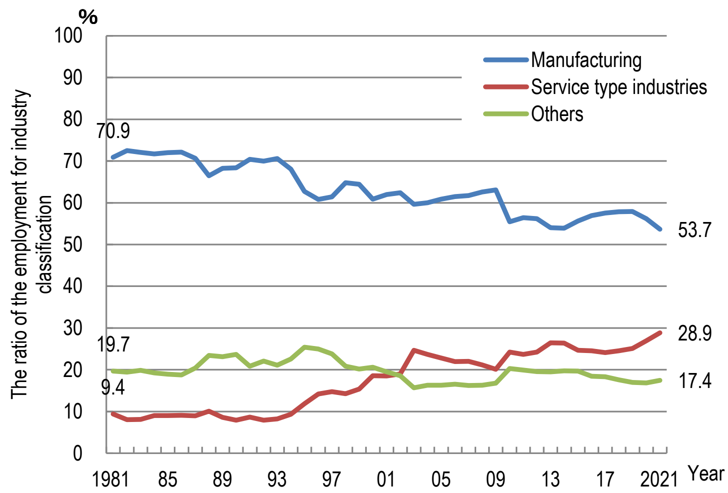
In the case of master's graduates in natural sciences and engineering, the percentage of those employed in the manufacturing industry has been declining over time, reaching 53.7% in 2021. The percentage of those employed in the service type industries is on a long-term increase, standing at 28.9% in 2021.

[Summary Chart 11] The employment status of students of natural sciences and engineering by industry classification

(A) College graduates entering employment



(B) Master's degree program graduates entering employment

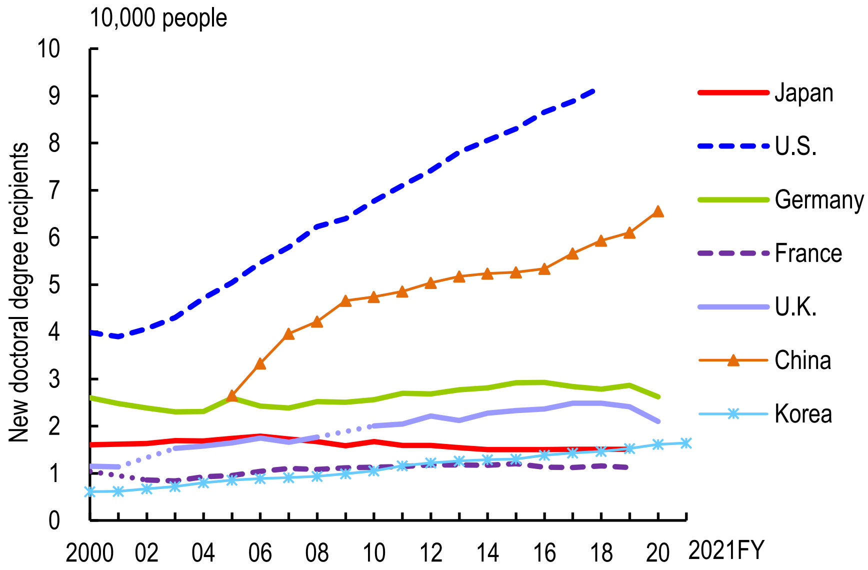


Note :
1) The service type industries include "Information and communication," "Academic research, professional and technical services," "Education and learning support," etc.
2) "Others" includes "Construction," "Electricity, gas, heat supply, and water supply," "Transportation, postal service," "Wholesale and retail trade," and "Financial industry and insurance industry."
Reference: Chart 3-3-4,5, Japanese Science and Technology Indicators 2022 (in Japanese)

(3) The number of new doctoral degree recipients in Japan is on the decline.

Comparing the latest year's data for each country, the U.S. has the largest number of new doctoral degree recipients (92,000), followed by China (66,000) and Germany (26,000). Japan has 15,000 new doctoral degree recipients. Compared with FY2000 (FY2005 for China), the number has more than doubled in Korea, China, and the U.S. Japan's number peaked in FY2006 and has been on a slight downward trend since. Germany and the U.K. saw large declines in FY2020.[1]

[Summary Chart 12] Changes in the number of new doctoral degree recipients in the selected countries



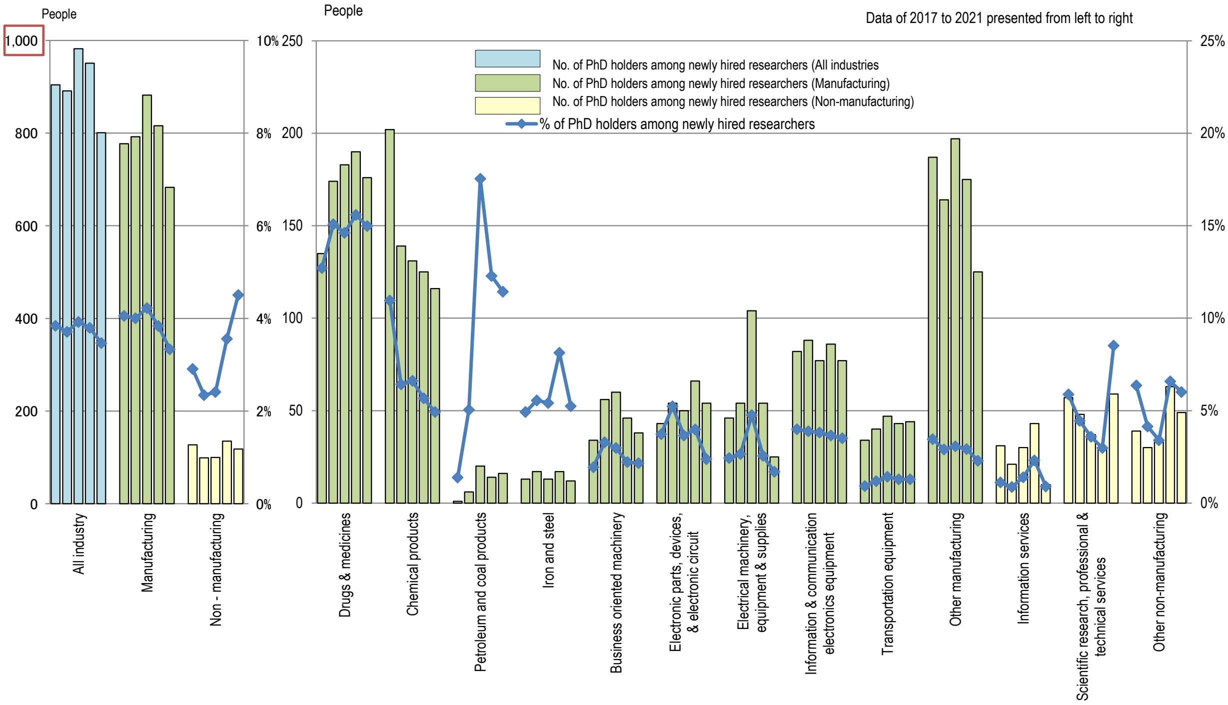
Note:
The number of new doctoral degree recipients in the United States is the value calculated by subtracting all the figures for "Professional fields" (formerly referred to as "First-professional degrees") from the figures for "Doctor's degrees" stated in the "Digest of Education Statistics."
Reference: Chart 3-4-4(A), Japanese Science and Technology Indicators 2022 (in Japanese)

[1] The Higher Education Statistics Agency (HESA), a U.K. source, suggests on its website that the outbreak of the COVID-19 pandemic may have affected the status of responses from individual universities.

(4) Trends in hiring of PhD holders vary by industry.

In many manufacturing industries, the number of PhD holders newly hired as researchers and the percentage of PhD holders among the newly hired researchers decreased in 2021. In the non-manufacturing industries as well, the number of PhD holders hired decreased in 2021, but the percentage of PhD holders among the newly hired researchers increased. Many industries have reduced hiring of PhD holders after 2019 or 2020.

[Summary Chart 13] PhD holders among newly hired researchers of business enterprises (by industry)



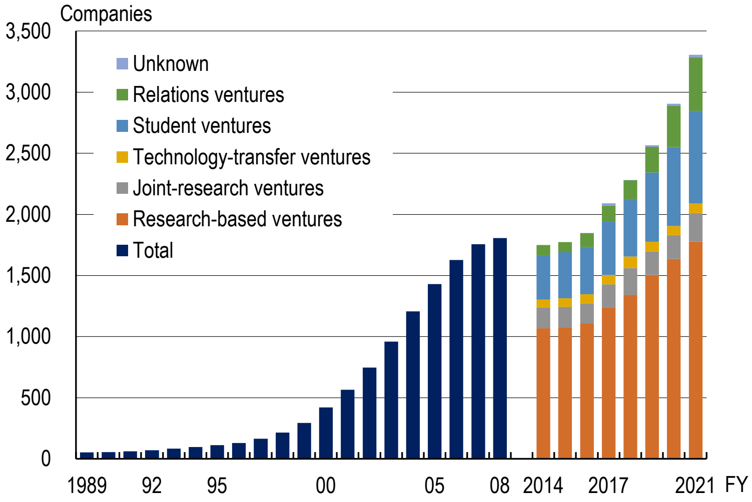
Reference: Chart 2-1-19, Japanese Science and Technology Indicators 2022 (in Japanese)

(5) PhD holders account for a large percentage of employees in Japan's university-launched venture companies

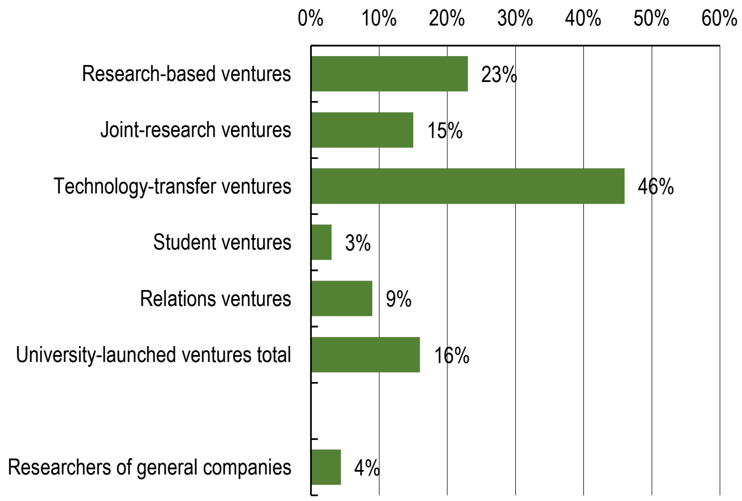
The number of university-launched venture companies in Japan has been steadily increasing, standing at 3,306 in FY2021. By venture category, “research-based ventures” accounted for 53.8% of the total. PhD holders account for 16% of the total number of employees in university-launched venture companies, which is substantial compared to the percentage of PhD holders among researchers in general companies (4%).

[Summary Chart 14] The status of university-launched venture companies

(A) Changes in the number of companies



(B) Percentage of PhD holders in the number of employees by venture category (FY2021 survey)



Note:
The source of Summary Charts 14(A) and 14(B) is the “FY2021 Industrial Technology Survey (Survey on University-Developed Venture Businesses) Report” by the Ministry of Economy, Trade and Industry (METI). The report includes a breakdown by venture category for FY2017 and thereafter, which is presented here. Summary Chart 14(B) is sourced from the Survey on University-Developed Venture Businesses (2022), showing the results of the survey of university-launched venture companies identified in the “Survey on the Establishment of University-Developed Venture Businesses (2022),” of which contact information was available (374/3,048 cases were collected, for a response rate of 12.3%). The largest percentage of PhD holders was found in the “technology-transfer ventures” category (46%), but it should be noted that the number of venture companies in the category is small.
Sources:
(A): METI, “Survey on the Establishment of University-Developed Venture Businesses (May 2022)”
(B): “Survey on University-Developed Venture Businesses (May 2022)”; General companies: Ministry of Internal Affairs and Communications, “Survey of Research and Development”
Reference: Chart5-4-10(A),12(A), Japanese Science and Technology Indicators 2022 (in Japanese)

3. R&D outputs and status of science, technology and innovation in the selected countries

(1) Number of papers from Japan has remained flat but has dropped in ranking due to the increase in papers from other countries and regions. The pronounced fall in Japan's ranking is evident in the number of adjusted top 10% papers. China ranked first in the world in the number of adjusted top 1% papers as well.

In terms of the number of scientific papers, which is one measure of R&D outputs, the number of papers from Japan (the average of PY2018–2020) is ranked 5th after China, the U.S., Germany, and India, when counted by the fractional counting method that measures the degree of contribution to paper production. Japan ranked 12th and 10th in the number of adjusted top 10% and top 1% papers in citation counts, respectively. Compared with the previous time frame, Japan dropped one rank in the number of papers, two in the number of adjusted top 10% papers, and one in the number of adjusted top 1% papers. China surpassed the U.S. and ranked first in the world in the number of adjusted top 1% papers as well.

[Summary Chart 15] Top countries/regions in the number of papers and in the numbers of adjusted top 10% and 1% papers in citation counts (in natural sciences, based on the fractional counting method)

All fields	1998 — 2000 (PY) (Average)		
	The number of papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	203,669	27.9	1
Japan	64,752	8.9	2
Germany	51,597	7.1	3
U.K.	51,053	7.0	4
France	37,657	5.2	5
Italy	24,707	3.4	6
Canada	24,320	3.3	7
China	22,549	3.1	8
Russia	22,351	3.1	9
Spain	17,140	2.3	10

All fields	2008 — 2010(PY) (Average)		
	The number of papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	246,188	22.7	1
China	107,955	10.0	2
Japan	64,783	6.0	3
Germany	58,095	5.4	4
U.K.	54,116	5.0	5
France	42,811	4.0	6
Italy	36,858	3.4	7
India	35,150	3.2	8
Canada	34,913	3.2	9
Korea	31,650	2.9	10

All fields	2018 — 2020 (PY) (Average)		
	The number of papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	407,181	23.4	1
U.S.	293,434	16.8	2
Germany	69,766	4.0	3
India	69,067	4.0	4
Japan	67,688	3.9	5
U.K.	65,464	3.8	6
Korea	53,310	3.1	7
Italy	52,110	3.0	8
France	45,364	2.6	9
Canada	43,560	2.5	10

All fields	1998 — 2000 (PY) (Average)		
	The number of adjusted top 10% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	30,710	42.1	1
U.K.	6,071	8.3	2
Germany	4,991	6.8	3
Japan	4,369	6.0	4
France	3,609	4.9	5
Canada	2,842	3.9	6
Italy	2,128	2.9	7
Netherlands	1,814	2.5	8
Australia	1,687	2.3	9
Spain	1,398	1.9	10

All fields	2008 — 2010(PY) (Average)		
	The number of adjusted top 10% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	36,910	34.1	1
China	9,011	8.3	2
U.K.	7,420	6.9	3
Germany	6,477	6.0	4
France	4,568	4.2	5
Japan	4,369	4.0	6
Canada	4,078	3.8	7
Italy	3,450	3.2	8
Australia	2,941	2.7	9
Spain	2,903	2.7	10

All fields	2018 — 2020 (PY) (Average)		
	The number of adjusted top 10% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	46,352	26.6	1
U.S.	36,680	21.1	2
U.K.	8,772	5.0	3
Germany	7,246	4.2	4
Italy	6,073	3.5	5
Australia	5,099	2.9	6
India	4,926	2.8	7
Canada	4,509	2.6	8
⋮	⋮	⋮	⋮
Japan	3,780	2.2	12

All fields	1998 — 2000 (PY) (Average)		
	The number of adjusted top 1% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	3,681	50.5	1
U.K.	622	8.5	2
Germany	445	6.1	3
Japan	333	4.6	4
France	310	4.2	5
Canada	258	3.5	6
Netherlands	181	2.5	7
Italy	163	2.2	8
Switzerland	155	2.1	9
Australia	152	2.1	10

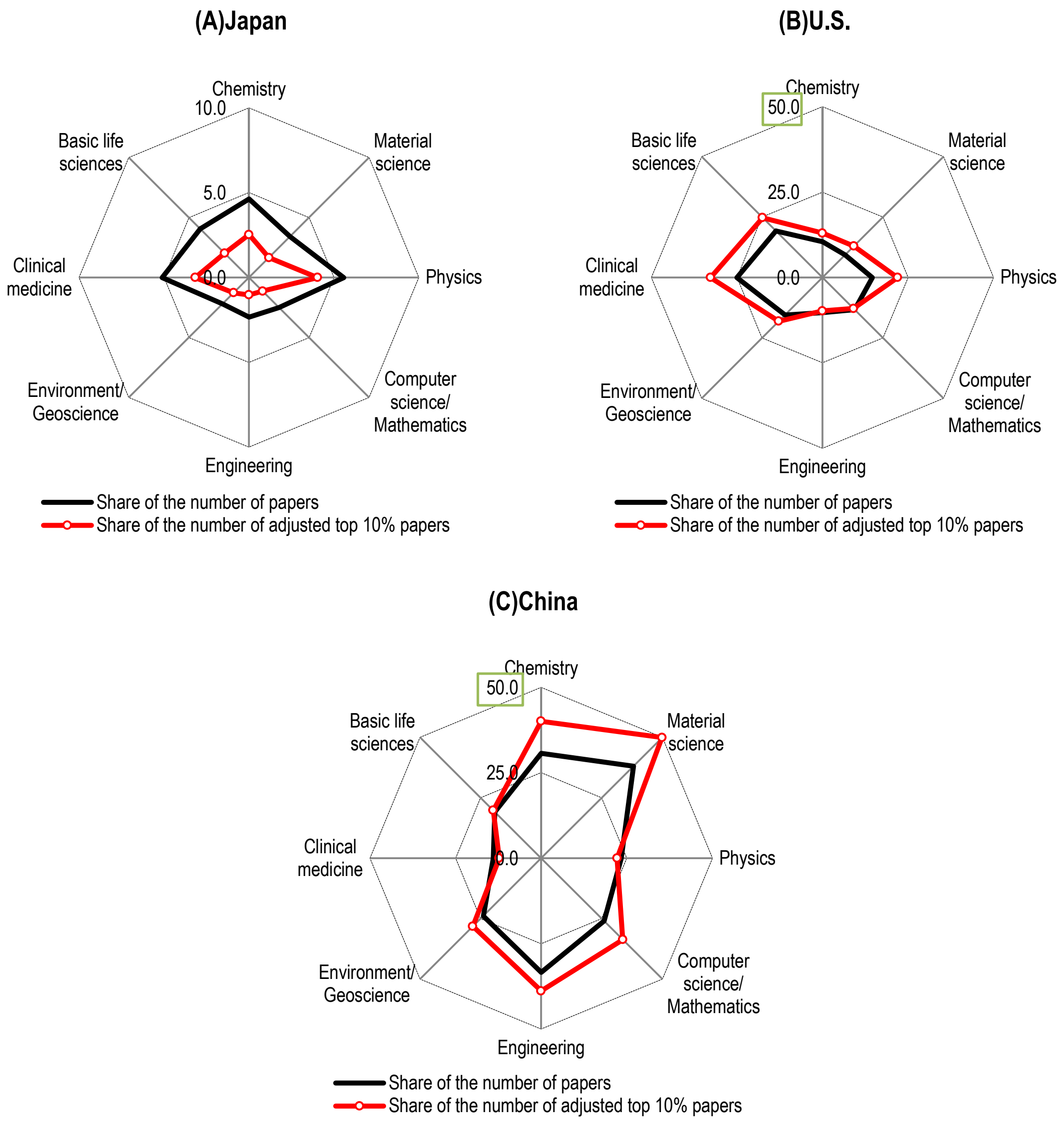
All fields	2008 — 2010(PY) (Average)		
	The number of adjusted top 1% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
U.S.	4,459	41.2	1
U.K.	818	7.6	2
China	696	6.4	3
Germany	642	5.9	4
France	419	3.9	5
Canada	411	3.8	6
Japan	351	3.2	7
Australia	301	2.8	8
Italy	279	2.6	9
Netherlands	278	2.6	10

All fields	2018 — 2020 (PY) (Average)		
	The number of adjusted top 1% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	4,744	27.2	1
U.S.	4,330	24.9	2
U.K.	963	5.5	3
Germany	686	3.9	4
Australia	550	3.2	5
Italy	496	2.8	6
Canada	451	2.6	7
France	406	2.3	8
India	353	2.0	9
Japan	324	1.9	10

Note:
The number of Articles and reviews was counted. Publication year (PY) was used for the year tally. The number of citations is the value at the end of 2021.
Reference: Chart 4-1-6(B), Japanese Science and Technology Indicators 2022 (in Japanese)

Comparing the shares of the number of adjusted top 10% papers by field, the shares of “Physics,” “Clinical medicine,” and “Chemistry” are higher in Japan than those of other fields. In the U.S., the shares of “Clinical medicine,” “Basic life sciences,” and “Physics” are high. In China, the shares of “Material science,” “Chemistry,” “Engineering,” and “Computer science/Mathematics” are high.

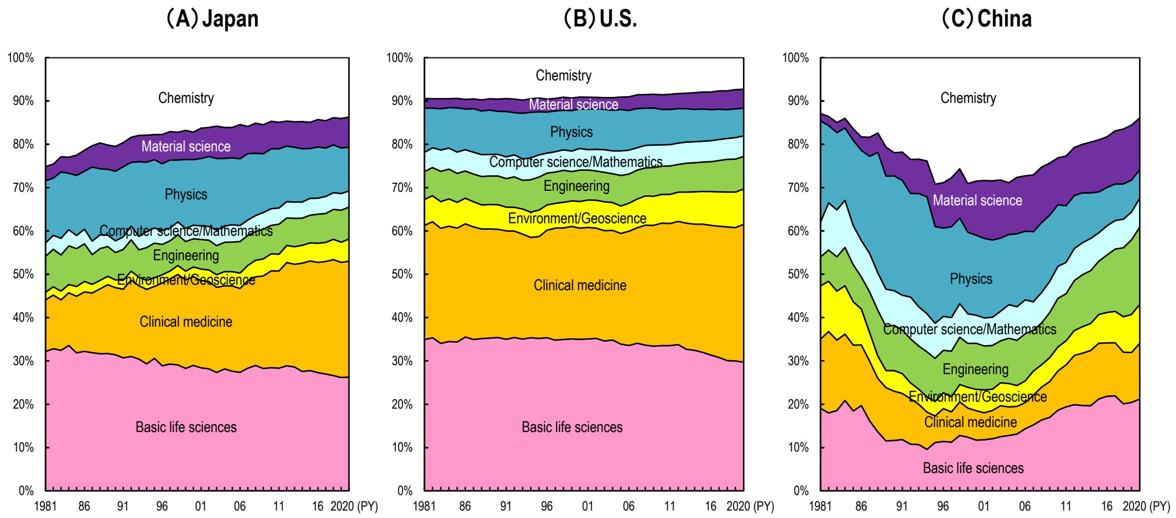
[Summary Chart 16] A comparison of the share of the papers and adjusted top 10% papers in Japan, the U.S. and China by field
(%, 2018–2020, fractional counting method)



Reference: Chart 4-1-10, Japanese Science and Technology Indicators 2022 (in Japanese)

Looking at the changes in the percentage of papers by field and by country, the share of “Chemistry,” “Basic life sciences,” and “Physics” has each decreased in Japan. In contrast, the share of “Clinical medicine” has increased significantly, indicating a change in the composition of fields of papers produced in Japan. The U.S. has seen a decrease in “Basic life Sciences” and “Physics” and an increase in “Clinical medicine. In China, “Materials science” and “Engineering” are larger in percentage than those in the other selected countries.

[Summary Chart 17] Changes in the percentage of papers by field in Japan, the U.S. and China (fractional counting method)



Reference: Chart 4-1-9, Japanese Science and Technology Indicators 2022 (in Japanese)

(D) Classification fields

Category	Consolidated ESI 22 field classification
Chemistry	Chemistry
Material science	Material science
Physics	Physics, Space science
Computer science/ Mathematics	Computer science, Mathematics
Engineering	Engineering
Environment/ Geoscience	Environment/Ecology, Geoscience
Clinical Medicine	Clinical medicine, Psychiatry/Psychology
Basic life sciences	Agricultural Science, Biology & Biochemistry, Immunology, Microbiology, Molecular Biology & Genetics, Neuroscience & Behavior, Pharmacology, Plant & Animal Science

Reference: Chart 4-1-4(B), Japanese Science and Technology Indicators 2022 (in Japanese)

Note:
1) Summary Charts 15, 16, and 17: The number of Articles and reviews was counted. Publication year (PY) was used for the year tally. The number of citations is the value at the end of 2021.
2) Summary Chart 17: Results do not include papers that cannot be categorized into the eight categories.
3) Summary Chart 17(D): The ESI 22 fields are journal-based classifications from http://esi.help.clarivate.com/Content/journal-list.htm (esi-master-journal-list-02-2022). The National Institute of Science and Technology Policy reclassifies papers included in the Web of Science (SCIE) using the ESI 22 field classification of the Essential Science Indicators (ESI). The eight categories do not include “Economics & Business,” “Multidisciplinary,” and “Social Sciences, general.”

(2) Japan has maintained the 1st position in the world in the number of patent families (patents filed in two or more countries/regions). Japan's shares in "Information and communications technology" and "Electrical engineering" are declining as China's shares increase.

This section examines the status of patent applications by analyzing the number of patent families, which is the number of inventions created in each countries/region measured in an internationally comparable manner.

Between 1995 and 1997, the United States was ranked the first and Japan the second. Between 2005 and 2007 and between 2015 and 2017, Japan was ranked the first and the United States the second.

Note that Japan's global share has been declining since the mid-2000s. And that China is in the fourth place in 2015-2017, steadily increasing the number of patent families.

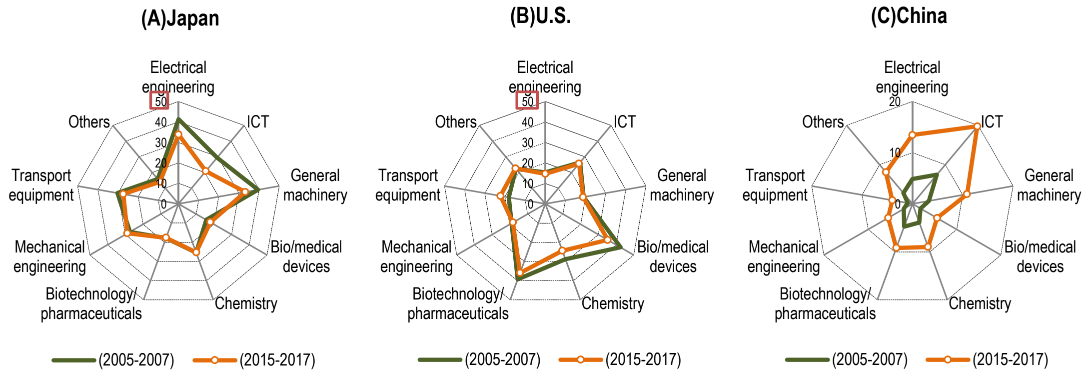
In terms of technological fields, Japan has high shares in "Electrical engineering" and "General machinery"; the U.S. has high shares in "Biomedical devices" and "Biotechnology/pharmaceuticals"; and China has high shares in "Information and communications technology" and "Electrical engineering." Compared to 10 years ago, China's shares have expanded while Japan's shares in "Information and communications technology" and "Electrical engineering" have shrunk.

[Summary Chart 18] The number of patent families by selected countries/region: top 10 countries/regions

1995 - 1997(Average)				2005 - 2007(Average)				2015 - 2017(Average)			
Country/Region	Number of patent families (Whole counting)			Country/Region	Number of patent families (Whole counting)			Country/Region	Number of patent families (Whole counting)		
	Patent Families	Share	World rank		Patent Families	Share	World rank		Patent Families	Share	World rank
U.S.	30,227	28.0	1	Japan	61,922	29.9	1	Japan	63,627	26.0	1
Japan	29,728	27.5	2	U.S.	48,732	23.5	2	U.S.	55,018	22.4	2
Germany	18,239	16.9	3	Germany	28,504	13.8	3	Germany	27,709	11.3	3
France	6,722	6.2	4	Korea	18,919	9.1	4	China	26,793	10.9	4
U.K.	5,747	5.3	5	France	10,583	5.1	5	Korea	22,298	9.1	5
Korea	4,774	4.4	6	Taiwan	8,874	4.3	6	France	11,075	4.5	6
Italy	3,094	2.9	7	U.K.	8,595	4.2	7	Taiwan	10,162	4.1	7
Switzerland	2,482	2.3	8	China	8,537	4.1	8	U.K.	8,624	3.5	8
Netherlands	2,469	2.3	9	Canada	5,262	2.5	9	Italy	5,815	2.4	9
Canada	2,294	2.1	10	Italy	5,242	2.5	10	Canada	5,160	2.1	10

Note:
Reference: Chart 4-2-5(B), Japanese Science and Technology Indicators 2022 (in Japanese)

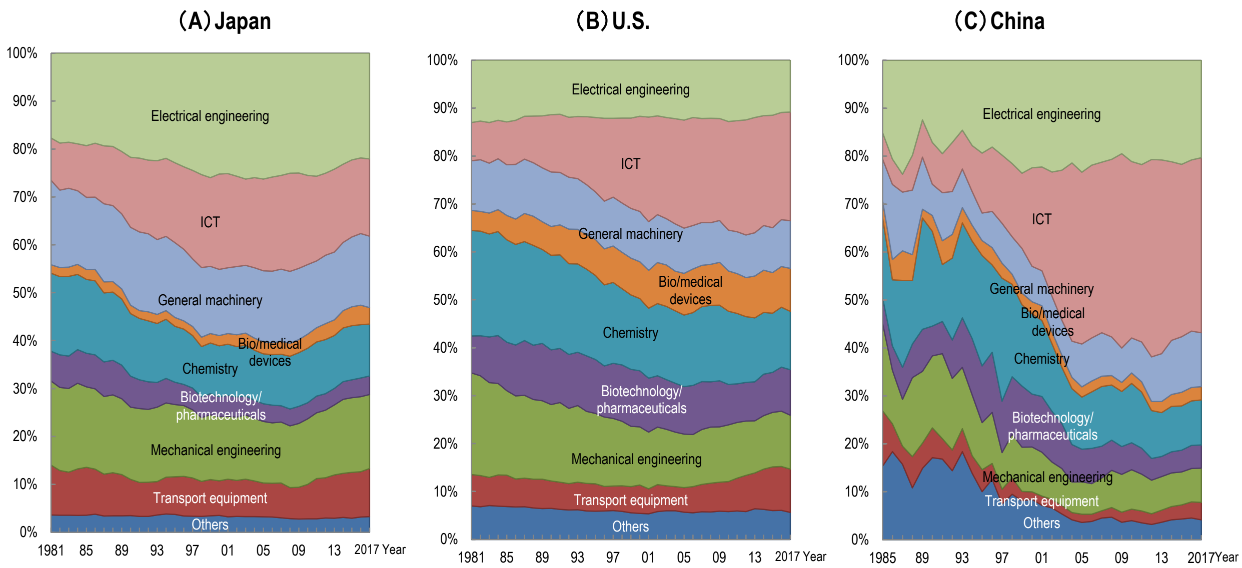
[Summary Chart 19] Comparison of the shares of patent families by technological fields in Japan, the U.S. and China (%, 2005-2007 and 2015-2017, whole counting)



Note:
Same as Summary Chart 18. The item "ICT" in Summary Chart 19 stands for "Information and Communications Technology."
Reference: Chart 4-2-12, Japanese Science and Technology Indicators 2022 (in Japanese)

Looking at the changes in the percentage of patent families by technological field and by country, “Electrical engineering,” which accounts for a large share in Japan, has been on a downward trend since around 2010. During the same period, the percentages of “Mechanical engineering” and “Transport equipment” have increased. Comparing 1981 and 2017 of the U.S., “Information and communication technology” has increased, while “Mechanical engineering” and “Chemistry” have decreased. Comparing 1985 and 2017 of China, “Information and communication technology” has increased significantly.

[Summary Chart 20] Changes in percentage of patent families by technological field in Japan, the U.S. and China



Reference: Chart 4-2-11, Japanese Science and Technology Indicators 2022 (in Japanese)

(D) Technological fields

Technological fields	35 detailed classifications (WIPO)
Electrical engineering	Electrical machinery, apparatus, energy, Audio-visual technology, Semiconductors
Information and communication technology	Telecommunications, Digital communication, Basic communication processes, Computer technology, IT methods for management
General machinery	Optics, Measurement, Control
Bio/medical devices	Analysis of biological materials, Medical technology
Chemistry	Organic fine chemistry, Food chemistry, Basic materials chemistry, Material, metallurgy, Surface, Micro-structure and nano-technology, Chemical engineering, Environmental technology
Biotechnology/pharmaceuticals	Biotechnology, Pharmaceuticals, Macromolecular chemistry, polymers
Mechanical engineering	Handling (elevators, cranes, robots, packaging devices, etc.), Machine tools, Textile and paper machines, Other special machines, Thermal processes and apparatus, Mechanical elements
Transport equipment	Engines, pumps, turbines, Transport
Other	Furniture games, Other consumer goods, Civil engineering

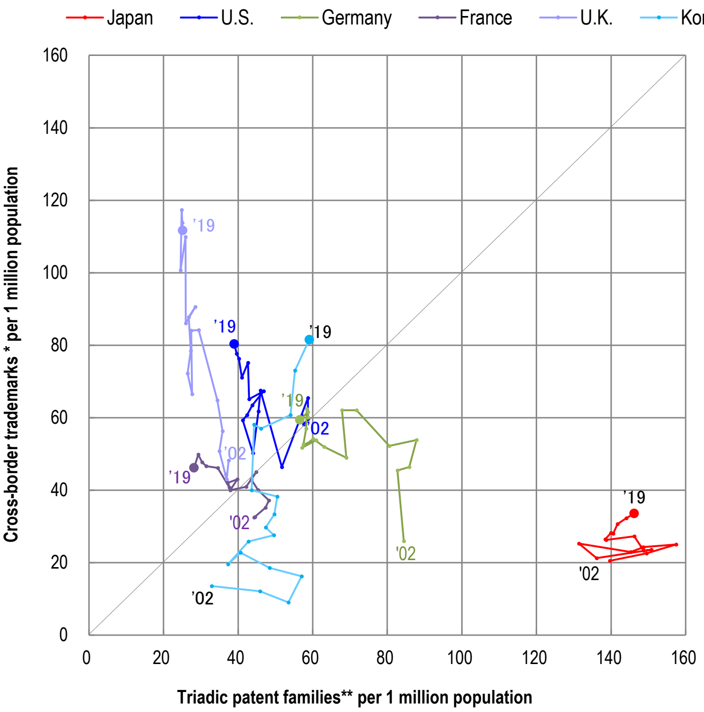
Reference: Chart 4-2-11, Japanese Science and Technology Indicators 2022 (in Japanese)
Note :
1) Summary Chart 18, 19, 20 : A patent family is a group of patents filed in two or more countries, directly or indirectly related to each other by priority rights. In many cases, the same patents filed in multiple countries belong to the same patent family.
2) Summary Chart 19 : Percentage of each technological field is the share of each country in the world.
3) Summary Chart 20 : Percentage of each technological field is the share of each field in the target country.
4) Summary Chart 20(D) : Classified by NISTEP based on WIPO, IPC-Technology Concordance Table.

(3) Japan has strength in technology yet with a possibility of lagging other selected countries in terms of international launching of new products or services based on their technologies.

When comparing the numbers of cross-border applications for trademarks and patent families per million populations, Japan is the only country with fewer trademark applications than patent family applications in the latest year.

In Korea, the U.K., and Germany, the number of trademark applications surged in the period between 2002 and 2019.

[Summary Chart 21] Cross-border trademark applications and patent applications (per 1 million population)

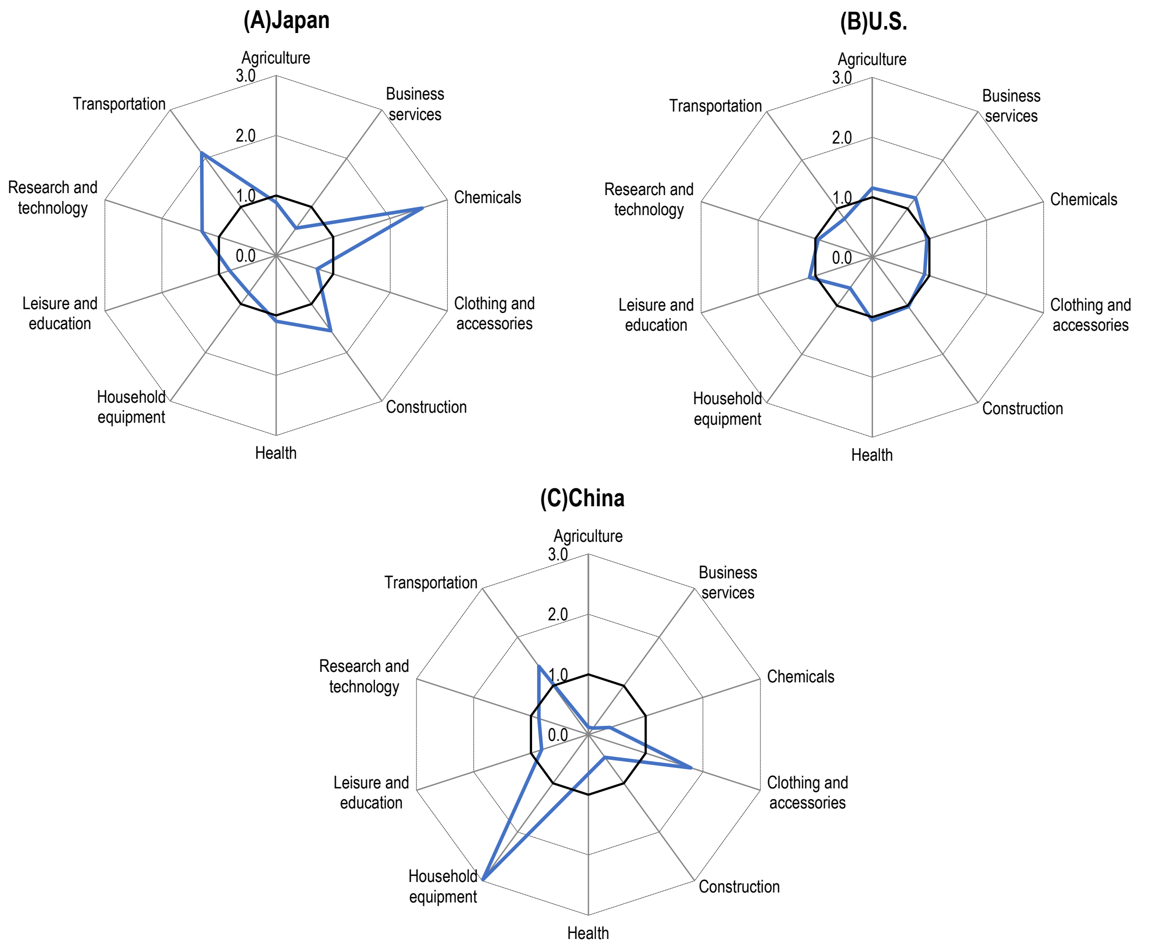


[Meaning of the number of trademark applications as an indicator]
The number of trademark applications is related to the concretization of innovations in the forms of new product or service introductions, or marketing activities thereof. In this sense, the number of trademark applications is considered as data that reflect the relationship between innovations and markets.

Note:
1)* For the definition of cross-border trademarks, "Measuring Innovation: A New Perspective" released by the OECD is followed. The specific definition is as follows.
・The number of trademarks in Japan, Germany, France, the U.K. and Korea is the number filed with the U.S. Patent and Trademark Office (USPTO).
・The number of trademarks for the U.S. is the average of (i) and (ii).
(i) The corrected number of the U.S. applications, based on the ratio of Japanese and the U.S. applications to the Office for Harmonization in the Internal Market (OHIM) = (number of the U.S. applications to the OHIM / number of Japanese applications to the OHIM) × number of Japanese applications to the USTPO
(ii) The corrected number of the U.S. applications, based on the ratio of European and the U.S. applications to the Japan Patent Office (JPO) = (number of the U.S. applications to the JPO / number of EU-15 applications to the JPO) × number of EU-15 applications to the USTPO
2)**Cross-border patent applications mean the number of triadic patent families (patents with the same content submitted to Japan, the U.S. and Europe).
Reference: Chart 5-3-3, Japanese Science and Technology Indicators 2022 (in Japanese)

Looking at the industry sector composition based on the International Classification of Goods and Services (Nice Classification) in trademark applications to the U.S., Japan has many trademark applications related to “Chemicals” and “Transportation.” China has many trademark applications related to “Household equipment” and “Clothing and accessories.”

[Summary Chart 22] Industry sector composition based on Nice Classification in trademark applications from the selected countries to the U.S. (specialization coefficient)



Note:

1) For a correspondence table between Nice Classification and industry sectors, “Annex B. Composition of industry sectors by Nice goods and services classes” in “World Intellectual Property Indicators 2020” by WIPO was consulted.
2) Applications for international registration using the Madrid System (international applications) and direct applications
3) The number of classes is measured. Data shown are specialization coefficients, which represent the ratio of applications (number of classes) to the U.S. by a particular country against applications to the U.S. from all countries, both in a particular industry sector. (Specialization coefficient = Composition rate of industry sector A (e.g. household equipment) in trademark applications from a particular country to the U.S. / Composition rate of industry sector A in trademark applications from all countries to the U.S.). The totals for 2018-2020 are used.

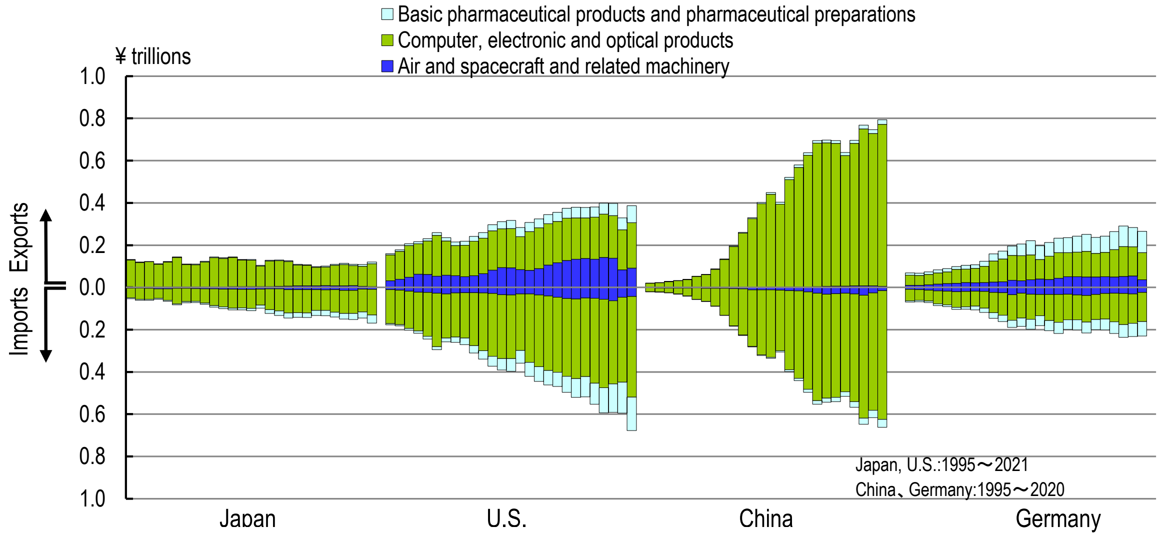
Reference: Chart 5-3- 4(C), Japanese Science and Technology Indicators 2022 (in Japanese)

(4) The balance of trade shows Japan's high R&D intensive industries are in trade deficit while medium-high R&D intensive industries are in trade surplus. Japan's trading partner countries and regions for the high R&D intensive industries have shifted from the U.S. to China and other Asian countries and regions in imports and exports.

Regarding trades in high R&D intensive industries, "Computer, electronic and optical products" is dominant in import and export in many countries. The balance of trade (of the latest year for each country) shows that Japan and the U.S. are in trade deficit while Germany and China are in trade surplus. Regarding the export value of medium-high R&D intensive industries, "Motor vehicles, trailers and semi-trailers" account for the largest share in Japan and Germany, "Chemicals and chemical products" being the largest in the U.S., and "Electrical equipment" in China. The balance of trade shows that Japan, Germany, and China are in trade surplus while the U.S. is in trade deficit.

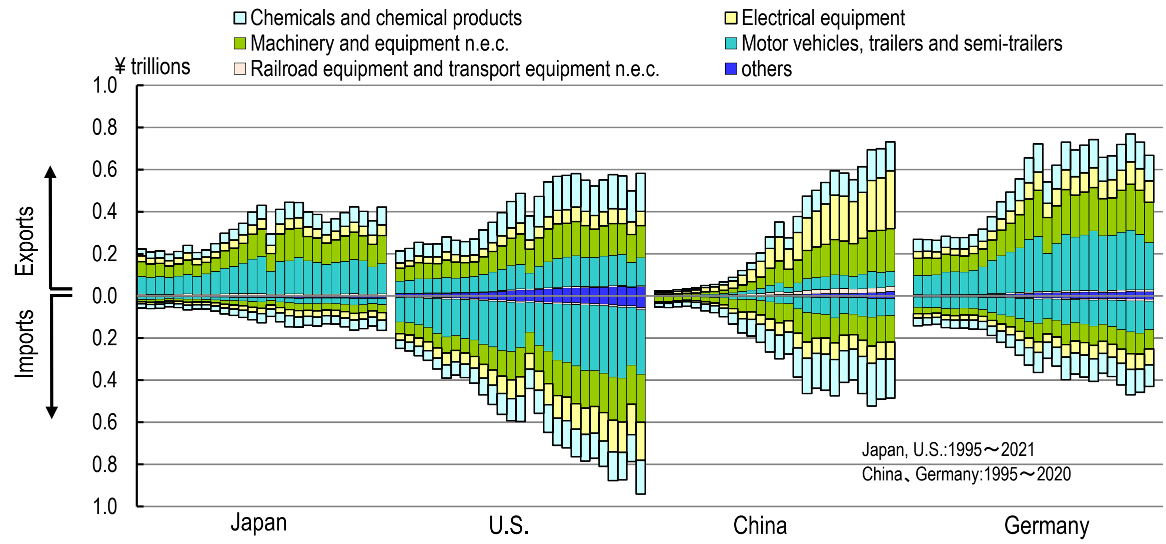
[Summary Chart 23] Trends in the value of industrial trade in the selected countries

(A) High R&D intensive industries



Reference: Chart 5-2-3, Japanese Science and Technology Indicators 2022 (in Japanese)

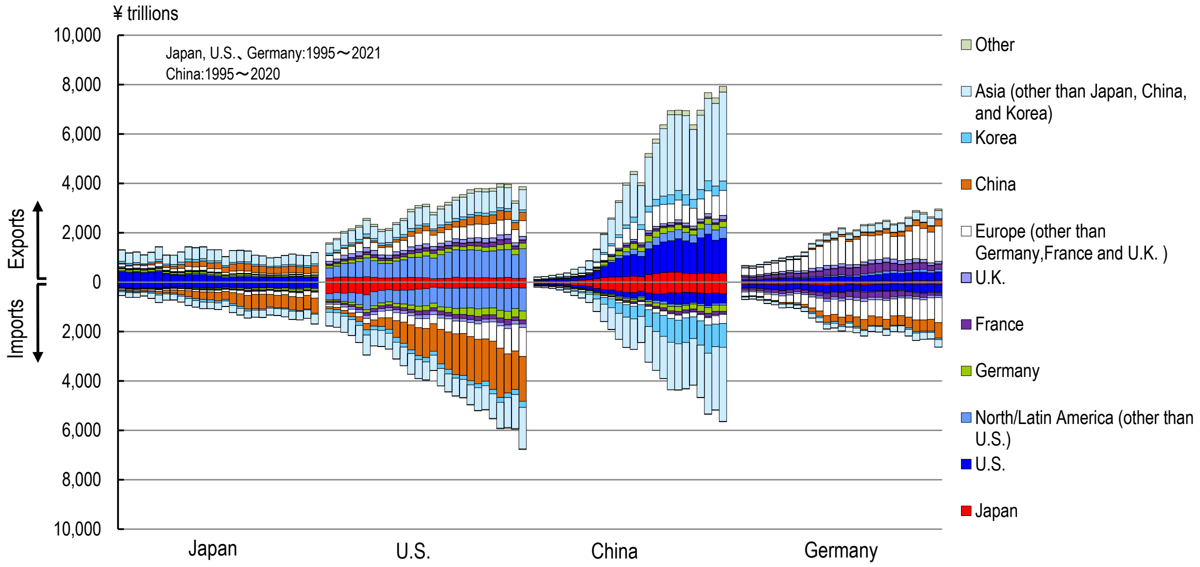
(B) Medium-high R&D intensive industries



Note:
Others" include "Magnetic and optical media" and "Medical and dental instruments and supplies.
Reference: Chart 5-2-6, Japanese Science and Technology Indicators 2022 (in Japanese)

Looking at the trading partners for the high R&D intensive industries, the U.S. was Japan's largest export partner in the past, shifted to China and Asia (other than Japan, China, and Korea) in the latest year. As for the U.S., Germany, and China, they maintain a certain level of exports to the regions to which they each belong, i.e., regions of America, Europe, and Asia. As for imports, Japan, the U.S., and Germany all import more from China than before (comparison between 1995 and 2021: Japan 5%→36%, the U.S. 5%→27%, and Germany 3%→24%). In China, Asia (other than Japan, China, and Korea) has replaced Japan and the U.S. as the largest source.

(C) Trading partner countries/regions for the high R&D intensive industries



Note.
The original data for China's imports also included the value of imports from China. Since this corresponds to re-imports, which was excluded in preparing this chart.
Reference: Chart 5-2-5, Japanese Science and Technology Indicators 2022 (in Japanese)

Characteristics of the Japanese Science and Technology Indicators

"The Japanese Science and Technology Indicators" is published annually to present the most recent statistics/indicators at the time of publication. The statistics/indicators are selected considering the following two conditions: 1) the indicators should allow either of the time-series comparison or the comparison among the selected countries and 2) the indicators should be possible to update annually in principle.

NISTEP conducted analysis of paper and patent databases

Paper data were aggregated and analyzed by NISTEP using Web of Science provided by Clarivate Analytics. Patents family data were aggregated and analyzed by NISTEP using PATSTAT (the patent database of the European Patent Office).

Use of "reminder marks" for international comparisons and time-series comparisons

The reminder marks "attention to international comparison" [Attention to international comparison] and "attention to trend" [Attention to trend] have been attached to graphs where they are required. Generally, the data for each country are collected in line with the OECD's manuals. However, differences in methods or scope of collecting data exist, and therefore attention is necessary when making comparisons in some cases. Such cases are marked "attention to international comparison." Likewise, for some time series data, data could not be continuously collected under the same conditions due to changes in statistical standards. Cases where special attention is required when reading chronological trends are marked "attention to trend." Specifics for such points requiring attention are provided in the notes of individual charts.

To download the collection of statistics (numerical data for the graphs in this report)

The numerical data for the graphs in this report can be downloaded from the following URL or QR code.

https://www.nistep.go.jp/research/indicators

The references shown below the summary charts in this report indicate the table numbers in the collection of statistics.

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