NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY POLICY

Current State of Research Activities in Japan

(Provisional Translation)

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National Institute of Science and Technology Policy, MEXT

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Structure of this document

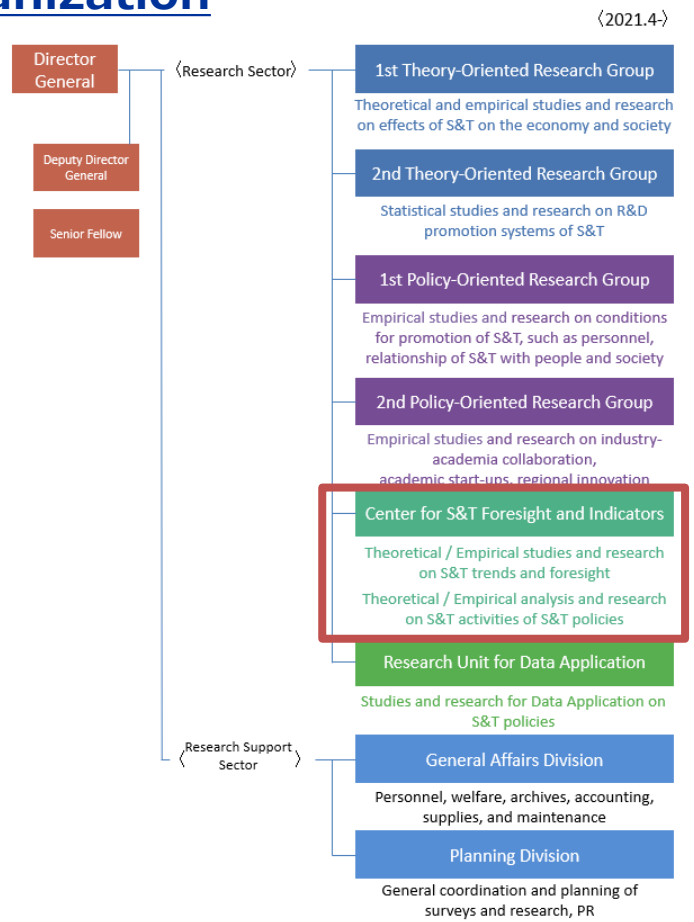
- Macro-level situation of research activities in Japan
- Analysis of the relationship between inputs and outputs
- Distribution of the number of papers in the university sector
- Changes in global research trends
- Awareness of the research environment at universities among researchers on the ground
- Understanding of the research process
- Changes in research activities

Organization of NISTEP

Organizational character

The National Institute of Science and Technology Policy (NISTEP) is a national research institute under the direct jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Organization



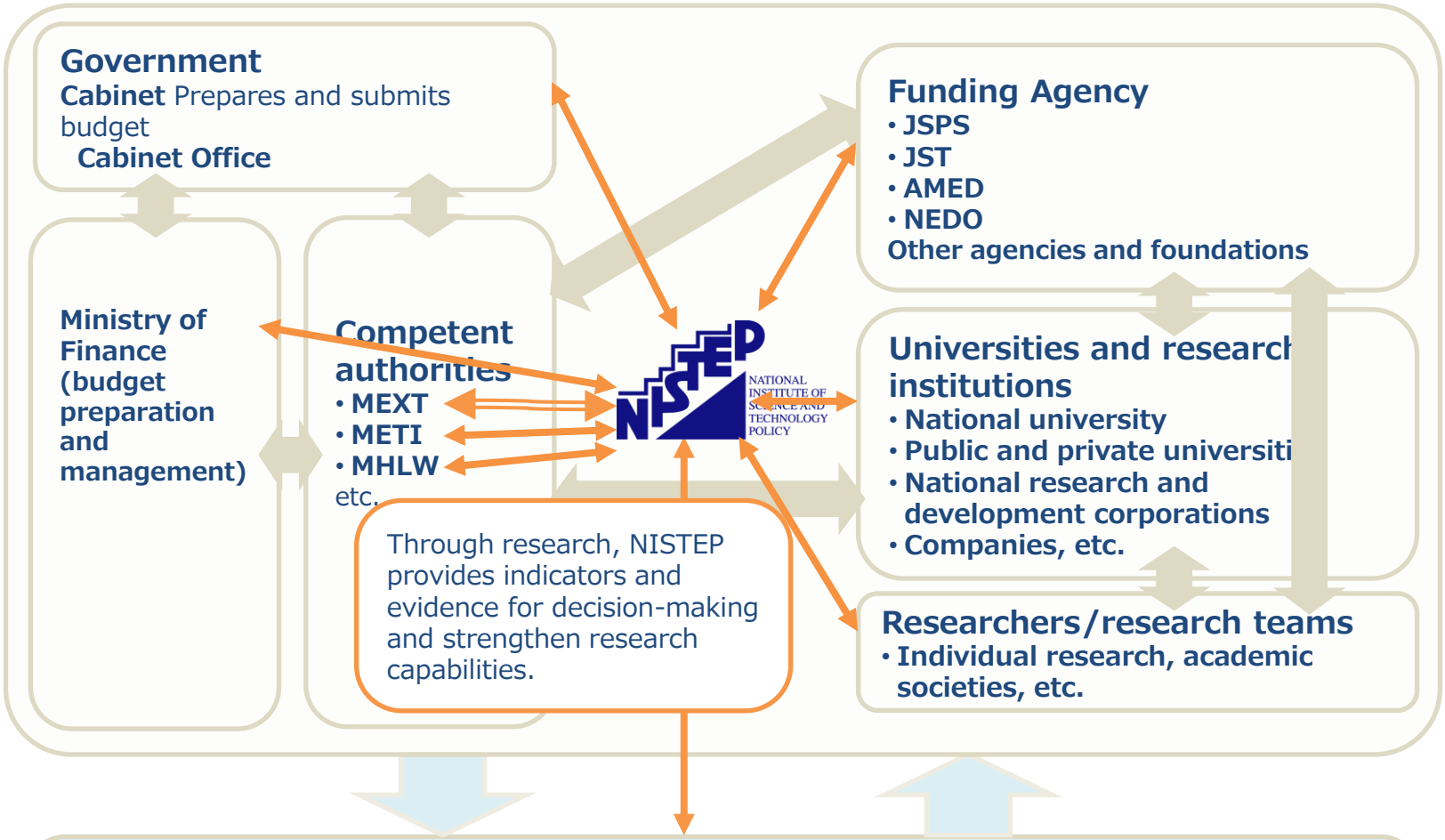
(Our mission)

- **Contribute to the advancement of Japan's science and technology by providing evidence to support the enhancement of policy formulation.**

(Examples of research items of our group)

- **Science and Technology Indicators**
- **Various analyses of scientific papers**
  - Benchmarking of scientific research
  - University Benchmarking
  - Science Map
- **Analysis focusing on the university's input, output, and research process**
- **Comprehensive Attitude Survey on the State of Science and Technology (NISTEP TEITEN Survey)**

Budgetary and Decision-Making Relationships in S&T Policies and the Role of NISTEP



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Macro-level situation of research activities in Japan

Source:
”Japanese Science and Technology Indicators 2024”, NISTEP, Research Material No.341,
http://doi.org/10.15108/rm341

Top countries/regions in the number of papers, top 10% and 1% highly cited)

- Regarding the number of papers (fractional counting method), Japan ranks 5th in the world. When focusing on highly cited papers, Japan ranks 13th and 12th in the top 10% and 1% highly cited papers, respectively.
- China ranks the 1st position in all categories of papers. These rankings are unchanged from last year.

All fields	2020 - 2022 (PY) (Average)		
	The number of papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	541,425	26.9	1
U.S.	301,822	15.0	2
India	85,061	4.2	3
Germany	74,456	3.7	4
Japan	72,241	3.6	5
U.K.	68,041	3.4	6
Italy	61,124	3.0	7
Korea	59,051	2.9	8
France	46,801	2.3	9
Spain	46,006	2.3	10
Canada	45,818	2.3	11
Brazil	45,441	2.3	12
Australia	42,583	2.1	13
Iran	38,558	1.9	14
Russia	33,639	1.7	15
Türkiye	33,168	1.6	16
Poland	27,978	1.4	17
Taiwan	23,811	1.2	18
Netherlands	23,144	1.1	19
Switzerland	16,723	0.8	20

All fields	2020 - 2022 (PY) (Average)		
	The number of adjusted top 10% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	64,138	31.8	1
U.S.	34,995	17.4	2
U.K.	8,850	4.4	3
India	7,192	3.6	4
Germany	7,137	3.5	5
Italy	6,943	3.4	6
Australia	5,151	2.6	7
Canada	4,654	2.3	8
Korea	4,314	2.1	9
France	4,083	2.0	10
Spain	3,991	2.0	11
Iran	3,882	1.9	12
Japan	3,719	1.8	13
Netherlands	2,878	1.4	14
Saudi Arabia	2,140	1.1	15
Brazil	2,131	1.1	16
Switzerland	2,071	1.0	17
Türkiye	2,052	1.0	18
Egypt	1,826	0.9	19
Pakistan	1,696	0.8	20

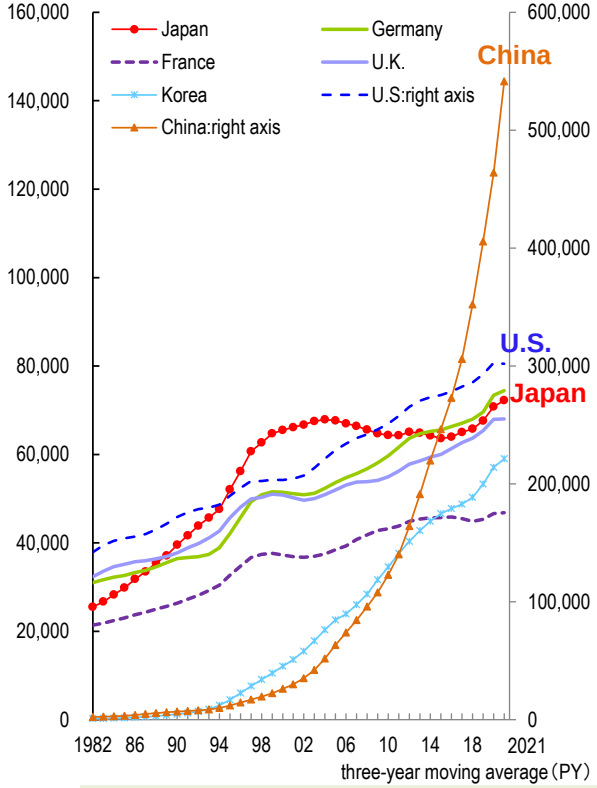
All fields	2020 - 2022 (PY) (Average)		
	The number of adjusted top 1% papers		
Country/Region	Fractional counting		
	Papers	Share	World rank
China	6,582	32.7	1
U.S.	4,070	20.2	2
U.K.	1,031	5.1	3
Germany	717	3.6	4
Italy	561	2.8	5
India	560	2.8	6
Australia	555	2.8	7
Canada	480	2.4	8
France	379	1.9	9
Korea	354	1.8	10
Spain	351	1.7	11
Japan	311	1.5	12
Netherlands	300	1.5	13
Iran	295	1.5	14
Switzerland	227	1.1	15
Singapore	207	1.0	16
Saudi Arabia	199	1.0	17
Türkiye	170	0.8	18
Pakistan	157	0.8	19
Sweden	150	0.7	20

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 2023.
Aggregation was performed by NISTEP using Web of Science XML (SCIE, the end-of-2023 version) provided by Clarivate Analytics.

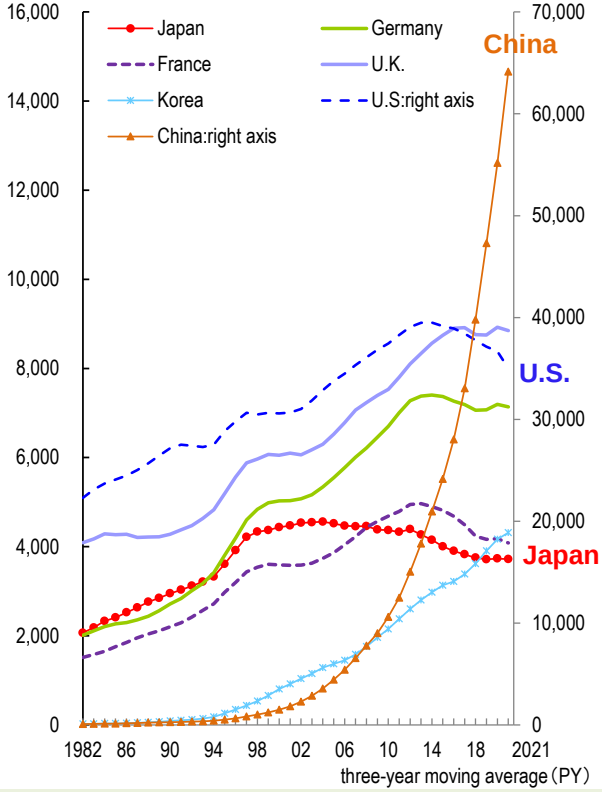
Changes in the number of papers and highly cited papers in the selected countries

- **The number of scientific papers from Japan has been increasing since the mid-2010s. Although the number of top 10% papers has been decreasing, there are recent signs of stabilization.**

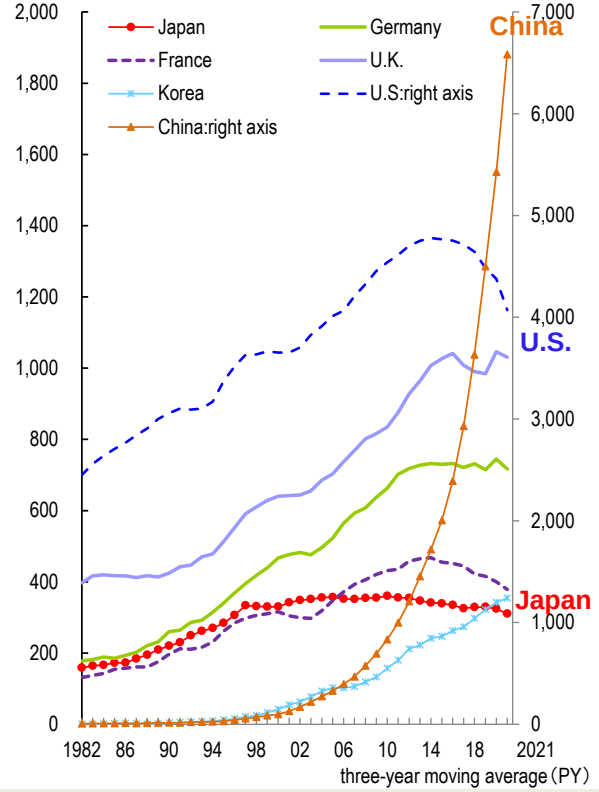
【The number of papers (FC, All Fields】



【The number of adjusted top 10% papers (FC, All Fields) 】



【The number of adjusted top 1% papers (FC, All Fields) 】

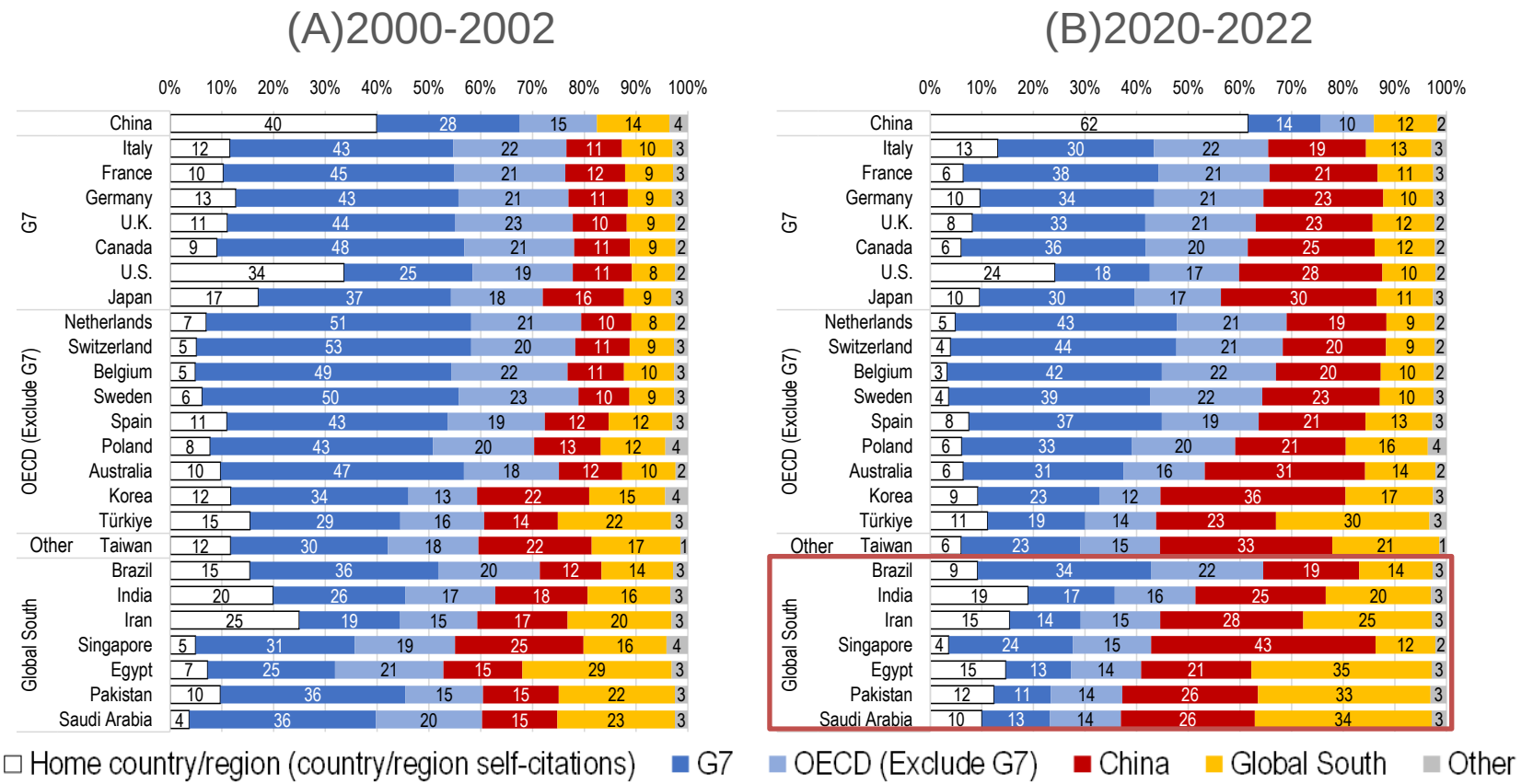


(Fractional counting method) In the case where one paper is co-authored by Japanese Organization A and US Organization B, this method counts Japan as 1/2 and the U.S. as 1/2. This indicates the degree of contribution to the production of papers.

Note :
1)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 2023.
2)The number of top 10% (top 1%) papers is the number of papers whose number of times cited (the value at the end of 2023) is in the top 10% (1%) of cited papers in the field concerned (22 fields) each year. The number of adjusted top 10% (top 1%) papers is the number obtained by extracting the number of top 10% (1%) papers and then this extracted number so that it is 1/10 (1/100) of the number of papers in terms of real numbers.
Aggregation was performed by NISTEP using Web of Science XML (SCIE, the end-of-2023 version) provided by Clarivate Analytics.

Citation structures by country/region in terms of the top 10% highly-cited papers

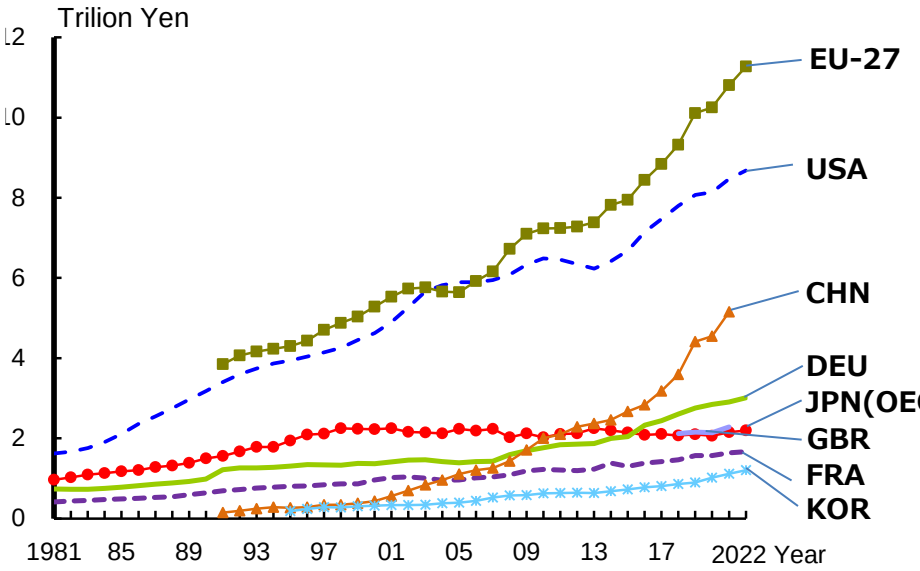
- **The citation structure of papers has changed over the past two decades, and the presence of China and the Global South has increased. Specifically, Iran, Egypt, Pakistan, and Saudi Arabia, about 70% of citations are self-citations and citations from China and Global South countries (2020-2022).**



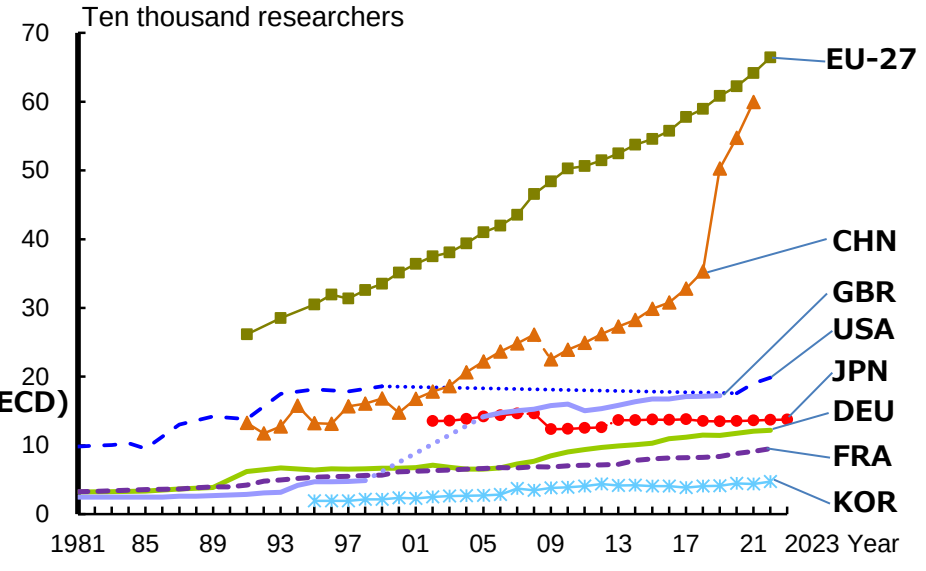
(Note 1) The number of articles and reviews was counted. Publication year (PY) was used for the year tally. Citation counts are analyzed by the fractional counting.
(Note 2) The citation structure of the adjusted top10% papers was analyzed for the top 25 countries/regions, ranked by the number of adjusted top 10% papers (fractional counting, 2020-2022 average).
(Note 3) Citations from the Home country/region (country/region self-citations) are included in the country self-citations and excluded from other applicable categories.
(Note 4) Countries and regions of the Global South are those participating in the Voice of the Global South Summit 2023 (https://mea.gov.in/voice-of-global-summit.htm) and the Group of 77 (G-77, http://www.fc-ssc. org/en/partnership_program/south_south_countries).
Based on Clarivate Web of Science XML (SCIE, version at the end of 2023), compiled by the National Institute of Science and Technology Policy.

Trends in R&D expenditure and number of researchers at universities in benchmarking countries

【Nominal amount of university R&D expenditure (OECD PPP conversion)】



【Number of researchers in universities】

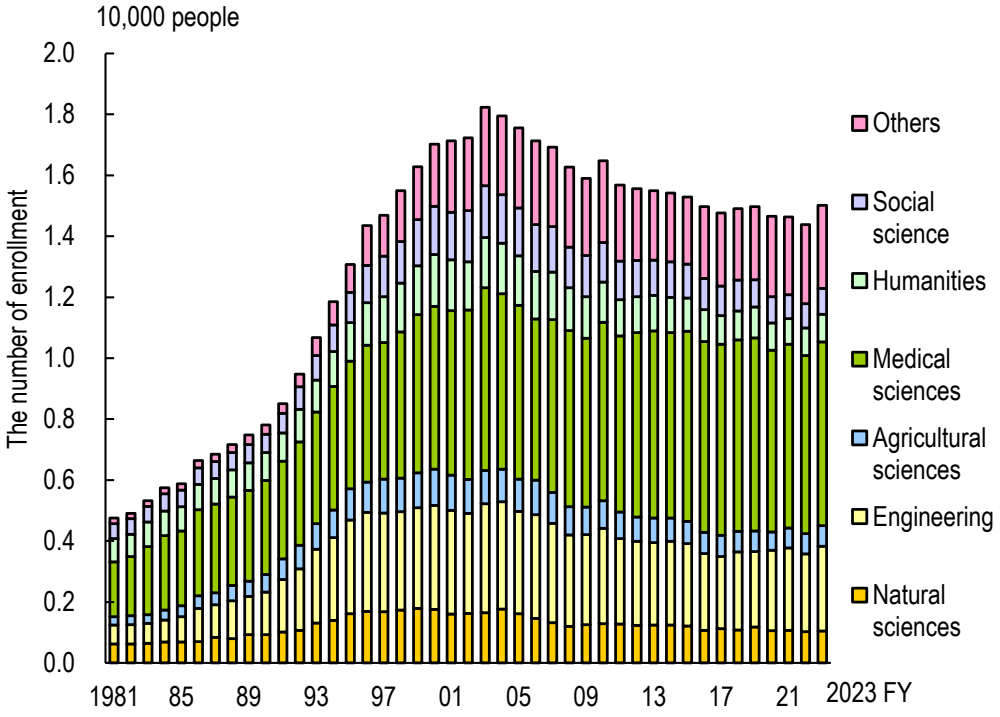


Note: 1) Japan (OECD estimate) is the research and development expenditure corrected considering the degree of involvement in research for the personnel cost part of Japan's university sector.
2) The number of researchers is shown in FTE (Full-Time Equivalent) values.

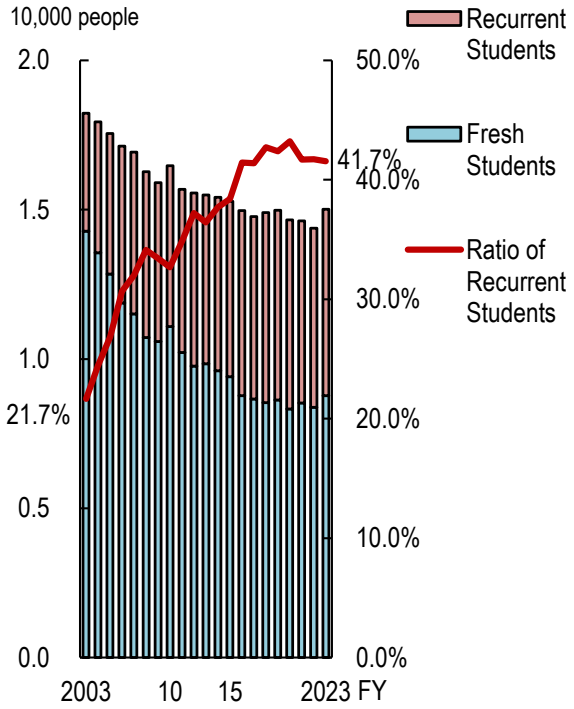
Number of Students Enrolled in The Doctoral Program

- In FY 2023, the number of enrollments in the graduate school doctoral programs increased to about 15,000, a 4.4% increase over the previous year.

(A)Number of students enrolled in the doctoral program



(B) Number of recurrent students newly enrolled in graduate schools



Analysis of the relationship between inputs and outputs

Source:
”Analyses on the production of scientific publications in Japanese universities using long-term input and output data”, NISTEP, Discussion Paper No.180, http://doi.org/10.15108/dp180

Purpose and characteristics of the Analysis

(Purpose of this analysis)

- To examine long-term trends (1981–2017) in input (researchers and R&D expenses) and output (natural science papers) in Japanese universities, identifying factors behind Japan's historical growth in publications and recent stagnation.

(Characteristics of this analysis)

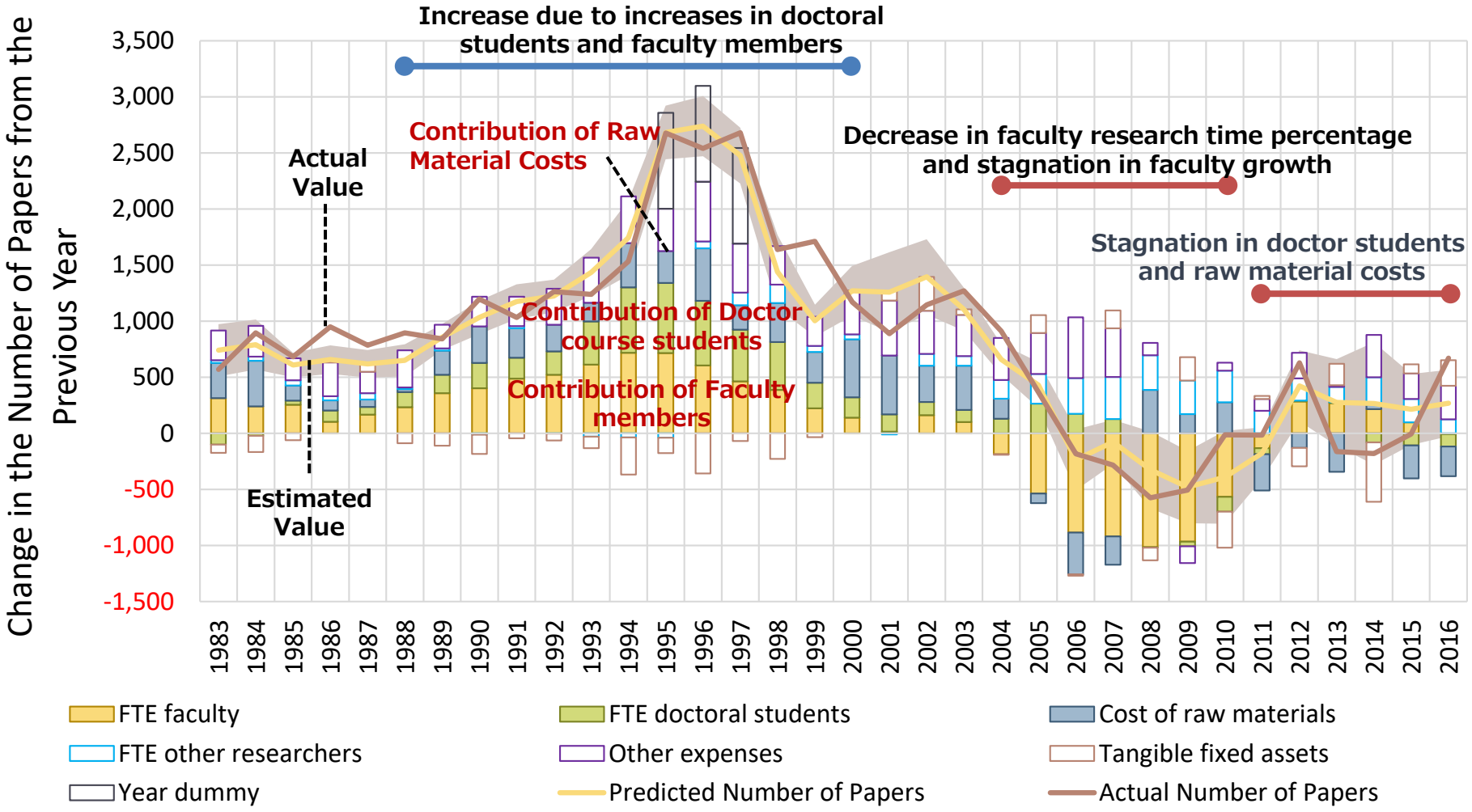
- This analysis highlights causes for changes in paper counts from the 1980s to today.

(Previous Studies)

- Econometric studies suggest Japan's stagnation in research papers is mainly due to researcher numbers and available research time.

Authors	Methodology	Findings
National Institute of Science and Technology Policy, 2005	Multiple regression analysis of various input information and the number of papers in universities	Key factors affecting the total number of papers in national universities: (i) number of doctoral students, (ii) number of faculty members, (iii) number of postdoctoral researchers.
Yonetani, Ikeuchi & Kuwahara, 2013	Fixed-effect model applied to 142 universities	When looking at time series changes within universities, the number of faculty members, self-funding (internal use), and personnel expenses positively correlate with the number of papers.
Aoki & Kimura, 2016	Analysis using growth accounting	The primary cause of the stagnation in the number of papers at national universities is the reduction in research time
Toyoda, 2019	Multiple regression analysis of various input information and the number of papers at the national level	A strong correlation was found between the number of researchers converted to full-time research equivalents and the number of papers.

Results of regression analysis (All Universities in the Fields of Science, Engineering, and Agriculture)



Note: The regression analysis used a two-year lag between inputs (number of researchers and R&D expenses) and outputs (number of papers). For example, the 2010 data uses 2009–2010 paper changes and 2007–2008 input changes. The shaded area with the predictions indicates the 95% confidence interval.

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Distribution of the number of papers in the university sector

Source:
” Benchmarking Research Capability of Universities in Japan, the United Kingdom and Germany 2023”, NISTEP, Research Material-340, https://doi.org/10.15108/rm340

Comparison of universities in Japan, the UK, and Germany by university group

- Group 1: Four, Five, and two universities in Japan, the UK, and Germany, respectively.
- The number of Group 2 universities is the largest in Germany (34).
- In the UK and Japan, the number of universities in Groups 2 and 3 is almost the opposite.
- More Group 4 universities are in Japan than in the UK and Germany.

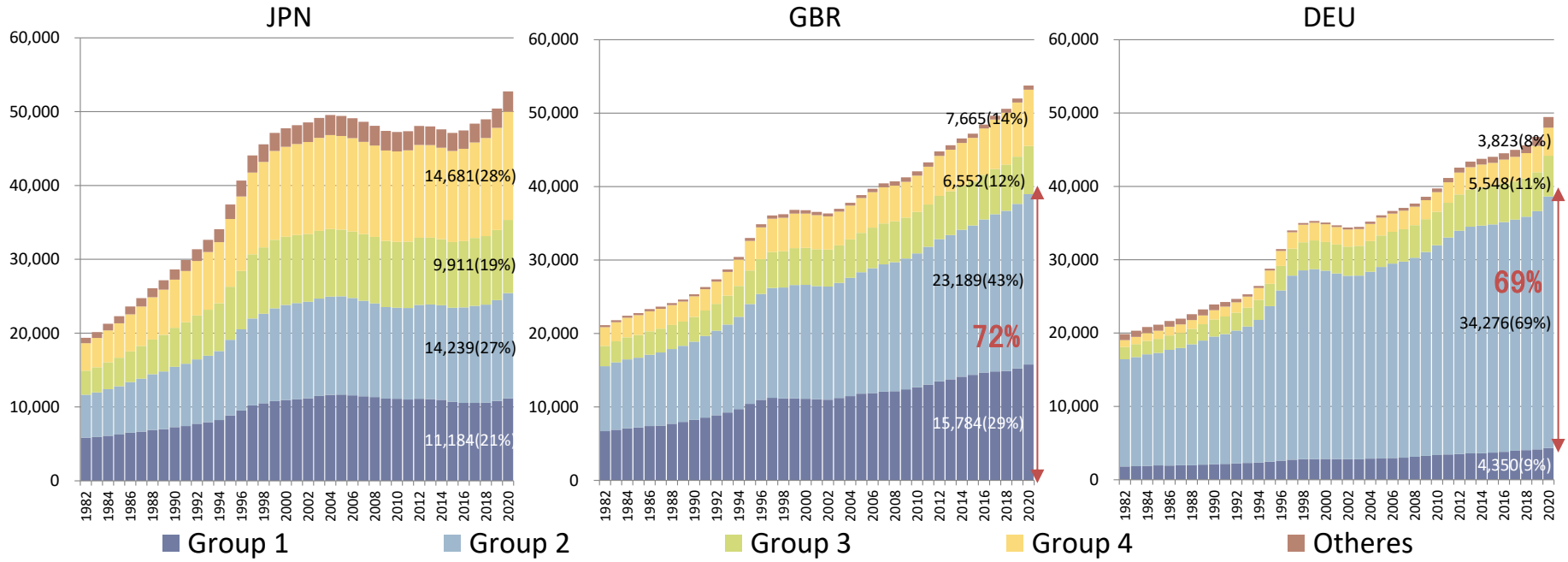
The number of Universities by University Group in Japan, the UK, and Germany (based on publication share in 2017-2021)

University group	Publication share in all universities of a target country	Japan	UK	Germany
Group 1	4.0% or more	4	5	2
Group 2	1% or more and less than 4.0%	14	21	34
Group 3	0.5% or more and less than 1%	28	16	14
Group 4	0.05% or more and less than 0.5	133	63	33
Total (Sum of groups 1 to 4)		179	105	83
Total number of universities		807	295	422

Note 1: Classification based on the publication share in natural science. The publication share represents the proportion of a university in all universities of a target country
Note 2: The number of universities in each country is taken from「諸外国の教育統計」of the Ministry of Education, Culture, Sports, Science, and Technology
Note 3: The total number of universities in Germany includes universities of applied sciences (Fachhochschulen (FH)), universities (including some technical universities and medical universities), teacher training colleges, theological universities and art universities.

The trends of the number of papers of universities in Japan, the UK, and Germany by university group

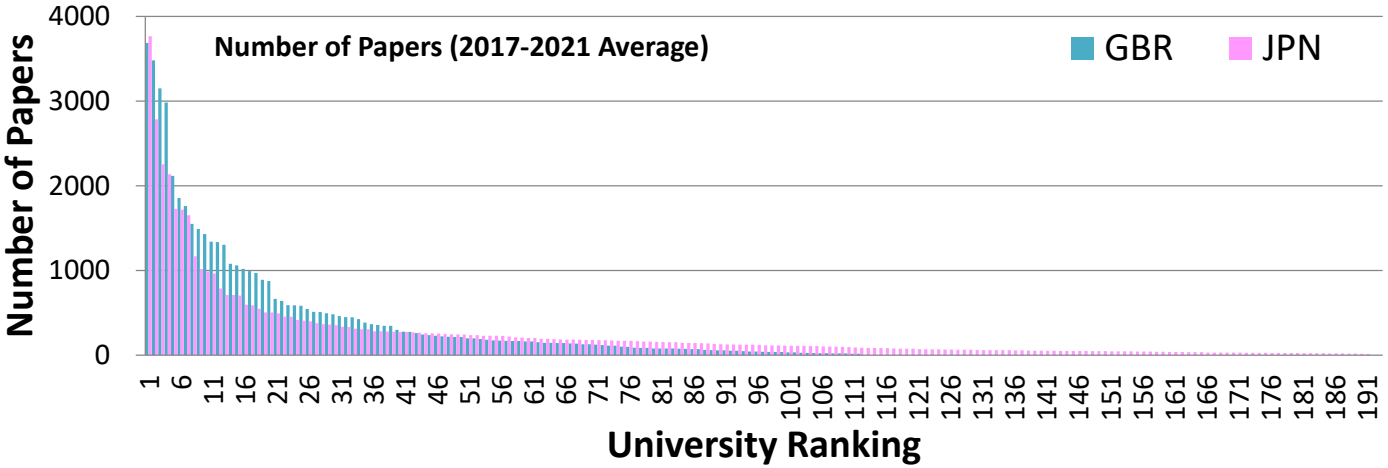
- In Japan, each university group accounts for a similar share.
- Group 2 has the largest share in the UK; together with Group 1, they produce about 70% of papers.
- In Germany, the proportion of Group 2 is substantial, and papers in Group 2 alone account for about 70% of the total.

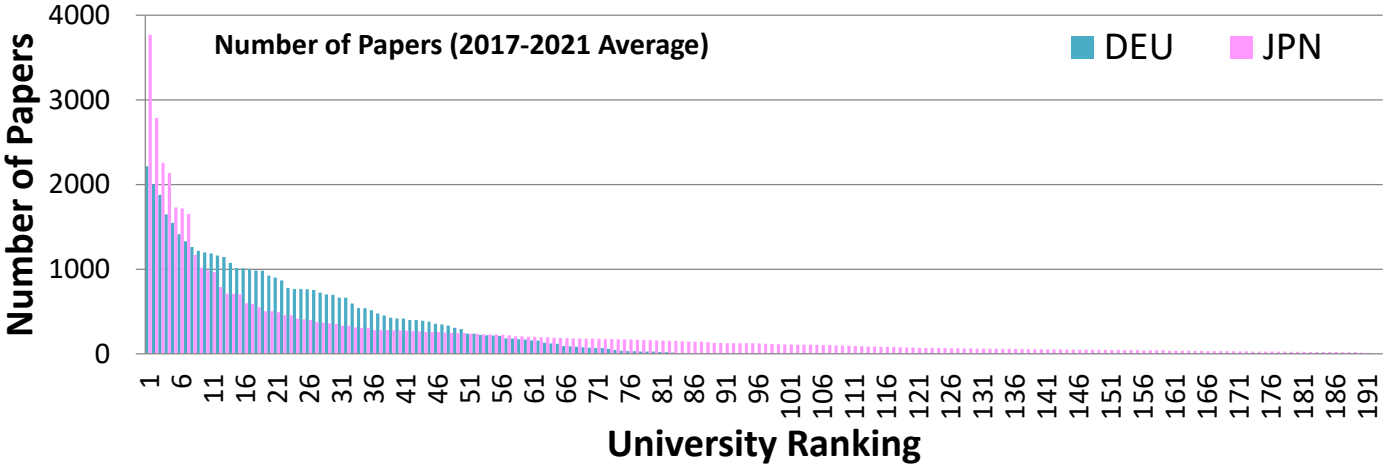


(Note 1) Articles and reviews were analyzed using the fractional counting method. The figures are three-year moving averages.
The NISTEP compiled the data based on Clarivate Analytics' Web of Science XML (SCIE, end of 2022 version).

Distribution of papers in Japan, the UK, and Germany (2017-2021)

- The number of papers from universities that follow the large universities in Japan is smaller than those in the UK and Germany.
- The structural differences are remarkable in top 10% highly-cited papers.





(Note 1) Articles and reviews were analyzed using the fractional counting method. The figures are three-year moving averages.
The NISTEP compiled the data based on Clarivate Analytics' Web of Science XML (SCIE, end of 2022 version).

Identifying the strengths of Japanese universities by their leadership in research fields

- We identified Japanese universities that lead international collaborative papers, ranking in the top 10 domestically across 19 natural science fields.
- While many of the top 10 universities are from groups 1 and 2, several from groups 3 and 4 also rank highly.

Japanese universities leading international collaborative papers (Top 10 universities in Japan, 2017–2021)

19 fields	1G	2G	3G	4G
Chemistry	Kyoto Univ., Univ. of Tokyo, Osaka Univ., Tohoku Univ.	Kyushu Univ., Hokkaido Univ., Tokyo Institute of Technology, Nagoya Univ., Hiroshima Univ.	Kumamoto Univ.	
Materials Science	Tohoku Univ., Osaka Univ., Univ. of Tokyo, Kyoto Univ.	Kyushu Univ., Hokkaido Univ., Tokyo Institute of Technology, Nagoya Univ., Univ. of Tsukuba	Shinshu Univ.	
Physics	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Nagoya Univ., Tokyo Institute of Technology, Kyushu Univ., Univ. of Tsukuba, Hokkaido Univ.		OIST
Space Science	Univ. of Tokyo, Kyoto Univ., Tohoku Univ., Osaka Univ.	Nagoya Univ., Tokyo Institute of Technology, Hokkaido Univ., Hiroshima Univ.	Ehime Univ.	National Graduate Institute for Policy Studies
Computer Science	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Waseda Univ., Kyushu Univ.		Japan Advanced Institute of Science and Technology, Univ. of Aizu, Muroran Institute of Technology, Univ. of Electro-Communications
Mathematics	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Waseda Univ., Nagoya Univ., Kobe Univ., Tokyo Institute of Technology, Hokkaido Univ.	Nihon Univ.	
Engineering	Univ. of Tokyo, Kyoto Univ., Tohoku Univ., Osaka Univ.	Kyushu Univ., Tokyo Institute of Technology, Hiroshima Univ., Waseda Univ., Hokkaido Univ., Nagoya Univ.		
Environment/Ecology	Univ. of Tokyo, Kyoto Univ., Tohoku Univ.	Hokkaido Univ., Kyushu Univ., Hiroshima Univ., Univ. of Tsukuba	Tokyo Univ. of Agriculture and Technology, Ehime Univ.	Univ. of the Ryukyus
Geosciences	Univ. of Tokyo, Tohoku Univ., Kyoto Univ.	Hokkaido Univ., Nagoya Univ., Kyushu Univ., Univ. of Tsukuba, Tokyo Institute of Technology, Hiroshima Univ., Kanazawa Univ.		
Clinical Medicine	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Tokyo Medical and Dental Univ., Nagoya Univ., Keio Univ., Hokkaido Univ., Okayama Univ.	Juntendo Univ.	
Psychiatry/Psychology	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Keio Univ., Chiba Univ., Kyushu Univ., Waseda Univ., Nagoya Univ., Tokyo Medical and Dental Univ.		
Agricultural Sciences	Univ. of Tokyo, Kyoto Univ.	Kyushu Univ., Hiroshima Univ., Hokkaido Univ., Univ. of Tsukuba, Nagoya Univ.	Tokyo Univ. of Agriculture and Technology, Tottori Univ.	Tokyo Univ. of Marine Science and Technology
Biology & Biochemistry	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Nagoya Univ., Hokkaido Univ., Kyushu Univ., Univ. of Tsukuba, Hiroshima Univ.	Tokyo Univ. of Agriculture and Technology	
Immunology	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Hokkaido Univ., Chiba Univ., Kobe Univ., Tokyo Medical and Dental Univ.	Nagasaki Univ., Juntendo Univ.	
Microbiology	Univ. of Tokyo, Osaka Univ., Kyoto Univ., Tohoku Univ.	Hokkaido Univ., Okayama Univ.	Nagasaki Univ., Tokyo Univ. of Agriculture and Technology, Kagoshima Univ.	Obihiro Univ. of Agriculture and Veterinary Medicine
Molecular Biology & Genetics	Univ. of Tokyo, Kyoto Univ., Osaka Univ., Tohoku Univ.	Hokkaido Univ., Nagoya Univ., Univ. of Tsukuba, Hiroshima Univ., Kyushu Univ.	Yokohama City Univ.	
Neuroscience & Behavior	Univ. of Tokyo, Kyoto Univ., Tohoku Univ., Osaka Univ.	Keio Univ., Univ. of Tsukuba, Kyushu Univ., Chiba Univ., Nagoya Univ.	Juntendo Univ.	
Pharmacology & Toxicology	Univ. of Tokyo, Osaka Univ., Tohoku Univ.	Kyushu Univ., Hokkaido Univ.	Univ. of Toyama, Kumamoto Univ., Tokushima Univ., Tokyo Univ. of Agriculture and Technology, Nagasaki Univ.	
Plant & Animal Science	Kyoto Univ., Univ. of Tokyo	Hokkaido Univ., Kyushu Univ., Nagoya Univ., Univ. of Tsukuba, Kobe Univ.	Tokyo Univ. of Agriculture and Technology, Kagoshima Univ.	Univ. of the Ryukyus

Note: The red text indicates the university ranked 1st domestically.

Changes in global research trends

Source:
”Science Map 2020”, NISTEP, NISTEP REPORT No.196, http://doi.org/10.15108/nr196

Scientific research has been expanding over time

- **The number of RAs increased by 54% from the Science Map 2002 to 2020**
  - Increasing of the number of scientific publications; Expansion of research community due to participation of emerging economies such as China. Emergence of new research area; division of an existing research area.
  - Science Map 2002-2020: Research expands (orange circle) in chemical synthesis, nanoscience, quantum information processing, and materials research.
  - Science Map 2010-2020: AI-related research areas and social science-related research areas emerge at the bottom of the map (white circle).

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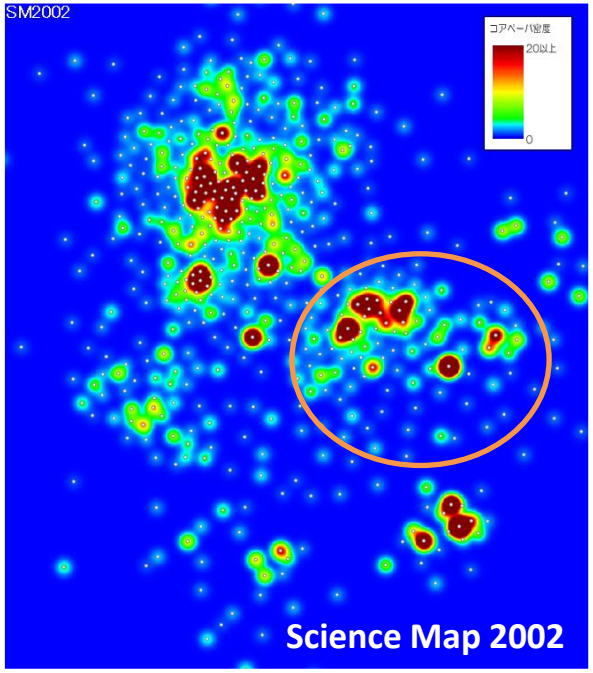

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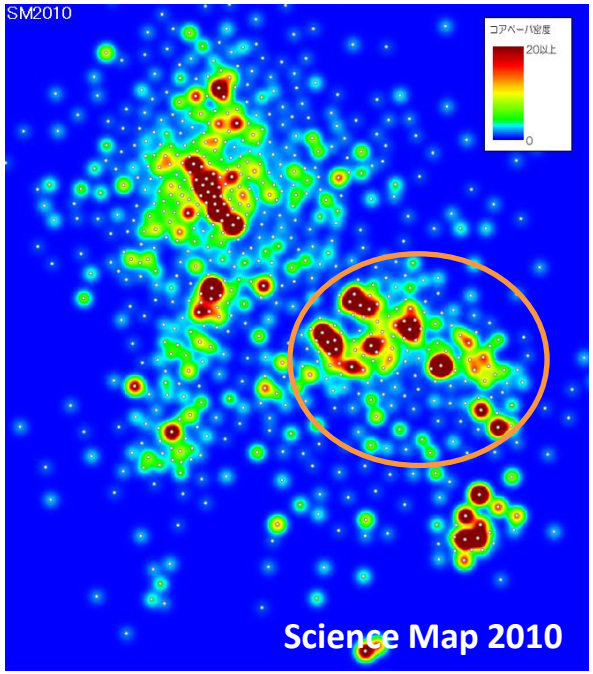

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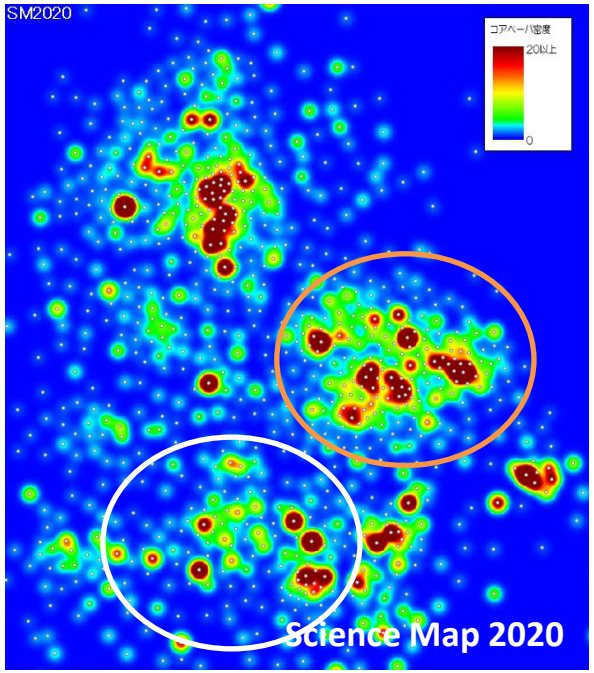
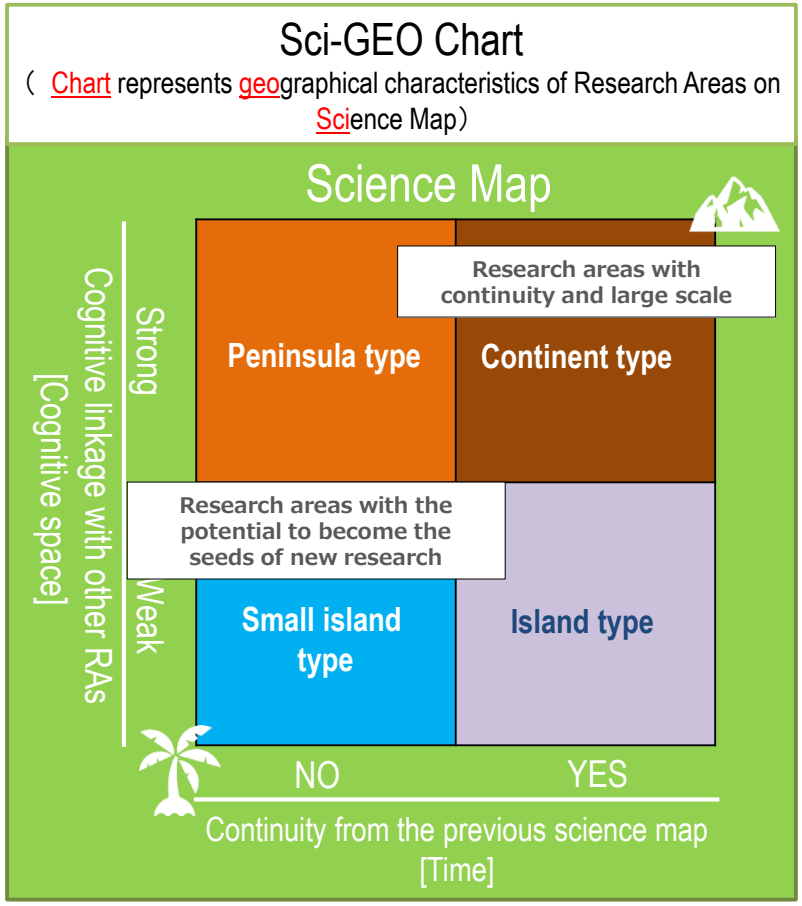
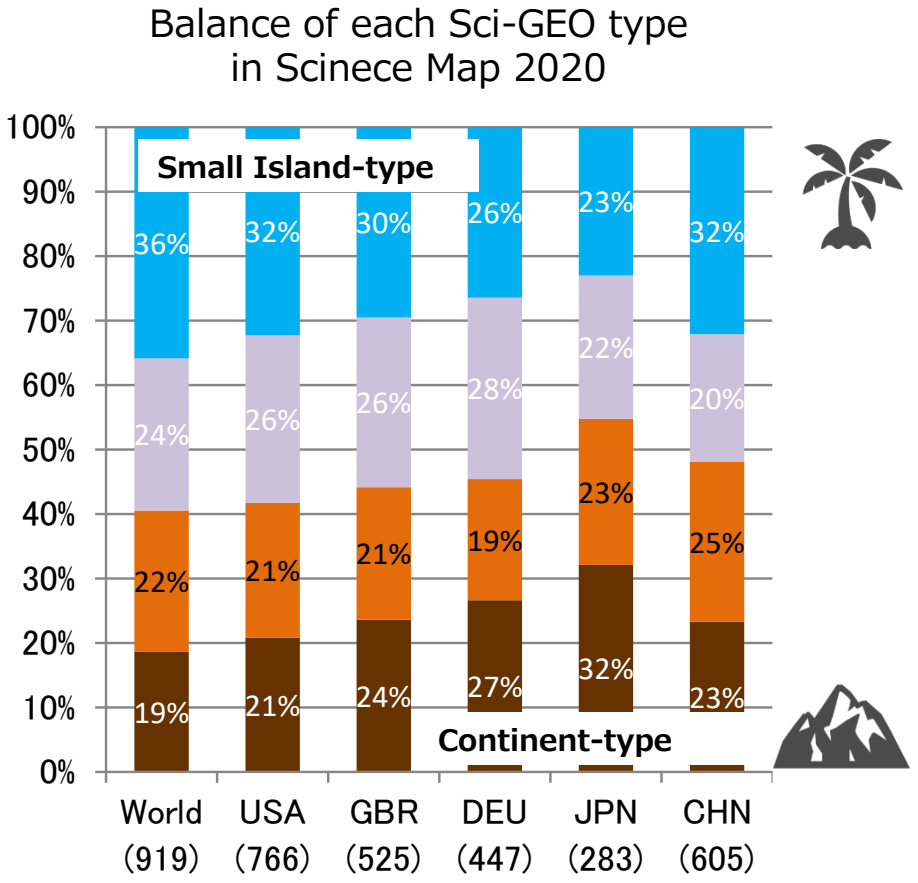


Data sources: NISTEP conducted analyses based on Essential Science Indicators (NISTEP version) and Web of Science XML (SCIE, as of the end of 2021).

Categorization of RAs by Sci-GEO chart

- **Japan has a small percentage of participation in research areas (small island type) that have the potential to become the seeds of new research.**





Data sources: NISTEP conducted analyses based on Essential Science Indicators (NISTEP version) and Web of Science XML (SCIE, as of the end of 2021).

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Awareness of the research environment at universities among researchers

Source:
”Analytical Report of Comprehensive Survey on the State of Science and Technology in Japan (NISTEP TEITEN Survey 2023)”, NISTEP, NISTEP REPORT No.201, http://doi.org/10.15108/nr201

Comprehensive Survey on the State of Science and Technology in Japan (NISTEP TEITEN Survey)

A survey to qualitatively understand changes in the situation of science, technology, and innovation, through the awareness of researchers and experts (the science and technology version of the Bank of Japan's Tankan survey).

- During the period of the 6th Science and Technology Innovation Basic Plan (FY2021-25), the same survey will be conducted once a year on the same group of people.
- NISTEP TEITEN Survey 2023 is the third survey during the 6th Basic Plan (conducted from September to December 2023, collection rate: 88.3%)

Aggregation of subjective opinions
(6-point scale from “Insufficient" to “Sufficient ")
If respondents have changed opinion from the previous year, we asked them to provide the reason for the change (Reason for change in opinion)

Researchers at universities, public research institutes, etc. engaged in R&D
Approx. 1,500

Natural science researchers at universities, public research institutes, etc,
Researchers of priority programs, humanities and social sciences

Condition: Answer the situation on department or organization.

Solid line: Mainly answer part
Dotted line: Partial answers

Experts
Approx. 800 respondents

University management, management of public research institutes, companies (large companies, small and medium-sized companies, university-launched ventures), and those with a bird’s-eye view (A member of the councils).

Condition: Respondents answered the situation from the perspective of Japan as a whole.

Question Category (Total number of questions: 65)

1. Research personnel	Young researchers, Young students aspiring to become researchers, Female researchers, Foreign researchers, Evaluation of researchers
2. Research Environment	Research resources, Research facilities and equipment, Transformation of research activities
3. Research Activities and Research Support	Academic research and basic research, Government research funding management
4. Industry-academia-government collaboration and the local community	Knowledge-based value creation, Intellectual property management, Regional revitalization, Innovation talent development
5. University functional expansion and strategic management	University management, University functional expansion
6. Science, Technology, Innovation and Society	Relationship with society, Utilization of "comprehensive knowledge", Building an innovation system, Promoting open innovation, International collaboration, Research integrity

Questions were asked to groups of respondents with different perspectives, and the results were compared as much as possible.

+
In-depth survey based on the situation at the time of the survey

Matters for which continuous awareness of issues has been identified

- The index in “Number of doctoral students with desirable competencies (Q105)" is the lowest and the index is declining among university natural science researchers.
- The index for "securing recurrent funding (Q202)" has declined particularly sharply since the 2021 survey.

Index (weather mark) of the 2023 survey for all university natural science researchers and list of index changes from the 2021 survey

Changes from the 2021 survey					
Stable (-0.3～＋0.3)		Q108 Number of female researchers Q111 Efforts to attract and retain outstanding foreign researchers Q204 Efforts to secure research time Q205 Developing or securing specialists in research management Q209 Progress in transforming research methodologies based on ICT technology Q301 Environment for exploring new themes and conducting challenging research Q304 Connecting R&D results to innovation Q403 Transferring academic knowledge to ventures Q404 Human resource mobility and exchange with the private sector Q410 Develop human resources with an entrepreneurial spirit	Q103 Expanding indefinite employment for young researchers Q104 Establishment of an environment for young researchers to pursue their studies abroad Q106 Environmental improvement for students to enter the doctoral program Q107 Diversifying career paths for PhD holders Q109 Support for female researchers to play an active role Q113 Treatment of researchers based on their assessment Q405 Management of intellectual property resulting from research and development Q604 Collaboration among different disciplines (when setting up research projects based on social issues) Q605 Collaboration among different disciplines (when conducting R&D based on social issues) Q613 Adequacy of the Japanese system for international joint research	Q101 Establishing an environment for young researchers to be independent and active Q110 Devising a human resources system to enable female researchers to play an active role Q211 Efforts to publish and share research data and results Q212 Utilization of publicly available and shared research data and results Q213 Diversification of methods for publishing research results Q401 Initiatives for organizational collaboration with the private sector Q402 Reflecting ideas into R&D through collaboration with the private sector Q407 Development of human resources that contribute to regional development Q602 Research activities co-created with diverse entities Q612 International collaboration in science and technology	Q601 Activities to promote public understanding for science, technology, and innovation Q603 Research activities that take into account social significance and value Q614 Researchers' awareness of risk factors associated with the internationalization of research activities Q615 Organizational efforts to address risk factors associated with the internationalization of research activities
Decline (-0.6～-0.3)	Q105 Number of doctoral students with desirable competencies	Q302 Diversity in basic research Q303 Internationally outstanding achievements in basic research Q306 Securing research funding for competent mid-level and above researchers Q307 Accessibility of government public research funding Q406 Securing funds to utilize the seeds generated by research and development	Q102 Number of young researchers independently conducting research and development Q203 Securing competitive funding Q206 Level of research facilities and equipment Q208 Accessibility of shared research facilities and equipment outside the organization Q305 Functions according to the role of the funding organization Q309 Diversification of perspectives for research project evaluation Q408 Research and innovation that contributes to regional revitalization Q409 Fostering R&D personnel in response to changes in society and industry	Q112 Introducing multi-faceted assessment of researchers Q201 Status of Research Infrastructure Q207 Mechanisms for sharing research facilities, equipment, and instruments within the organization Q308 Content and frequency of interim- and post-evaluations of government public research funding Q501Ability to collect and analyze information on the organization's education / research and management Q502 Efforts to promote self-improvement by making the most of the organization's individuality and characteristics Q503 Efforts to secure various financial resources	Q210 Going remote in research exchange, education, etc.
Significant Decline (～-0.6)		Q202 Securing recurrent funding			

Note: The index for university natural science researchers as a whole (weather symbol) is on the horizontal axis, and the index difference from the 2021 survey is on the vertical axis, and the stationary questions are arranged in a matrix.

Status of young students aspiring to become researchers

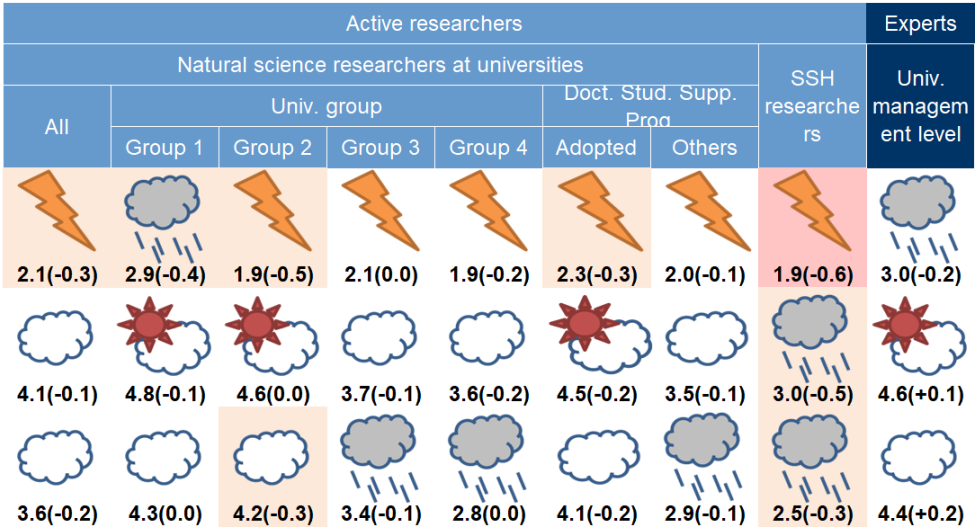
- The index for Q105 remains relatively low and has declined in many attributes. For Q106 and Q107, the index for Group 1 and 2 universities is relatively high.
- The index for those adopted to the doctoral student support program is high overall, but the difference for Q105 is small.

Young students aspiring to become researchers

Q105: Number of doctoral students with desirable competencies

Q106: Environmental improvement for students to enter the doctoral program

Q107: Diversifying career paths for PhD holders



Examples of reasons for increasing the degree of sufficiency	Example of reasons for lowering the degree of sufficiency
• Because financial support for doctoral students (including policy programs such as JST SPRING, as well as the university's own programs) has been enhanced (Q106).	• Fewer Japanese students are entering doctoral programs (Q105) • The fields of doctoral students are unevenly distributed (Q105) • I think that society as a whole needs to raise the value of the doctoral degree. D. degrees need to be more rigorously screened (Q105).

注3: "Adopted" in “Doctoral students support programs" refers to respondents belonging to universities that have been adopted by the Programs to support doctoral students.

Status of research resources

- **The indices for Q202, Q204, and Q205 are small, and the indices for many attributes have declined for Q201 to Q203.**

Research resources

Q201: Status of Research Infrastructure

※Research infrastructure: university libraries, access to research information such as academic papers, data platforms, research information networks

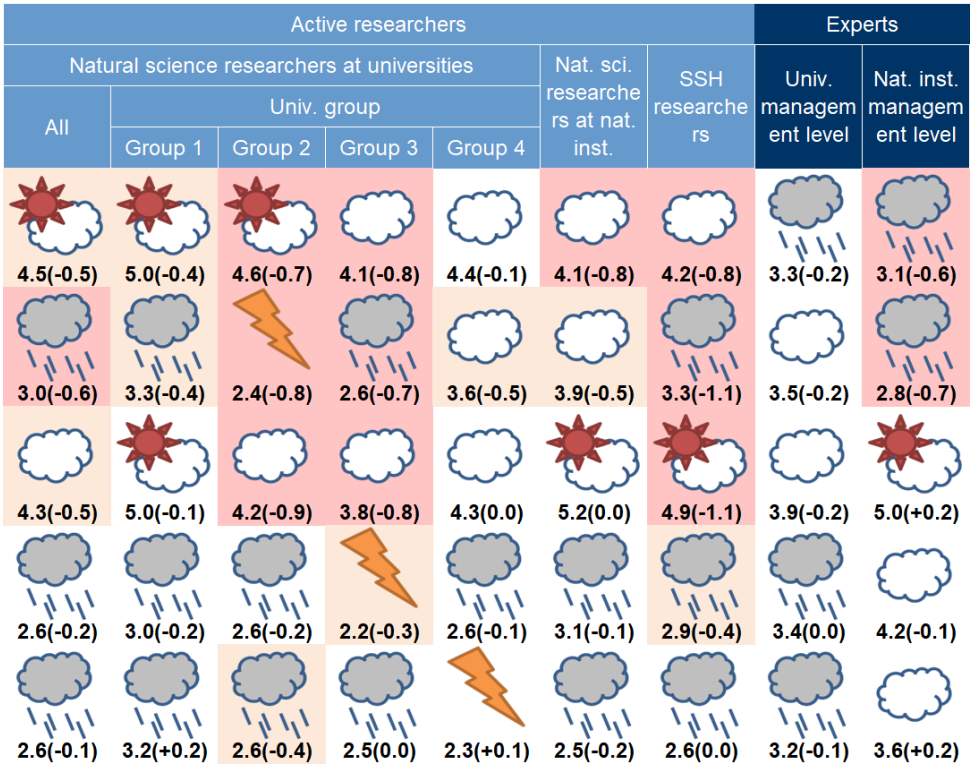
Q202: Securing recurrent funding

※Fundamental expenses: internal research expenses, etc.

Q203: Securing competitive funding

Q204: Efforts to secure research time

Q205: Developing or securing specialists in research management



Examples of reasons for increasing the degree of sufficiency	Example of reasons for lowering the degree of sufficiency
• Support by research administrators has been activated (Q205)	• Due to the depreciation of the yen and the rising cost of labor, utilities, and commodities, basic expenses are inadequate or are being substantially reduced (Q202) • University workload other than research is too much (Q204) • Administrative workload of researchers is increasing year by year (Q204)

Status of academic research and basic research

- **The index is low for all questions, and the index declines for many attributes. The perception that it is insufficient has not changed since the 2021 survey.**

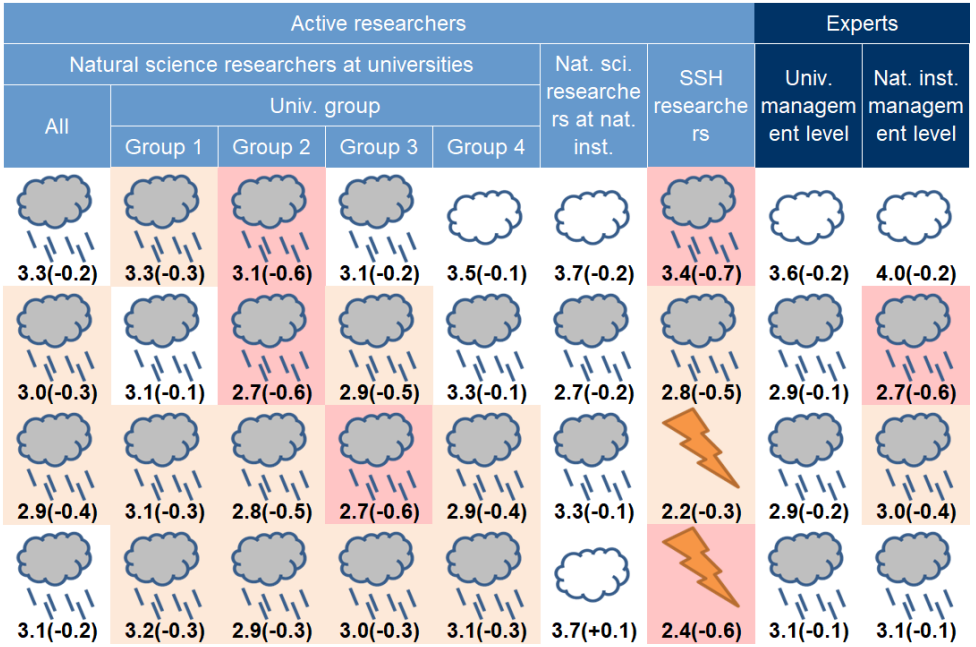
Academic research and basic research

Q301: Environment for exploring new themes and conducting challenging research

Q302: Diversity in basic research

Q303: Internationally outstanding achievements in basic research

Q304: Connecting R&D results to innovation



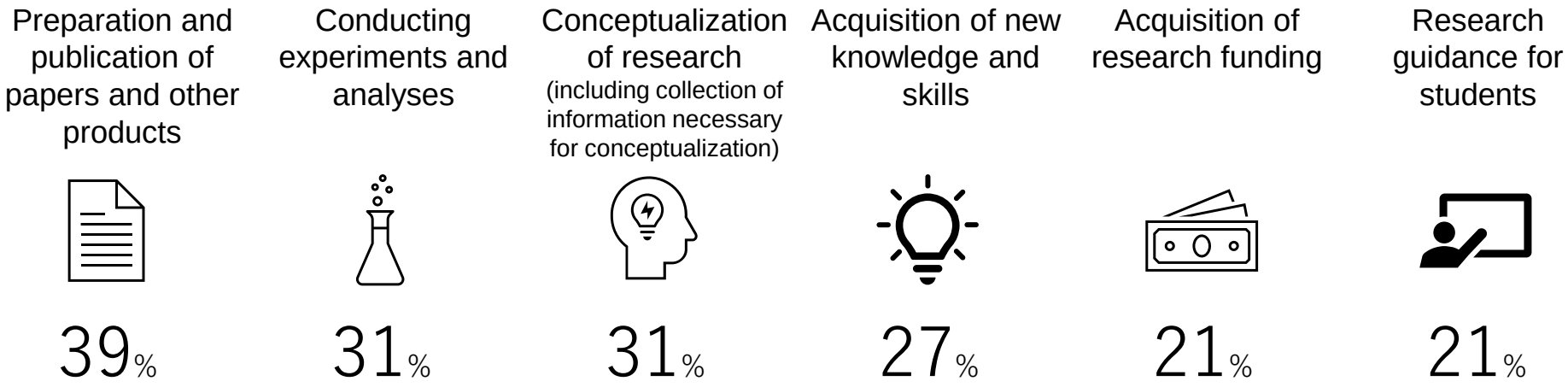
Examples of reasons for increasing the degree of sufficiency	Example of reasons for lowering the degree of sufficiency
• The diversity of basic research is being secured through the FOREST (Fusion Oriented REsearch for disruptive Science and Technology) program and the reform of the Grants-in-Aid for Scientific Research (Q302) • Progress in the satellite data application business is the result of the accumulation of past basic research (Q304)	• There is a bias toward non-exploratory, problem-solving research (Q301) • Research funds are concentrated on certain types of research, such as research groups and problem-solving research (Q302) • The relative presence of Japan is declining (Q303)

What do faculty members tend to sacrifice when research time is in short supply?

- **About 80% of university faculty members※ recognize that they spend less time on research than ideal. Accordingly, they perceived that activities such as "preparation and publication of papers and other products," "conducting experiments and analyses," and "conceptualization of research (including collection of information necessary for conceptualization)" were sacrificed as a priority among their research activities.**

  ※ Since the roles of universities are diverse and the characteristics of faculty members differ, we looked here at the differences from the respondents' ideals.

(Percentage of selections when asked to respond to up to two items that apply in particular)



Note 1: Results for all respondents in the natural sciences. The percentages are calculated as “the sum of the weights of respondents who selected the relevant item out of the nine options in either Answer 1 or 2” / "the sum of the weights of the respondents with that attribute”. The remaining three options other than the above are "recruiting laboratory members," "finding and conducting collaborative research with research partners," and "other”.

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Structure and Proposed Solutions to the Problem of "Research Time Availability"

Structure of the problem and proposed solutions regarding research time

Faculty perceptions of research time pressures identified through the survey

Note: Quantitative (areas with yellow background) and qualitative (areas with light blue background) findings of the in-depth survey are organized based on the analyst's subjective view.

Sacrifices in research activities
Top issues that had to be sacrificed in research activities

Tendency to give priority to activities that are within one's discretion and that require more time and thought

- Preparation and publication of papers and other products
- Conducting experiments and analyses
- Conceptualization of research
- Acquisition of new knowledge and skills
- Acquisition of research funding
- Research guidance for students

Top factors limiting research time

- Meetings and work for organizational management
- Preparation and implementation of lectures and practical training
- University admissions
- Administrative procedures
- Application for research funding
- Student support other than lectures

Reduction of "meetings and tasks for organizational management" is recognized by more than 70% of management-level employees.
Perceived as being implemented by over 70% of respondents

Discrepancy

The structure of the problem identified through the survey

Issues specific to competitive research funds

- Low selection/fulfillment rate and volume of applications
- Inconsistency of rules and regulations among programs

Changes in the external environment

- Reduction of basic expenses Reduction
- Weaker yen and higher prices
- Diversification of university functions Diversification measures
- Declining birthrate
- Response to research misconduct, etc. Response to research misconduct, etc.

Changes in the internal environment

- Insufficient financial resources
- Reorganization Diversification of operations
- Diversification of admissions
- Diversification of students Diversification

Position cuts → Shortage of human resources

Research budget cuts → Increase in applications for competitive research funding

Inhibiting factor

Loss of opportunity at the time of non-adoption, burden of evaluation at the time of adoption

Necessity of various types of care

Increase in faculty workload

Development of local rules

Inconsistency of organizational priorities

Top initiatives not implemented by the organization

- Efforts to enable faculty members who have obtained research funding to concentrate on their research
- Reduction and equalization of university admissions burden
- Simplification of administrative procedures

Example of Solution

Faculty level

- AI-based Automation
- Reduction of work, Proposals to improve efficiency

Institutional level

- Expansion of professional personnel in administration, support, and management
- Establishment of admissions and student affairs organizations
- Clarification and streamlining of rules
- Consensus building on the importance of research

Policy level

- Expansion of basic expenses
- Unify rules for competitive research funding
- Change in management policy to avoid errors
- Shift from inter-university competition to collaboration

Understanding of the research process

Laboratory Panel Survey

- **Goals of the Laboratory Panel Survey**
  - Construct a data set to enable analysis of the process of research activities and the factors that impact them.
  - Conduct such analyses and give related bodies helpful information (e.g., to increase "research capabilities" from their perspectives).
- **Survey respondents**
  - University faculty members (more than 2,000 out of 3,601)
- **Structure of the questionnaire**
  - Information of the respondents and their laboratories; research management activities; and research project(s).

Part 1: Information about the faculty member and laboratory
Basic information about the respondent
Basic information about the laboratory to which the respondent belongs
The respondent's authority and experience in research activities
The respondent's work activities
What the respondent personally values when conducting research

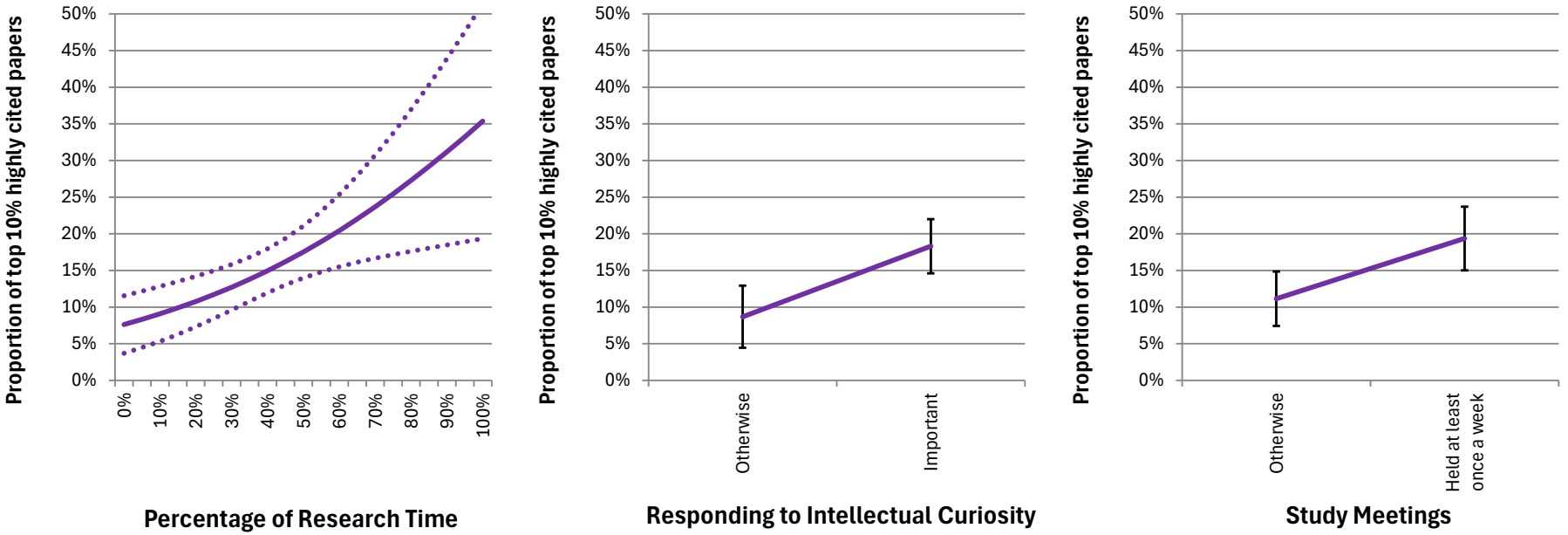
Part 2: Status of the laboratory and research management
Number of members of the laboratory
Research and development expenditure of the laboratory
Management of the laboratory
Communication in the laboratory
Use of literature resources within the laboratory
Use of digital data and tools within the laboratory
Communication with other laboratories

Part 3: Details of the research projects carried out in the laboratory
Research portfolio of the laboratory
Basic information about the research project
Research and development costs used in the research project
Purpose of the research project
Role of the respondent in the research project
Details of members of the laboratory involved in the research project
Decision-making in the conduct of the research project
Details of external collaborators involved in the research project
Use of external research equipment, facilities and analytical services
Papers produced as a result of the research project
Patent applications produced as a result of the research project
Other results produced as a result of the research project

Critical factors for producing highly-cited papers

- **Results summary on top 10% highly-cited paper production**
  - "Science, Engineering, and Agriculture" has more significant items than "Health sciences".
  - The "Total R&D budget for the Laboratory" and "Percentage of Research Time" are both significant and positive.
  - "Responding to Intellectual Curiosity" and "Study Meetings" (positive) and "Securing a Stable Job" and "Master's/Undergraduate Students Participation" (negative) are significant in natural sciences.

Results of logistic regression analysis using the presence or absence of a top 10% paper as the dependent variable (Natural sciences).



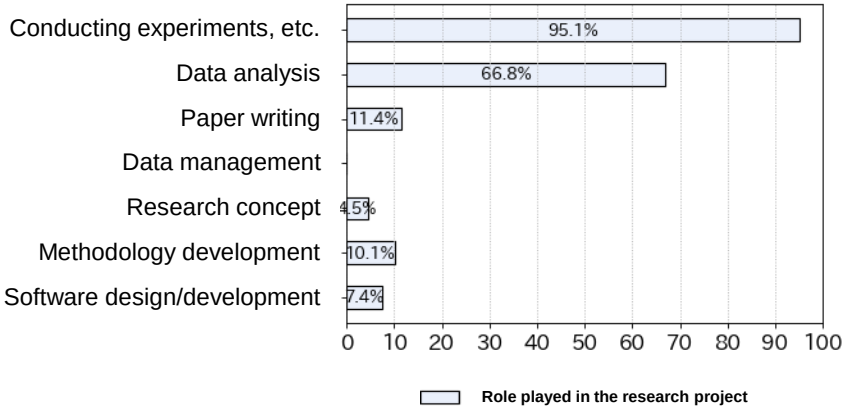
Note 1: A logistic regression analysis was conducted on faculty members whose main papers (up to three) produced by their research projects were included in Scopus. The analysis used the production of top 10% highly-cited papers as the dependent variable. Dotted lines show 95% confidence intervals.

What kind of experiences are students gaining through research projects?

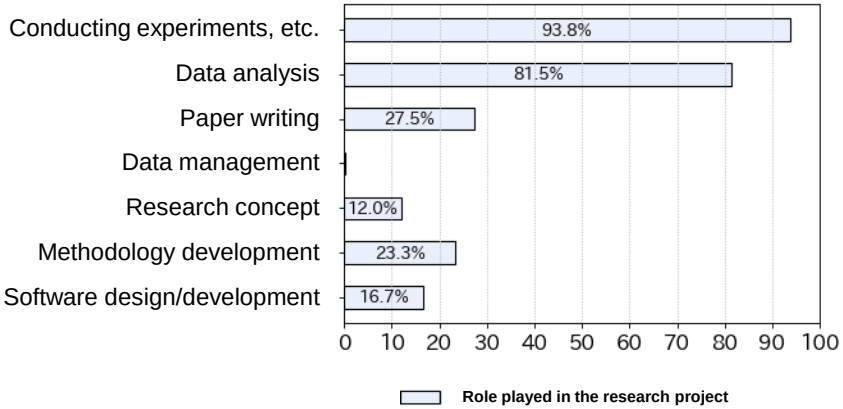
- As students advance through higher education, their roles in research projects expand, and they gain diverse experiences through the implementation of these projects.

Experiences gained through research projects

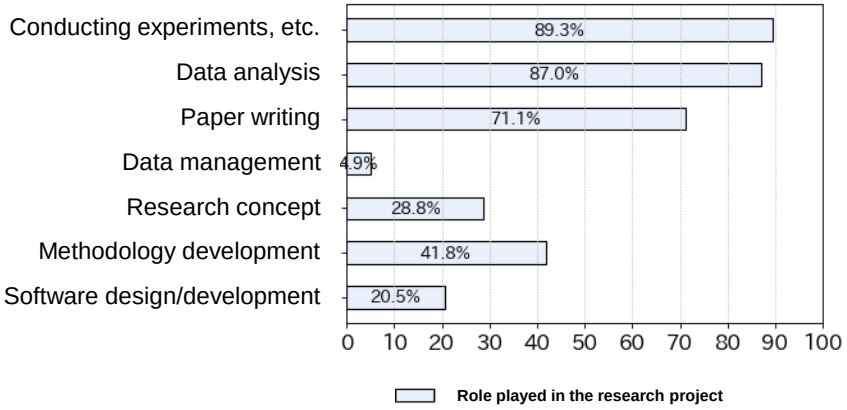
(a) Undergraduate students



(b) Master's students



(c) Doctoral students



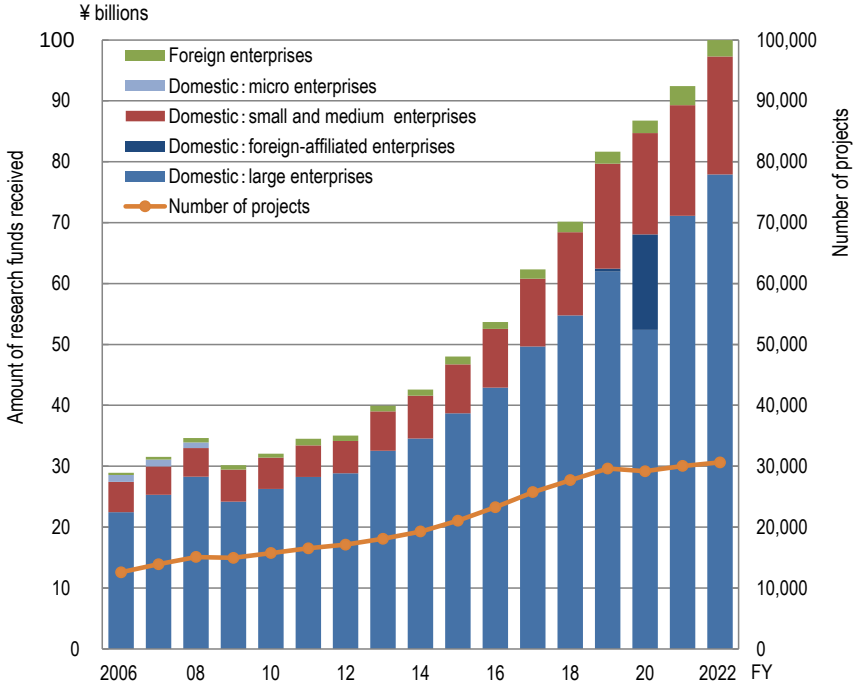
Note 1: Aggregated using valid responses to the relevant RS questions (results from surveys conducted between FY2020 and FY2023), based on population estimation.

Changes in research activities

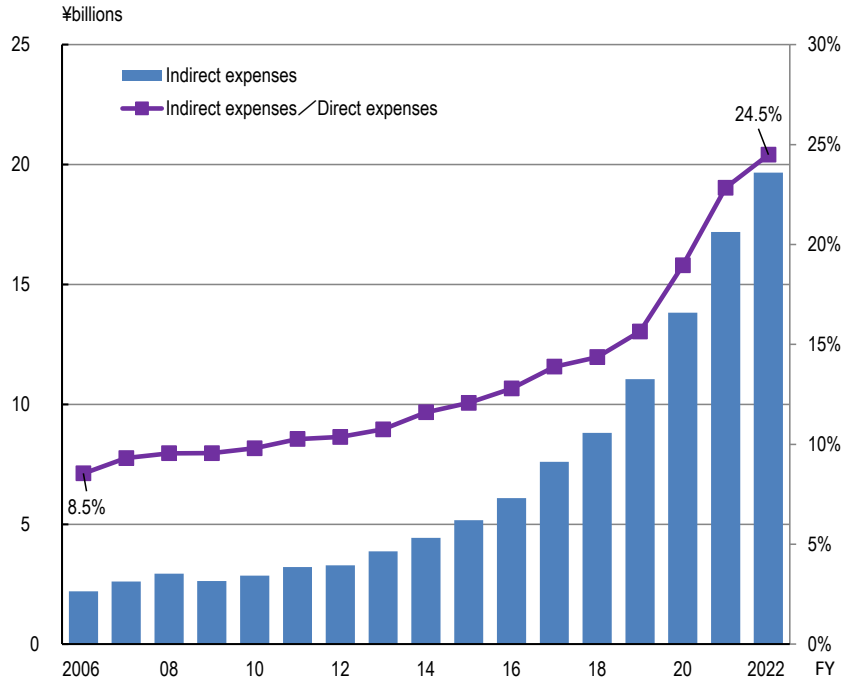
Changes in funding and project numbers for joint research between universities and private enterprises in Japan

- **The amount of "joint research" between Japanese universities and private enterprises has continuously increased, reaching 100 billion yen in FY2022.**

【Trends in the amount of funds received and number of projects implemented for joint research】



【Trends in indirect costs for joint research】

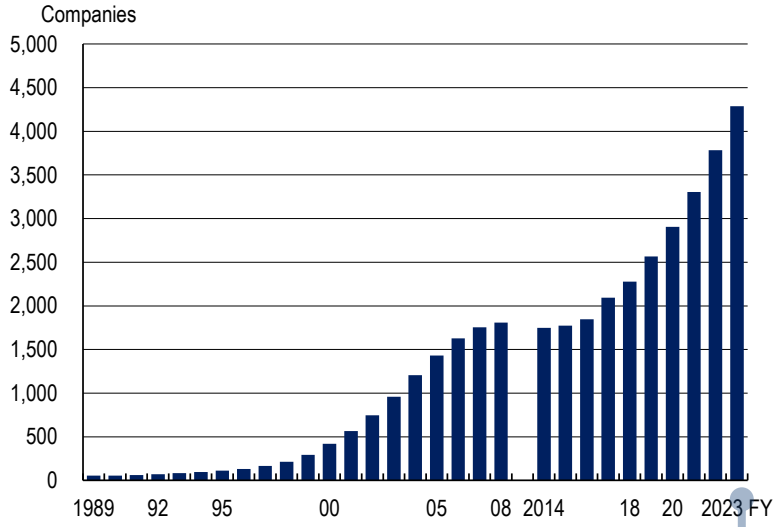


Note：
1) Joint research: Joint research and development by institutions and private business, etc., in which the other party bears the expenses. Until FY2008, the amount of funding and the number of projects were classified according to the size of the enterprises - small and medium, micro and large enterprises.。
2) Regarding the breakdown of domestic enterprises, data have been available for large enterprises, small and medium enterprises, and micro enterprises from 2006. However, data of micro enterprises was provided only up to FY2008, and data of foreign-affiliated enterprises only in FY2019 and FY2020.
3) Direct expenses are those expenses that are directly required for the joint research, and indirect expenses are those expenses for promoting industry-academia collaboration, expenses other than direct expenses, and administrative expenses.
Retabulation by NISTEP using the individual data of the "Status of Industry-Academic Collaboration at Universities, etc. (obtained on February 28, 2024)" published by the Ministry of Education, Culture, Sports, Science and Technology.

The status of university-launched venture companies

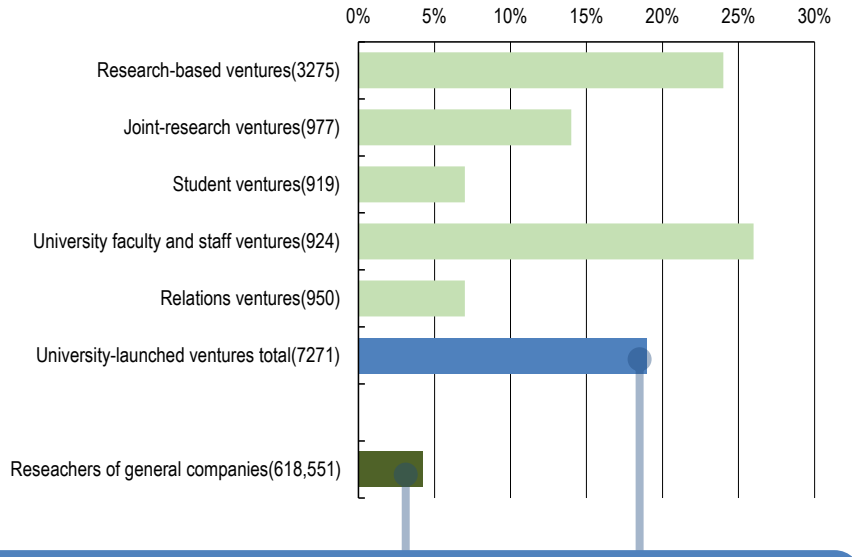
- **PhD holders account for a large percentage of employees in Japan's university-launched venture companies.**

【Changes in the number of university-launched venture companies】



- **The number of university-launched venture companies in Japan is steadily increasing, with 4,288 companies (cumulative value) in FY2023.**

【Percentage of PhD holders among the employees by venture category (FY2023 survey) 】



- **PhD holders account for 19% of employees in university-launched venture companies, which is substantially higher compared to the percentage of PhD holders among researchers in general companies (4%).**

Note:
1)Right Chart is sourced from the Survey on University-Developed Venture Businesses (2024), showing the results of the survey of university-launched venture companies identified in the "Survey on the Establishment of University-Developed Venture Businesses (2024)," of which contact information was available (682/4,288 cases were collected, for a response rate of 15.9%).
2)Figures in parentheses ( ) are the number of employees, and the number of researchers for the figure of "researchers of general companies." Technology-transfer ventures are not listed due to the small number of employees.
Source：
Left Chart ：METI, "Survey on the Establishment of University-Developed Venture Businesses (2024)"
Right Chart ：METI, ″Survey on University-Developed Venture Businesses (2024)," General companies：Ministry of Internal Affairs and Communications, ″Report on the Survey of Research and Development″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Summary

Japan's situation as seen from NISTEP analysis

(Macro Status of Research Activities in Japan)

- Due to the increase in the number of papers in other countries/regions, Japan's ranking has declined in relative terms. In terms of the number of highly-cited papers (Top 10% highly cited papers), the decline in ranking is remarkable.
- Growth in the number of Japanese researchers and R&D expenditures at universities, which is small compared to other major countries.
- Compared to FY2003 (when enrollment peaked), the number of enrollments in graduate doctoral programs in Japan has declined.
- Over the past twenty years, the presence of China and Global South countries has increased alongside G7 and OECD countries in the production and exchange of scientific knowledge, leading to a shift in the meaning of highly cited papers.

(Role of mid-tier universities in terms of paper production)

- Universities in the U.K. and Germany have formed a thicker layer of universities following the top ranks than in Japan.
- Japan also has a number of universities with strengths in specific fields among small and medium-sized universities in terms of the number of papers.

(Analysis using long-term input-output macro data)

- Factors contributing to the stagnation of the number of papers (in science, engineering, and agriculture at all universities) in Japan.
  - Decline in the percentage of faculty time spent on (mid-2000s to around 2010).
  - Decrease in the number of students enrolled in doctoral programs (since around 2010)
  - Decrease in the amount of expenditures directly related to the implementation of research, such as the cost of raw materials (since 2010)

Japan's situation as seen from NISTEP analysis, continued

(Changes in global research trends)

- Scientific research continues to expand: Number of hot research areas increased by 54% from Science Map 2002 to 2020 (from 598 to 919 areas)
- Japan has a small percentage of participation in research areas that have the potential to become the seeds of new research (small island type).

(Awareness of researchers and experts on the research environment)

- Continued strict perceptions regarding the number of doctoral students with desirable competencies, securing recurrent funding, efforts to secure research time, status of academic research and basic research, etc.
- Positive references continued to be made to JST SPRING, which supports doctoral students, and JST's FOREST (Fusion Oriented REsearch for disruptive Science and Technology) program, particularly regarding research time and the state of academic and basic research. Additionally, unique efforts by universities were also positively highlighted.
- About 80% of university faculty members feel that they have less time for research than ideal, and tend to sacrifice activities that require more coherent time and deeper thinking, such as preparing and publishing papers and other results, conducting experiments and analysis, etc.

Japan's situation as seen from NISTEP analysis, continued

(Understanding the research process)

- When focusing on the production of highly-cited papers, the following may be important.
  - R&D expenditures and research time
  - An environment that allows research to be conducted while emphasizing intellectual curiosity
  - Sharing the latest knowledge and enhancing the research capabilities of team members
- These results suggest that it is important to "focus on the environmental aspects that serve as the source when considering policies and other measures aimed at producing Top 10% papers.
- Students play an expanding role in research projects as they move up the ladder of higher education.

(Changes in research activities)

- The number of industry-academia collaborations and university-launched ventures has increased significantly over the past 20 years.

Why reconsider research capabilities now?

- Perhaps it is time to reconsider research capabilities and “foundation for maturing research capabilities” for the future.
- To achieve this, it is necessary to improve and transform the dialogue, awareness and behavior of researchers, URA professionals, FA professionals, analysts and policy makers.
- NISTEP is doing its best, but there are limits to what we can do on our own, and we need your cooperation and help.

Changes in the environment surrounding scientific research	Changes in the meaning of highly-cited papers
Development towards responsible research assessment (RRA), acceleration of open science	Increasing presence of China and the global south countries. The meaning of “highly-cited papers” has changed compared to the past.
The need for multidimensional indicators	**The need for an understanding of the research process**
Diversification of research activities.	Analysis that provides hints for guiding future actions

Changes in the environment surrounding scientific research

- Starting with the DORA in 2012 and the Leiden Manifesto in 2015, there has been a rapid acceleration in the revision of research evaluation, the development of Responsible Research Assessment (RRA), and the promotion of open science.

(The Leiden Manifesto for research metrics)

1. Quantitative evaluation should support qualitative, expert assessment.
2. Measure performance against the research missions of the institution, group or researcher.
3. Protect excellence in locally relevant research.
4. Keep data collection and analytical processes open, transparent and simple.
5. Allow those evaluated to verify data and analysis.
6. Account for variation by field in publication and citation practices.
7. Base assessment of individual researchers on a qualitative judgement of their portfolio.
8. Avoid misplaced concreteness and false precision.
9. Recognize the systemic effects of assessment and indicators.
10. Scrutinize indicators regularly and update them.

(Source) Hicks, D., Wouters, P., Waltman, L., de Rijcke, S. and Rafols, I. The Leiden Manifesto for research metrics. Nature, 2015, 520(7548), 429-431 (23 April 2015)