

International Appraisal of Japanese Research Results (Research Papers) — Increase of "First-class Papers" Produced in Japan —

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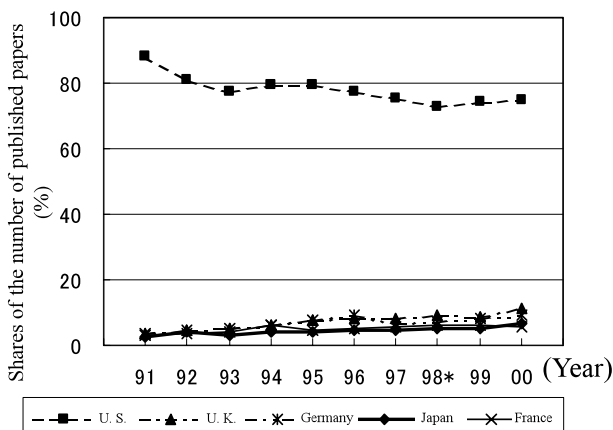
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8.1 Introduction

Dr. Ryoji Noyori, professor of the Graduate School of Science of Nagoya University, was awarded the Nobel Prize in Chemistry for 2001. In addition, Dr. Hideki Shirakawa, professor emeritus of Tsukuba University (now a member of the Council for Science and Technology Policy) was awarded the Nobel Prize in Chemistry for 2000. It is possible to say that the fact that two Japanese scientists have won the Nobel Prize for two consecutive years is evidence that scientific research activities in Japan have produced excellent results.

Based on this background, we analyzed the international appraisal of Japanese research papers using "shares of research papers in first-class journals" and "the number of times cited," etc. in this report.

Figure 1: Shares of research papers printed in "Science"



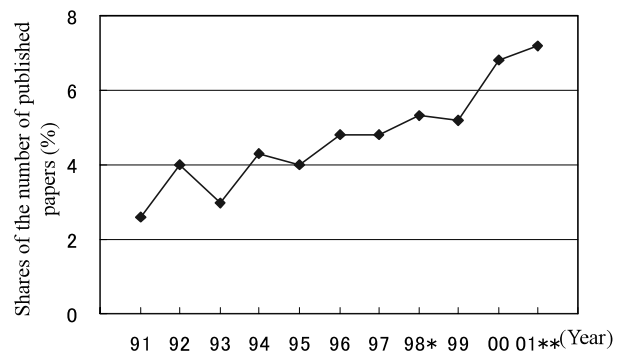
Note: — The subject papers are "Research Articles," "Reports," and "Reviews".
— For 1998, data for 11 months from January to November are aggregated.
— Legends are shown in the order of shares in 2000.

8.2 Production of research papers in the overall fields of natural science and engineering in Japan

The shares of research papers printed in "Science" among major advanced countries are shown in Figure 1, and the same shares limited to only Japanese research papers are shown in Figure 2. In addition, the shares of research papers printed in "Nature" among major advanced countries are shown in Figure 3, and the same shares limited to only Japanese research papers are shown in Figure 4.

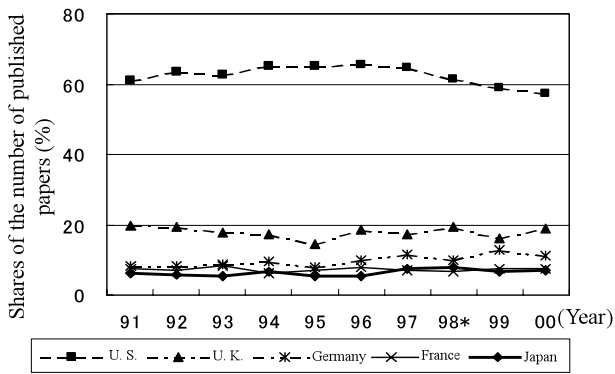
"Nationalities" of the respective research papers are judged by the addresses of institutes the respective authors belong to. If the addresses of institutes of coauthors number more than one, the nationality of that paper is counted twice. For instance, if a research paper is written by three authors, and one author belongs to an institute in

Figure 2: Shares of Japanese research papers printed in "Science"



Note: — The subject papers are the same as Figure 1.
— For 2001, data for 6 months from January to June are aggregated.
— Legends are shown in the order of shares in 2000.

Figure 3: Shares of research papers printed in "Nature"



Japan and the remaining two authors belong to institutes in the U. S., the paper is counted once for Japan and the same paper is counted once for the U. S.

Data for the period from 1991 to 2000 are aggregated from the SCI database, while data of 2001 shown in Figure 2 and 4 are aggregated from "Science" and "Nature" independently.

Since 1991, the shares of Japanese research papers printed in "Science" and "Nature" have tended to increase, and, in particular, increased more in these few years.

The shares of research papers of major advanced countries, among journals recorded in the SCI database covering all fields of natural science and engineering, are shown in Figure 5.

Since 1991, the shares of Japanese research papers among journals in the fields of natural science and engineering have increased gradually to around 10%. It may be possible to infer that the increase of shares of Japanese papers in "Science" and "Nature" as mentioned above are approaching to the level of these shares.

Figure 5: Transition of shares of the number of published papers of major advanced

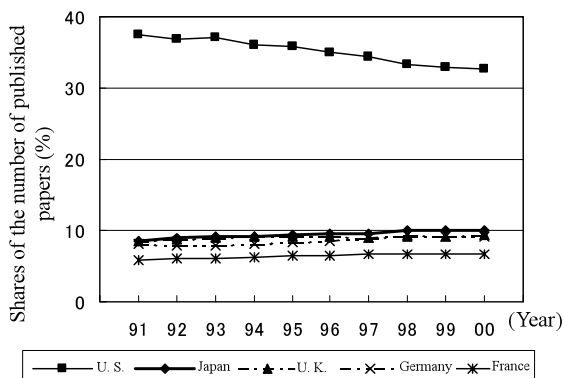
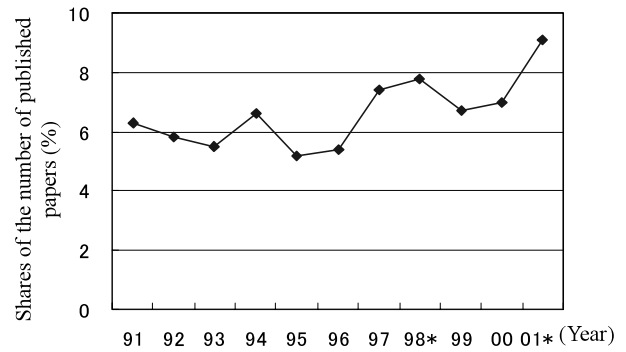


Figure 4: Shares of Japanese research papers printed in "Nature"



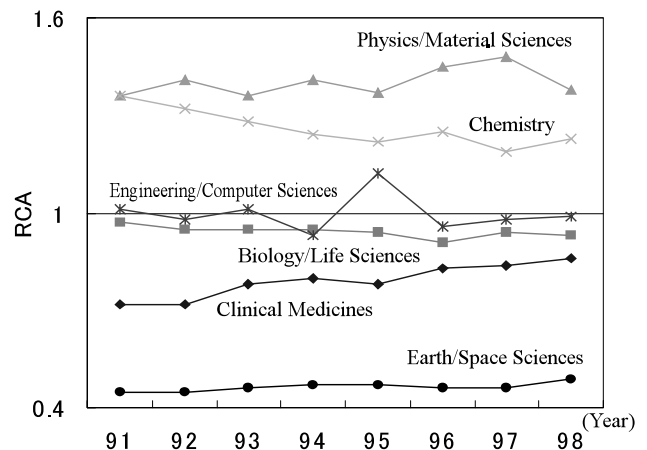
Note: — The subject papers are the same as Figure 3.
 — For 2001, data for 6 months from January to June are aggregated.
 — Legends are shown in the order of shares in 2000.

8.3 Production of research papers by field in Japan

The RCA (Relative Comparative Advantage) by field in Japan is shown in Figure 6.

The RCA is a value calculated by dividing the ratio of the number of research papers for a certain field in a certain county to the total number of research papers for the entire field of natural science and engineering, by the ratio of the number of research papers for the certain field throughout the world. For instance, the ratios of the clinical medicine field in 1997 are 22.2% for Japan and 26.4% for all over the world, respectively. The RCA of this field in Japan will be $22.2\% \div 26.4\% = 0.841$. Fields of which RCA exceeds 1 can be considered as fields that Japan

Figure 6: RCA by field in Japan



Source: National Institute of Science and Technology Policy aggregated figures on the basis of the NSI database (Deluxe, 1981 - 1998) Science and Technology Indicator (FY 2001), National Institute of Science and Technology Policy

takes great interest in.

In Japan, the RCAs in the fields of Physics/Material Sciences and Chemistry are high, while the same in the fields of Earth/Space Sciences, Clinical Medicines and Biology/Life Sciences are low.

8.4 Ranking of institutes by field according to the number of times cited

As a result of investigation executed by ISI, the ranking of institutes according to the number of times cited for the period from 1991 to 2000 in 19 fields; namely, Biology/Biotechnology, Microbiology, Molecular Biology, Genetics, Immunology, Neuroscience, Clinical Medicine, Pharmacy, Zoology and Botany, Agriculture, Computer Science, Environment, Material Science, Engineering, Earth Science, Space Science, Physics, Mathematics, Chemistry and Psychology, Japanese institutes have been ranked within the top 5 in 4 fields; namely, Biology/Biotechnology, Material Science, Physics and Chemistry (Table 1).

Among these 4 fields, RCAs of the fields of Material Science, Physics and Chemistry in Japan are high. Japan takes great interest in these fields, and there are world-leading institutes in Japan.

8.5 Tendency of research papers related to nanotechnology

In the previous chapter, we outlined institutes producing many research papers cited in the respective existing fields. However, many of the most advance research themes are progressing in boundary fields or merged fields, which cannot be categorized into the existing research fields, and thus it is difficult to analyze the tendency of cited research papers using ordinary methods.

In this chapter, we outline the tendency of cited research papers related to nanotechnology, being spotlighted recently in Japan and overseas, based on the data aggregated by ISI individually.

ISI had extracted 32,605 papers including the word "nano" in their titles or keywords described by the authors from all research papers published in the term from 1991 to 2000 registered in the SCI database, and provided a ranking of journals according to the number of times cited as shown in Table 2.

According to Table 2, we can observe that journals in the fields of Physics, Chemistry and Material Science are ranked within the top 10, except for "Science" and "Nature" covering overall natural science in general.

In the same way, the rankings of nations, institutes

Table 1: Ranking of institutes according to the number of times cited

(1) Biology / Biotechnology

Rank	Institute	No. of times cited	No. of research papers
1	Harvard University (USA)	184,786	7,325
2	University of Texas (USA)	149,017	8,009
3	UCSF (USA)	93,710	3,952
4	University of Tokyo (Japan)	79,673	5,571
5	NCI (USA)	72,923	2,966

(2) Material Science

Rank	Institute	No. of times cited	No. of research papers
1	Tohoku University (Japan)	13,889	3,231
2	IBM (USA)	13,160	1,369
3	UCSB (USA)	12,001	871
4	MIT (USA)	11,723	1,506
5	University of Illinois (USA)	9,826	1,328

(3) Physics

Rank	Institute	No. of times cited	No. of research papers
1	AT&T (USA)	98,264	4,921
2	University of Tokyo (Japan)	92,058	10,920
3	IBM (USA)	87,982	4,649
4	MIT (USA)	86,292	6,462
5	CERN (Switzerland)	85,319	5,937

(4) Chemistry

Rank	Institute	No. of times cited	No. of research papers
1	UC Berkeley (USA)	57,039	3,846
2	Kyoto University (Japan)	56,981	7,215
3	University of Tokyo (Japan)	56,860	6,781
4	University of Texas (USA)	50,919	4,052
5	University of Cambridge (UK)	48,634	4,287

Source: Science Watch Vol.12, No.4 July / August 2001, ISI

Table 2: Journals ranking of nanotechnology

Rank	Journal	No. of times cited	No. of research papers
1	SCIENCE	13,341	237
2	APPLIED PHYSICS LETTERS	12,586	1,132
3	NATURE	11,312	192
4	PHYSICAL REVIEW B	9,525	820
5	PHYSICAL REVIEW LETTERS	8,023	424
6	JOURNAL OF PHYSICAL CHEMISTRY	6,422	182
7	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	5,582	270
8	JOURNAL OF APPLIED PHYSICS	5,415	825
9	CHEMISTRY OF MATERIALS	5,392	405
10	NANOSTRUCTURED MATERIALS	4,893	1,099

Source: Essential Science Indicators of "Nanotechnology," ISI, October 2001

and authors are shown in Table 3.

Japan is ranked within the top 10 of nations, institutes and authors, respectively.

8.6 Conclusion

The shares of Japanese research papers among all papers printed in "Science" and "Nature" have tended to increase, and we can observe that the number of international-class research results is increasing in Japan. Of course, it is not enough to only analyze the shares in both magazines for appraising our research results. However, the shares by nation must be considered remarkable indicators for appraising our research results, since both magazines cover overall natural science in general and are recognized as first-class magazines internationally.

If we look at nanotechnology, Japan has produced research papers watched all over the world for these 10 years. Although it was previously difficult to analyze the tendency of research papers in interdisciplinary fields using databases constructed in accordance with the ordinary concept of research fields, we can now speculate on the international appraisal of our research papers in interdisciplinary fields (Bioinformatics or System biology, etc.) by applying the method used by ISI.

Table 3: Rankings of nations, institutes and authors of nanotechnology

(1) Ranking of nations

Rank	Nations	No. of times cited	No. of research papers
1	The U. S.	92,108	9,993
2	Japan	26,267	4,251
3	Germany	20,673	3,579
4	France	17,168	2,673
5	The U. K.	9,466	1,415
6	Switzerland	8,233	792
7	China	7,653	3,168
8	Canada	5,707	754
9	Spain	5,131	874
10	The Netherlands	4,767	514

(2) Ranking of institutes

Rank	Institute	No. of times cited	No. of research papers
1	UC Berkeley (USA)	6,591	393
2	MIT (USA)	5,370	366
3	Rice University (USA)	4,329	156
4	IBM (USA)	4,305	282
5	NEC (Japan)	4,016	140
6	Harvard University (USA)	3,278	155
7	Tohoku University (Japan)	3,244	485
8	University of Illinois (USA)	3,093	289
9	Ecole Polytech Fed Lausanne (Switzerland)	3,092	212
10	US Navy (USA)	3,045	302

(3) Ranking of authors

Rank	Authors	No. of times cited	No. of research papers
1	Smalley RE, Rice University (USA)	3,816	78
2	Alivisatos AP, UC Berkeley (USA)	3,084	97
3	Ajayan PM, NEC (Japan)	2,659	63
4	Ebbesen TW, NEC (Japan)	2,424	36
5	Thess A, Rice University (USA)	2,213	23
6	Gratzel M, Ecole Polytech Fed Lausanne (Switzerland)	1,980	79
7	Sumio Iijima, NEC (Japan)	1,959	75
8	Rinzler AG, Rice University (USA)	1,937	36
9	Dai HJ, Rice University (USA)	1,851	31
10	Akihisa Inoue, Tohoku University (Japan)	1,719	184

Source: Report of ISI / Thomson Scientific (October 2001) Essential Science Indicators of "Nanotechnology"