

## C 6 SCIENTIFIC PUBLICATIONS AND PERFORMANCE

### Overview

For many years, the importance of “knowledge” has been discussed as a factor for successful economic development. A knowledge lead can often prove to be a decisive comparative advantage in fierce international competition. Developing this knowledge lead is one of the primary objectives of science. In a macroeconomic context, training qualified specialists and establishing a sound scientific base for future technological developments is among the key tasks of science.

The importance attached to “knowledge” as a production factor is indicated by the fact that it is now usual to include the scientific capability when evaluating the technological capability of a country. The focus is not on the direct economic benefit, but the longer-term orientation towards further technological developments.

However, it is difficult to measure the performance of science, because the structures and scientific backgrounds in various disciplines are very different. In most cases, scientific publications are used as an indicator of research performance, but they only reflect the formal aspect of scientific communication. The differences between disciplines can lead to misinterpretations, so that a careful methodology is necessary. Bibliometry (the analysis of scientific publications) can draw on decades of experience gained by various international research groups.

The numbers of scientific publications is only a first indicator of performance, but it says little about the quality of the contributions. In order to include qualitative aspects, it is also usual to analyse citations, which reflect the scientific impact, i.e. the perception of a publication by the scientific community. In particular when investigating citations it is essential to meet strict methodological requirements. The following section draws on the results of a study<sup>193</sup> of leading international journals and covers natural sciences, engineering, medicine, and life sciences. Humanities and social sciences were not included.

### Investigated indicators:

- Shares of selected countries and regions in all publications in the *Science Citation Index* (SCI)
- International Alignment (IA) of selected countries and regions for SCI publications
- Journal-specific scientific regard (SR) of selected countries and regions for SCI publications

## SHARES OF SELECTED COUNTRIES AND REGIONS FOR ALL SCI PUBLICATIONS

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Country/Region	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USA	34.3	33.7	32.9	32.3	31.9	32.1	31.9	31.7	31.4	30.8	30.5	29.9	28.3
Japan	9.5	9.5	10.0	10.2	10.2	10.2	10.1	10.0	9.4	9.0	8.5	8.2	7.5
Germany	8.2	8.6	9.0	9.0	9.0	9.0	8.8	8.7	8.4	8.4	8.2	8.0	7.7
Great Britain	9.6	9.3	9.4	9.3	9.4	9.1	8.8	8.6	8.4	8.2	8.1	8.1	7.5
France	6.4	6.6	6.7	6.7	6.6	6.6	6.4	6.4	6.1	6.0	5.9	5.8	5.8
Switzerland	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.0	1.9
Canada	4.7	4.4	4.3	4.3	4.3	4.1	4.2	4.3	4.8	4.4	4.5	4.6	4.4
Sweden	2.1	2.1	2.1	2.1	2.0	2.1	2.1	2.0	2.6	1.9	1.8	1.8	1.7
Italy	4.2	4.2	4.3	4.4	4.4	4.6	4.7	4.8	0.9	4.7	4.7	4.9	4.8
Netherlands	2.6	2.7	2.6	2.5	2.5	2.5	2.5	2.5	2.8	2.6	2.6	2.5	2.5
Korea	–	–	–	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.1	2.9	3.3
China	–	–	–	–	–	–	5.2	5.8	3.5	7.6	8.6	9.3	9.9
EU-15	–	–	–	40.9	40.7	40.6	39.9	39.4	42.0	38.8	38.4	38.0	36.8
EU-12	–	–	–	–	–	–	3.4	3.4	3.5	3.5	3.5	3.5	4.1
EU-27	–	–	–	–	–	–	42.4	41.9	41.3	40.9	40.9	40.4	40.1
<b>World</b>	<b>100</b>												

Source: SCI. Research by the University of Leiden (CWTS). Calculations by Fraunhofer ISI.

The bibliometric analyses draw on the database of the Science Citation Index (SCI). The shares of countries are considered, and not absolute numbers, in order to allow for changes to the journal covered by the database.

### Increased presence of Asian authors in the SCI reduces shares of major industrialised countries

Since 2001 there has been a steady decline in the share of publications from Germany, the USA, Japan, Great Britain, and France. British and Japanese scientists are affected by this trend more than German scientists. In contrast, authors from Canada, Italy and the Netherlands have at least been able to maintain their positions. The falling shares of many countries are due to the increasing significance of China, and to a lesser extent of South Korea. But India, Russia, and Brazil are also catching up.<sup>194</sup> Since the SCI index only covers a limited number of journals, the increase in the share of publications from such countries necessarily reduces the shares of publications from the established countries. In the 1980s, the emerging economies had a share of 7.4 percent of all SCI publications. In 2007, one in four SCI publications had at least one author from an emerging country. The examination of regions shows a gradual decrease in the share of publications from the EU-15 member countries. The publication share of the new EU member states (EU-12) is showing a slight upward trend, though from a relatively low level. The new EU member states are therefore much less dynamic than South Korea and China. The following sections show the qualitative evaluation of publications in terms of international alignment and journal specific scientific regard.

## C 6-2 INTERNATIONAL ALIGNMENT (IA) OF SELECTED COUNTRIES AND REGIONS FOR PUBLICATIONS IN THE SCIENCE CITATION INDEX

Country/Region	1998	1999	2000	2001	2002	2003	2004	2005	2006
USA	36	36	34	33	33	32	32	31	30
Japan	-14	-14	-18	-11	-11	-10	-6	-7	-6
Germany	3	5	7	6	8	9	11	13	16
Great Britain	10	12	15	15	19	19	20	21	21
France	2	0	3	4	5	3	5	7	7
Switzerland	29	30	29	28	28	27	30	31	29
Canada	11	13	11	16	14	15	15	14	16
Sweden	8	8	11	12	11	15	15	16	18
Italy	1	2	1	-1	-1	3	3	7	7
Netherlands	14	21	20	19	21	24	26	27	28
Finland	-	8	10	6	8	9	8	9	8
Korea	-	-45	-38	-38	-37	-34	-32	-30	-29
China	-	-	-	-	-56	-47	-45	-42	-37
EU-15	-	1	3	2	4	5	6	8	8
EU-12	-	-	-	-	-38	-36	-38	-36	-32
EU-27	-	-	-	-	1	2	3	4	5

Source: SCI, Research by the University of Leiden (CWTS). Calculations by Fraunhofer ISI.

The IA Index<sup>195</sup> shows whether the authors of a country publish in internationally visible or in less visible journals, compared with the world average. A positive IA value is above average. Self-citations are not included.

### Increased international alignment of publication activity in almost all the countries investigated

The steady increase in IA values for German authors indicates an increasing international alignment. However, most of the selected countries also showed an increased IA. Here the career motives of authors have to be taken into consideration, because successful international publication activity is associated with high citation rates, and these are often regarded as an important evaluation criterion for research performance. American journals often have a dominant position internationally, and this gives American scientists an advantage, which is reflected in high IA values. Comparably high values are achieved by Switzerland and the Netherlands. The authors from these countries have fewer domestic opportunities for publication, so that they have to publish their papers internationally. The situation is problematic for authors from Asian countries. However, Japanese authors have managed to find better access to the international scientific discussion, although the IA values still only correspond to the world average. It is also noticeable that the values for the new EU member states are also very poor. In this context, the IA for EU-12 is comparable with that of China.

## JOURNAL-SPECIFIC SCIENTIFIC REGARD (SR) FOR PUBLICATIONS FROM SELECTED COUNTRIES AND REGIONS

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Country/Region	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
USA	10	10	11	11	11	9	9	9	10	9	9	8	7
Japan	-7	-7	-8	-7	-4	-7	-6	-7	-7	-10	-9	-10	-8
Germany	10	9	9	7	8	7	7	8	8	7	7	7	6
Great Britain	10	9	5	4	3	8	9	9	10	7	8	8	8
France	2	4	4	3	2	1	3	2	1	2	2	1	3
Switzerland	24	20	23	22	17	15	17	17	16	17	15	15	16
Canada	5	5	6	5	9	5	9	3	4	6	5	4	6
Sweden	15	12	13	14	12	15	9	8	9	11	9	8	11
Italy	-4	-4	-5	-5	-4	-3	-2	-4	0	-5	-2	-1	0
Netherlands	12	13	10	15	14	10	7	11	8	13	11	9	9
Finland	-	-	-	-	-	2	7	8	8	3	2	4	9
Korea	-	-	-	-	-	-16	-11	-11	-9	-5	-2	4	-3
China	-	-	-	-	-	-	-	-	-11	-1	1	3	4
EU-15	-	-	-	-	-	2	2	2	2	2	2	2	2
EU-12	-	-	-	-	-	-	-	-	-15	-13	-11	-12	-8
EU-27	-	-	-	-	-	-	-	-	1	1	1	1	1

Source: SCI, Research by the University of Leiden (CWTS). Calculations by Fraunhofer ISI.

The SR indicator<sup>196</sup> shows whether the articles of a country or region are cited on average more or less frequently than the articles in the journals in which they appear. Positive (negative) values indicate that the citation rate is above (below) average.

### Qualitative improvement of Chinese publications

The SR indicator shows a relative decline in the significance of German publications. German authors are increasingly contributing to leading international journals but are still receiving less attention. Comparable SR values are calculated for the USA, Great Britain, and Canada. But because the language disadvantages are eliminated, Germany has a much better position in comparison to the English-speaking countries in terms of SR values than with straightforward citation rates. The high SR values of Switzerland and the Netherlands show that as well as retaining their shares of publications they also receive recognition for research results. The increasing SR values for South Korea and China suggest a qualitative improvement in the publications. However, the authors are publishing in lower-ranking journals (cf. IA indicator), so that in terms of quality they remain behind the international standard. Japanese authors continue to receive poor scientific regard, with a further slight downward trend in the latest figures. The authors are increasingly publishing in higher-ranking international journals and are thus finding themselves in competition with established scientists. The new EU member states currently have a poor position in the scientific community, with poor SR values plus publication in lower-profile journals (cf. IA indicator).