Performance and Structures of the German Science System 2015

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0 Executive Summary

This study provides an overview of bibliometric indicators for Germany and its international position compared with 22 countries and the EU for the period 2004-2014.

The trend of increasing total publications in the observation period continued in 2014. In many Western countries, however a stagnation or at least a smaller growth can be found. Also Germany remains constant at the same publication level between 2013 and 2014. The majority of the worldwide growth is driven by China which is still the country with the highest growth, but also India and South Korea are able to increase their output. Some countries like Great Britain, Japan, France, Belgium, Canada, Spain or Netherlands also stagnate. In consequence, the shares in worldwide publications continue to decrease for these countries. The USA still have an annual publication output far higher than those of the other countries, but it also stagnates recently in absolute term, also resulting in further decreasing shares of worldwide publication output. The USA accounts for 21.3% of worldwide publications – a decline from 28.3% in 2004. China reached 15% and Germany 4.9%. In a longer-term perspective Japan is the only country that publishes fewer articles in the Web of Science in 2014 than in 2004.

The citation-based indicators – meant to indicate the quality of the scientific publications – show a slightly increasing performance of Germany. German authors are able to publish more and more of their papers in higher ranked journals and are – at the same time – able to keep their relative citation rate in these higher ranked journals. The Excellence Rate – an indicator that addresses the share of top 10% highly cited papers – also increases for Germany in a longer perspective and recently kept a high level of 16%. Chinese authors have also been able to not only increase their absolute publication output, but also their quality – at least reflected by citations. China is still below the world average, but approaching it. The USA are – together with Switzerland and a number of smaller European countries like Denmark or the Netherlands – at the top in terms of the quality of their scientific output, but they also show slightly decreasing trends in all of these indicators.

The trend to more co-publications continues in almost all countries – an indication of higher international cooperation. Germany has a rather high share of international co-publications, given the size of its science system. The highest co-publication share can be observed for Switzerland. The USA are the most attractive partner for most countries, but they only reach a co-publication level of 36.5% – a strong increase since 2004.

1 Introduction to this issue

A continuous monitoring of the research and innovation system allows assessments of the present and future competitiveness of an economy. Scientific publications instantiate such developments and build the foundation for a fluctuant and adaptable knowledge system. Their analysis can shed light on frontier research, co-operations, structures, changes and the role of institutions in science systems.

This year, the study focuses on the core indicators and the updating of the data and illustrations describing the basic output of science systems in an international comparison, their trends and their visibility/quality in terms of citations as well as international co-publication structures. The bibliometric performance of a set of 23 countries and three regions (EU-28, EU-15 and EU-13)[1], (see Appendix p. 24) is analyzed in these report. The focus lies on Germany's performance in this global context.

In particular, this study there are seven indicators analyzed. The number of publications of the selected industrialized countries and regions provides a first comparison among countries over time. The publication share of the world also shows the size relationships between countries. The number and percentage of international co-publications of the countries and regions depicts the extent to which a country or region is internationally oriented. The International Alignment (IA) indicated whether the authors of a country frequently publish – compared to the world average – in internationally more or less respected journals. The Scientific Regard (SR) indicates whether publications of one country are more or less often cited compared to publications of the same research field. These two indicators should be considered and interpreted together. The Excellence Rate (ER) indicates how many of the publications of a country or a region belong to the worldwide most "excellent" publications – in our case to the 10% most cited publications.

A final analysis focuses on the German science system. We provide the number of publications and citations from German universities and non-university research institutions per full time equivalent (FTE).

The journal publications are retrieved from the Science Citation Index Expanded (SCIE) and the Social Science Citation Index (SSCI), which are both sub-products of the database Web of Science (WoS). The analysis covers "articles", "letters", "notes" and "reviews" for journal papers. Most analyses use fractional counting of the publications. By this, each publication is weighted according to the relative share of a country. Whole

1 EU-28 includes all EU countries, EU-15 includes countries which acceded up to April 2004 and EU-13 countries which acceded later.

count is used for the co-publication analysis, where a fractional counting is less intriguing. As external citations are the most relevant for evaluative purposes, this study follows the recommendation of CWTS to exclude self-citations (Nederhof, 1993). Whenever the period of analysis are not explicitly specified, publication-based indicators are presented for the period 2004 to 2014 and citation-based indicators for the period 2004 until 2012. For citation-based indicators we employ a three-year citation window, which means that we count all citations that a publication receives in the year of publication and the two subsequent years. A more detailed description of the underlying methods is provides in Michels et al. (2013).

2 Journal publications in an international comparison

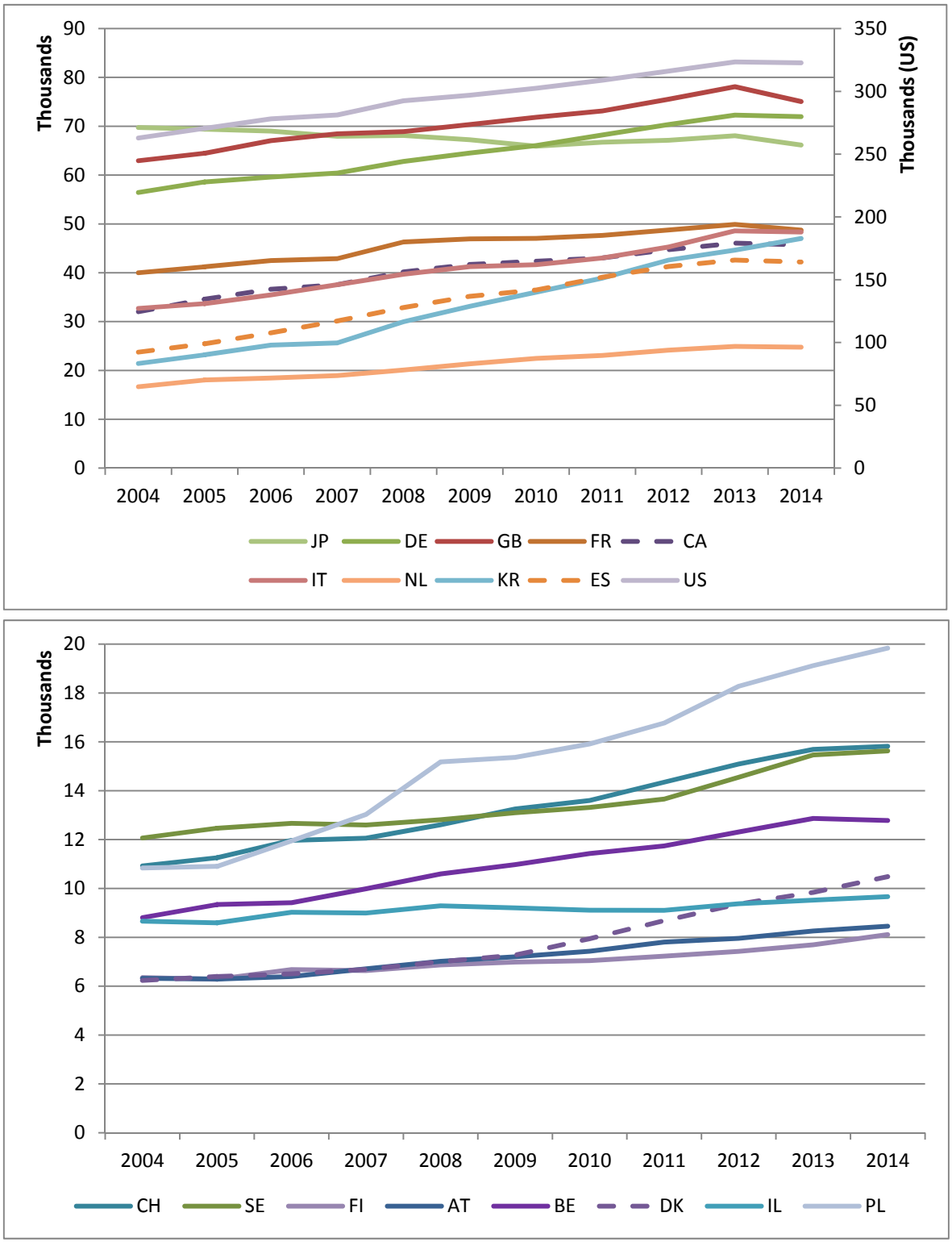
2.1 Number of publications and share of publications

Due to increases of the scientific output, of the science orientation of emerging countries, and also of the database coverage (see e.g. Michels and Schmoch, 2012), publication numbers worldwide steadily grow in the observation period 2004-2014.

Figure 1 shows the publication output until 2014 of the selected industrialized countries in the WoS. Since the countries work on very different output levels, the graph was split up in two groups of countries. The upper panel shows ten countries that publish the most: Japan, Germany, The United Kingdom, France, Canada, Italy, Netherlands, South Korea, Spain and the USA (see right hand scale). The lower panel shows the publications of some other industrialized countries like: Switzerland, Sweden, Finland, Austria, Belgium, Denmark, Israel and Poland. This separation of country into two groups is used throughout the whole report.

As the different scales show, the USA still have a yearly publication output far higher than those of the other countries. China is the only country that comes close to their numbers (Figure 2). Regarding only the industrialized countries, The United Kingdom has the second highest publication number, even if the number of publications decreased considerably in 2014. There is a visible publication trend in 2014. The number of publications of almost all countries in the first graph (Figure 1) stagnates or decreases in 2014. Even the USA, where the number of publications constantly grew in the previous years, remains at the same level as in 2013. Japan, Canada and the Netherlands also stagnate in 2014. An exception builds South Korea, which overtops Canada in 2014. In the second graph (Figure 1) the trend is different; almost all countries increased their numbers of publications in 2014. Especially in Poland and Denmark the growth is noticeable. Belgium is the only country of the countries with lower publications which has a decreased number of publications in 2014.

Figure 1: Publication numbers of the selected industrialized countries in the SCIE and the SSCI (fractional counting)

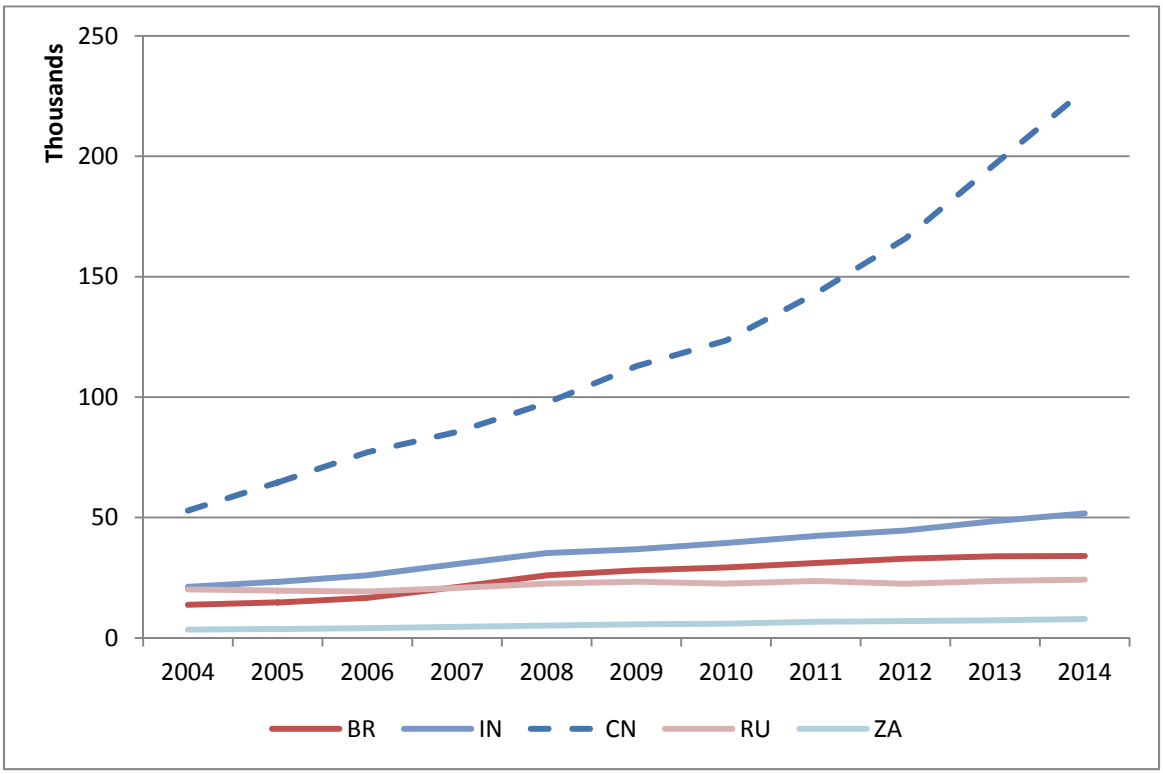


Source: Web of Science, queries and calculations by Fraunhofer ISI

Figure 2 shows the publication numbers for the BRICS countries.[2] China is still the country with the highest growth. Compared to 2013, the number of publications has increased by 16% up to 228,000 publications and still approaches the top-ranked USA. Thus, China has more than three times as much publication as Germany in 2014; ten years before Germany and China accounted for almost the same number of publications.

The other BRICS countries were also able to increase their absolute annual publication output. India increased the number of publications by 7 % up to more than 51.000. South Africa was also able to increase the absolute number of publications by more than 7% between 2013 and 2014. The average growth rates (CAGR) per year between 2004 and 2014 are 9.3% for India and 8.5% for South Africa. However, they are considerably outperformed by China with a compound annual growth rate of 15.7% in this period – and it is still growing at this pace. Brazil stagnated recently, but also reached an average growth rate between 2004 and 2014 of 9.5%.

Figure 2: Publication numbers of the BRICS countries and Mexico in the SCIE and the SSCI (fractional counting)



Source: Web of Science, queries and calculations by Fraunhofer ISI

Table 1 shows a publication index per year in relation to the number in 2004. The worldwide increase accounts for 63% between 2004 and 2014 and a compound annual growth rate of 5% heavily affected by the trends in China, Brazil or India. Compared to

2 In consistency with last year's report, the BRICS countries have been supplemented by Mexico.

the worldwide total most of the Western industrialized countries had a lower growth of publications in 10 years. Spain is among the only Western countries which reached a higher growth than the world. Two other European countries – Poland and Denmark – were also able to increase their publications above the world average. Some of them are very close to the world average (Netherlands, Italy, Switzerland or Belgium). Especially the more recently acceded countries of the EU (EU-13) also published above the world average; they reached 87% more publication in 2014 than in 2004. Germany was able to increase its publication numbers by 28%, but compared to 2013, the numbers remained constant. Japan is still the only country here that publishes fewer articles in Web of Science in 2014 than in 2004.

Table 1: Development of the publication numbers of the selected countries and regions in the SCIE and the SSCI according to fractional counting (Index 2004=100)

Country/ region	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AT	100	100	101	106	111	114	118	124	126	131	134
BE	100	106	107	113	120	125	130	133	140	146	145
BR	100	107	121	154	189	204	213	227	239	247	248
CA	100	108	114	117	125	130	132	134	140	144	143
CH	100	103	110	110	115	121	125	131	138	144	145
CN	100	122	146	162	185	213	233	270	314	372	430
DE	100	104	106	107	111	114	117	121	125	128	128
DK	100	103	104	107	112	117	127	139	150	158	168
ES	100	107	117	127	138	148	154	165	174	179	178
FI	100	99	105	105	108	110	111	114	117	121	128
FR	100	103	106	107	116	117	118	119	122	125	122
GB	100	102	107	109	109	112	114	116	120	124	119
IL	100	99	104	104	107	106	105	105	108	110	112
IN	100	110	123	145	166	174	186	200	210	229	244
IT	100	103	109	115	121	126	127	132	138	149	148
JP	100	100	99	97	98	96	95	96	96	98	95
KR	100	108	118	120	140	155	168	182	199	208	220
NL	100	108	111	114	121	128	135	139	145	150	149
PL	100	101	110	120	140	142	147	155	169	176	183
RU	100	98	96	103	112	116	112	118	112	118	120
SE	100	103	105	104	106	109	110	113	121	128	130
US	100	103	106	107	111	113	115	118	120	123	123
ZA	100	106	118	133	149	163	170	194	202	211	226
EU13	100	104	114	133	154	160	165	171	179	188	187
EU15	100	104	108	111	117	121	124	128	133	138	136
EU28	100	104	109	113	120	124	127	132	137	142	141
WORLD	100	105	111	117	125	132	136	144	151	159	163

Source: Web of Science, queries and calculations by Fraunhofer ISI

Table 2 shows the shares of the countries of the worldwide publication output. The USA is still holding the highest share in 2014, with a slight decrease compared to the previous year. The influence of China continues to increase. In 2014 China already held 15% of the worlds' publications. Germany's share has decreased in the observation period from 6.1%in 2004 to 4.8% in 2014. All the EU regions show the same slightly declining trend, which occurs due to the higher growth rates in China, India and South Korea.

Table 2: Shares (in percent) of the selected countries and regions in percent in the SCIE and the SSCI within all publications (fractional counting)

Country/ region	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AT	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
BE	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8
BR	1.5	1.5	1.6	2.0	2.2	2.3	2.3	2.3	2.4	2.3	2.2
CA	3.5	3.6	3.6	3.5	3.5	3.4	3.4	3.2	3.2	3.1	3.0
CH	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0
CN	5.7	6.6	7.5	7.9	8.4	9.2	9.8	10.7	11.8	13.3	15.0
DE	6.1	6.0	5.8	5.6	5.4	5.3	5.2	5.1	5.0	4.9	4.8
DK	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
ES	2.6	2.6	2.7	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.8
FI	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
FR	4.3	4.2	4.1	4.0	4.0	3.8	3.7	3.6	3.5	3.4	3.2
GB	6.8	6.6	6.5	6.3	5.9	5.8	5.7	5.5	5.4	5.3	5.0
IL	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.6
IN	2.3	2.4	2.5	2.8	3.0	3.0	3.1	3.2	3.2	3.3	3.4
IT	3.5	3.5	3.4	3.5	3.4	3.4	3.3	3.2	3.2	3.3	3.2
JP	7.5	7.1	6.7	6.3	5.9	5.5	5.2	5.0	4.8	4.6	4.4
KR	2.3	2.4	2.4	2.4	2.6	2.7	2.8	2.9	3.0	3.0	3.1
NL	1.8	1.9	1.8	1.8	1.7	1.8	1.8	1.7	1.7	1.7	1.6
PL	1.2	1.1	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3
RU	2.2	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.6	1.6	1.6
SE	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0
US	28.3	27.8	27.0	26.0	25.1	24.3	23.9	23.2	22.6	21.9	21.3
ZA	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
EU13	2.9	2.9	3.0	3.3	3.6	3.5	3.5	3.4	3.4	3.4	3.3
EU15	30.7	30.4	30.0	29.4	28.6	28.2	27.9	27.4	27.1	26.6	25.7
EU28	33.6	33.3	32.9	32.7	32.2	31.8	31.4	30.8	30.5	30.0	29.0
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Web of Science, queries and calculations by Fraunhofer ISI

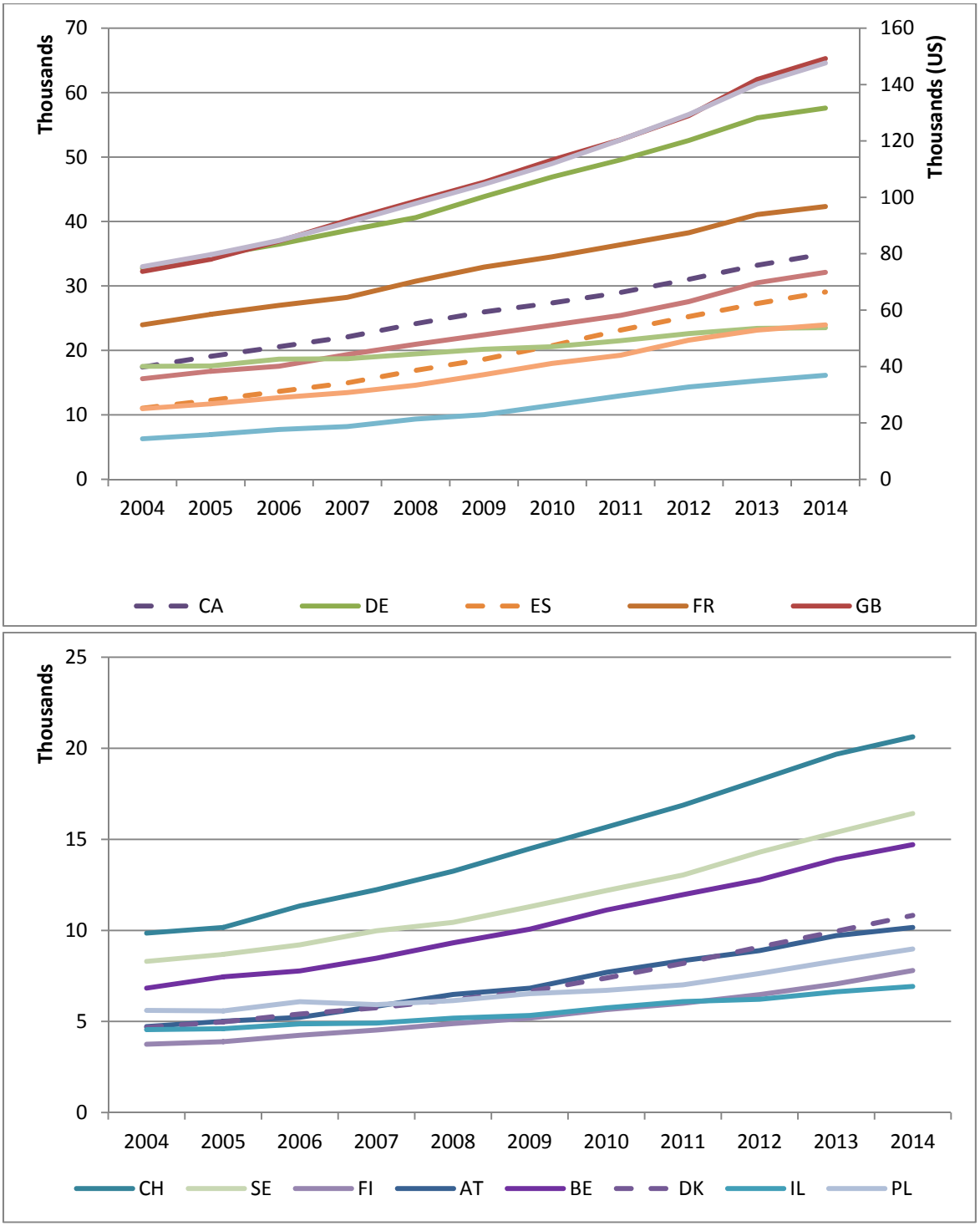
2.2 International Co-Publications

Co-publications can be divided into international and national co-publications. International co-publications are defined as publications that have at least one partner from abroad. By contrast, purely national co-publications are defined as publications with at least one cooperation partner from the same country, but who do not belong to the same organization. In this section the focus lies on international co-publications which are an indicator for scientific collaborations.

Figure 3 and Figure 4 show the number of international co-publications of the industrialized countries and the BRICS countries. The analyses depict the overall development of Germany's (and other countries') behaviour in collaborations over time by comparing the absolute as well as relative numbers of co-publications.

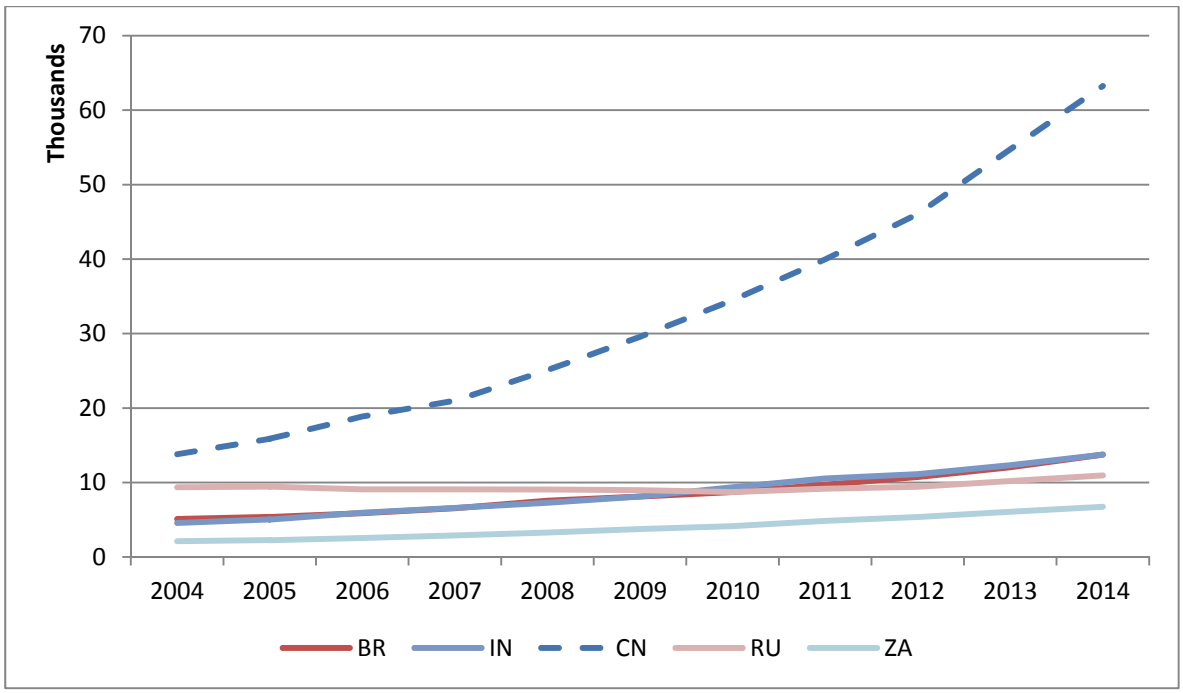
In all of the countries there is a visible trend to more international cooperation. This is not a surprising trend, because the number of publications has risen proportionally. It should be noted that China's international publications have risen as much in recent years that most of the industrialized countries are surpassed. The US remains far ahead (see secondary axis in Figure 3).

Figure 3: Number of international co-publications of the selected countries (whole counting)



Source: Web of Science, queries and calculations by Fraunhofer ISI

Figure 4: Number of international Co-Publications for the BRICS countries (whole counting)



Source: Web of Science, queries and calculations by Fraunhofer ISI

Even though the absolute number of co-publications increased for all collaboration partners, the relative share of co-publications with the individual countries changed substantially in several countries in the period between 2004 and 2014. Table 3 shows the relative share of all countries under analysis here, the EU regions and the world.

In comparison to other countries, Germany has a relatively high share of international co-publications. In 2014, more than every second German publication was written in collaboration with a foreign author. This co-publication share is exceeded by 10 other countries in our set (CH, AT, BE, SE, DK, FI, NL, FR, GB and ZA). The highest co-publication share can be observed for Switzerland with 70%. The relative share of international co-publications of the USA increased from 25% in 2004 to 37% in 2014. Poland and Russia are the only countries in the set which have lower shares of international co-publications in 2014 compared to 2004. Except for South Africa all BRICS countries had a relatively low share of international co-publications in the whole time period. It is impressive that China was able to keep its level of international co-publications (about 24%), given its enormous growth of scientific publications in absolute terms.

Table 3: Shares of the selected countries and regions in the CPCI of international co-publications relative to their total number of publications (whole counting)

Country/ region	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AT	51.6	53.7	54.6	56.9	58.9	59.5	62.6	63.4	64.8	66.5	67.2
BE	53.1	54.1	55.1	56.0	57.4	58.8	60.6	62.1	62.8	64.3	66.4
BR	31.0	30.4	29.7	26.6	25.2	25.1	25.7	26.7	27.7	29.8	33.0
CA	41.6	42.0	42.4	43.9	44.6	45.7	46.8	48.1	49.1	50.3	52.3
CH	57.9	58.0	59.7	62.0	63.3	64.8	66.4	67.0	67.9	69.2	70.4
CN	23.0	21.8	21.8	21.8	22.8	23.2	24.5	24.5	24.4	24.5	24.5
DE	43.5	44.2	45.3	46.6	47.0	48.7	50.1	50.8	51.7	53.0	54.0
DK	51.6	52.7	55.0	56.1	57.1	58.0	58.5	59.0	59.9	61.3	62.0
ES	36.8	37.8	38.6	38.7	39.9	40.7	42.8	44.2	45.2	46.7	49.2
FI	44.2	45.5	46.4	48.7	50.0	51.3	54.1	55.1	56.9	58.7	60.3
FR	44.6	45.7	46.5	47.6	47.9	49.8	51.3	52.7	53.6	55.3	57.3
GB	39.5	40.5	41.6	43.5	45.5	47.0	48.7	50.0	51.2	53.3	56.4
IL	40.6	41.1	41.4	41.5	42.2	43.4	46.0	48.0	47.5	49.0	49.8
IN	19.3	19.4	20.4	19.3	18.6	19.7	21.0	21.9	21.9	22.3	23.1
IT	37.9	39.1	38.9	40.0	40.8	41.6	43.2	44.1	45.1	46.1	47.9
JP	22.2	22.3	23.6	23.9	24.7	25.7	26.6	27.3	28.3	28.8	29.5
KR	25.6	25.9	26.5	27.3	26.9	26.2	27.3	28.3	28.5	29.0	29.0
NL	47.2	46.8	48.6	49.7	50.6	51.9	53.6	55.1	57.4	58.7	60.2
PL	39.7	39.4	39.2	35.7	32.6	33.8	33.5	33.2	33.1	34.3	35.3
RU	36.5	37.5	36.8	34.8	32.4	31.3	31.4	31.4	33.4	34.2	35.6
SE	49.0	49.3	50.7	53.6	54.5	56.4	58.2	59.6	60.4	60.8	62.6
US	24.9	25.5	26.2	27.6	28.4	29.6	30.9	32.2	33.5	35.0	36.5
ZA	45.2	45.3	45.7	46.3	46.1	47.7	49.4	50.4	52.1	54.7	55.6

Source: Web of Science, queries and calculations by Fraunhofer ISI

2.3 Journal-specific Scientific Regard (SR) and International Alignment (IA)

The Scientific Regard (SR) and the International Alignment (IA) put the citation rate in perspective with the reputation – in terms of average citation rates per journal – of the publishing journals. While the IA shows whether a country publishes in more or less cited journals (compared with the world average), the SR relates the citation rate of a publication to the average citation rate in that each journal and indexes the average for all publications.

Table 4: Index of the journal-specific Scientific Regard (SR) for the selected countries and regions in the SCIE and the SSCIE according to fractional counting

Country/ region	2004	2005	2006	2007	2008	2009	2010	2011	2012
AT	8	3	5	7	2	4	3	1	2
BE	0	4	5	5	6	5	4	5	4
BR	-23	-20	-19	-14	-12	-11	-11	-12	-14
CA	3	1	1	1	1	1	1	0	0
CH	13	17	15	13	14	12	11	12	9
CN	1	1	1	3	4	3	3	5	6
DE	8	9	8	7	6	5	6	5	5
DK	12	12	12	9	13	9	9	10	9
ES	-9	-9	-6	-6	-7	-5	-7	-6	-6
FI	1	-1	2	-1	-2	-1	0	0	0
FR	-1	0	0	0	0	0	-1	-2	-2
GB	8	7	6	5	7	7	7	6	5
IL	-11	-13	-12	-11	-14	-13	-14	-13	-14
IN	-18	-13	-11	-10	-8	-7	-6	-5	-4
IT	-8	-6	-7	-6	-6	-3	-4	-4	-1
JP	-11	-12	-11	-12	-12	-14	-14	-14	-14
KR	-6	-7	-6	-8	-6	-6	-7	-9	-8
NL	10	8	8	7	8	7	8	8	8
PL	-23	-21	-21	-18	-20	-16	-16	-14	-12
RU	-9	-10	-10	-7	-8	-11	-8	-9	-11
SE	5	3	3	2	0	3	2	1	0
US	10	10	9	9	8	8	7	7	6
ZA	-13	-9	-6	-7	-3	-6	-2	-7	-7
EU13	-18	-16	-14	-12	-12	-10	-9	-8	-7
EU15	3	3	3	2	2	2	2	2	2
EU28	1	1	1	1	1	1	1	1	1

Source: Web of Science, queries and calculations by Fraunhofer ISI

Table 4 shows the SR values for the countries under observation here for the years 2004 to 2012. The German index has been only slightly decreasing from 8 in 2004 to 5 in 2012. In the recent years this level is rather constant. Some European countries like France, The United Kingdom and Switzerland show a decreasing trend in the SR since about 2009. Among the EU countries only Italy, Poland and Austria show increasing trends in the recent years.

China, India, and South Korea increased their SR index values at the current edge, which means that their increasing absolute numbers of scientific publications in the Web of Science are also more frequently cited compared to the journals where they are published. To some extent this might be explained by the fact that authors tend to cite authors from their own countries more frequently than foreigners. This is partly explainable by collaboration, interaction, similar national research priorities as well as cultural overlaps. In consequence of the absolute increase of publications also the citations increase.

Table 5: Index of the International Alignment (IA) for the selected countries and regions in the SCIE and the SSCI according to fractional counting

Country/ region	2004	2005	2006	2007	2008	2009	2010	2011	2012
AT	-2	0	-1	2	0	-3	1	0	-1
BE	-1	1	2	2	3	6	2	4	5
BR	-47	-44	-44	-50	-55	-56	-56	-55	-54
CA	4	4	6	7	6	6	6	6	5
CH	25	23	22	23	25	25	25	24	26
CN	-55	-52	-48	-41	-36	-32	-28	-25	-20
DE	0	3	4	5	7	8	9	9	10
DK	12	11	13	13	15	15	15	12	13
ES	-14	-13	-11	-10	-12	-11	-8	-8	-7
FI	-2	0	0	0	2	0	2	1	-1
FR	-5	-3	-3	0	1	1	3	5	5
GB	7	9	8	11	13	11	11	11	11
IL	6	7	6	7	9	7	10	11	10
IN	-57	-55	-49	-50	-52	-48	-48	-45	-41
IT	-3	0	0	-2	0	-2	-2	-3	-4
JP	-11	-11	-11	-10	-7	-6	-7	-5	-6
KR	-41	-38	-37	-29	-30	-29	-26	-23	-20
NL	18	20	21	22	22	22	23	21	20
PL	-59	-52	-53	-56	-61	-58	-57	-56	-56
RU	-85	-84	-83	-84	-84	-85	-84	-84	-80
SE	7	8	8	11	9	10	10	8	7
US	28	27	27	27	27	26	25	25	24
ZA	-48	-45	-44	-46	-44	-46	-40	-48	-44
EU13	-55	-52	-50	-55	-59	-57	-56	-55	-53
EU15	0	2	2	4	5	5	5	5	5
EU28	-4	-2	-2	-1	-1	-1	0	-1	-1

Source: Web of Science, queries and calculations by Fraunhofer ISI

Table 5 shows the IA values for the selected countries and regions, as a supplement to the SR values. This index indicates if the journals are high or low cited – on average. In general, the IA values are more dispersed than the SR values, i.e. there are countries with relatively low values (e.g. Russia, Poland and Brazil), but also with high values (e.g. Switzerland, the USA and the Netherlands). Such a high disparity could not be observed for the SR values. It is interesting to note that the US-American index slightly decreases over time from a level of 28 in 2004 to a level of 24 in 2012.

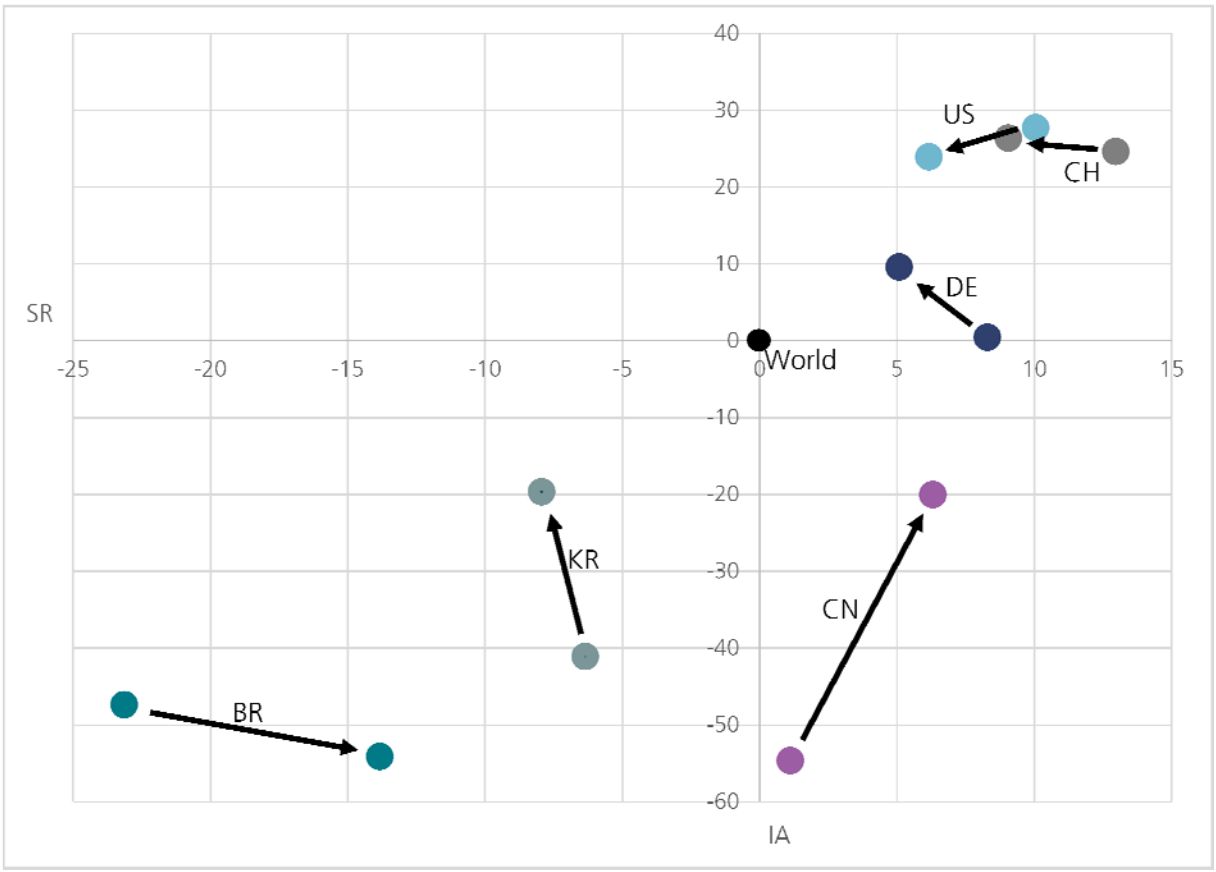
The IA index of the EU15 countries is only slightly positive, which indicates a publication behaviour that targets – on average – journals which are cited on a worldwide average. The Eastern European countries (EU13) are not yet on this same level. They only achieve to publish in journals that are less frequently cited than the world average. Their index level is considerably negative. What is even more of a concern is the fact that it does not change over the past 11 years since 2004.

Germany is able to considerably increase its IA index from zero (world average) to a level of 10, which brings it to the level of the United Kingdom or Denmark and even beyond Sweden, which recently shows a slightly decreasing trend of this indicator.

China, South Korea and India were able to publish their research findings in higher ranked journals since 2004. Their IA index considerably increases over time, but it is still negative, however.

Figure 5 shows the SR and the IA in comparison for six selected countries and the world. The initial situation in 2004 as well as in 2012 – different to the absolute publication numbers the citation based indicators only reach until 2012 due to the citation window of three years – are depicted for each country. Their development over time is indicated by arrows. Both indicators have a value of 0 for the world average, which is used as a reference level for the comparison.

Figure 5: Index of the journal-specific Scientific Regard (SR) and the International Alignment (IA) for six selected countries in 2004 and 2012 in the SCIE and the SSCI according to fractional counting



Source: Web of Science, queries and calculations by Fraunhofer ISI

At the top level (upper right quadrant) an approximation of the countries can be detected. The leading countries in terms of citation-based indicators – the USA and Switzerland – show decreasing trends, while Germany is able to improve its position in the

International Alignment index. Thus, Germany now targets journals with a higher international reputation. It increases its visibility, aiming for journals with a higher international standing. In turn, its relative citation rate in comparison with other articles in its journals slightly decreases. The absolute citation rates in these journals are higher – also resulting in higher absolute citation numbers. On the other hand, Germany cannot maintain its level in the SR, which means that within these – on average – higher cited journals, German authors cannot keep their relative position like in the lower ranked journals. This, however, is no reason to worry.

The three countries in the lower panel were selected to show their development over time. While Brazil is hardly able to catch up with the worldwide scientific activities, South Korea is able to considerably increase its performance over time. Authors from South Korea are still cited below the average of the journals they publish in. However, their International Alignment strongly increases and approached the worldwide average.

Chinese authors, on the other hand, are already cited more frequently than the average of the authors in their journals and they even increase their SR values over time. At the same time they clearly direct their attention to internationally more visible (and more highly cited) journals.

2.4 Share in top cited publications (Excellence Rate)

The focus of this section lies on the share of publications that belong to the worldwide top cited publications. The 10% top cited publications per field are selected (to account for varying citation rates in the scientific fields). For each country, the number of publications belonging to the top 10% in at least one field is calculated and set in relation to the total number of its publications. In that way, its share of highly cited publications is derived, that is also denoted as Excellence Rate (Bornmann et al. 2012; Waltmann and Schreiber 2013).

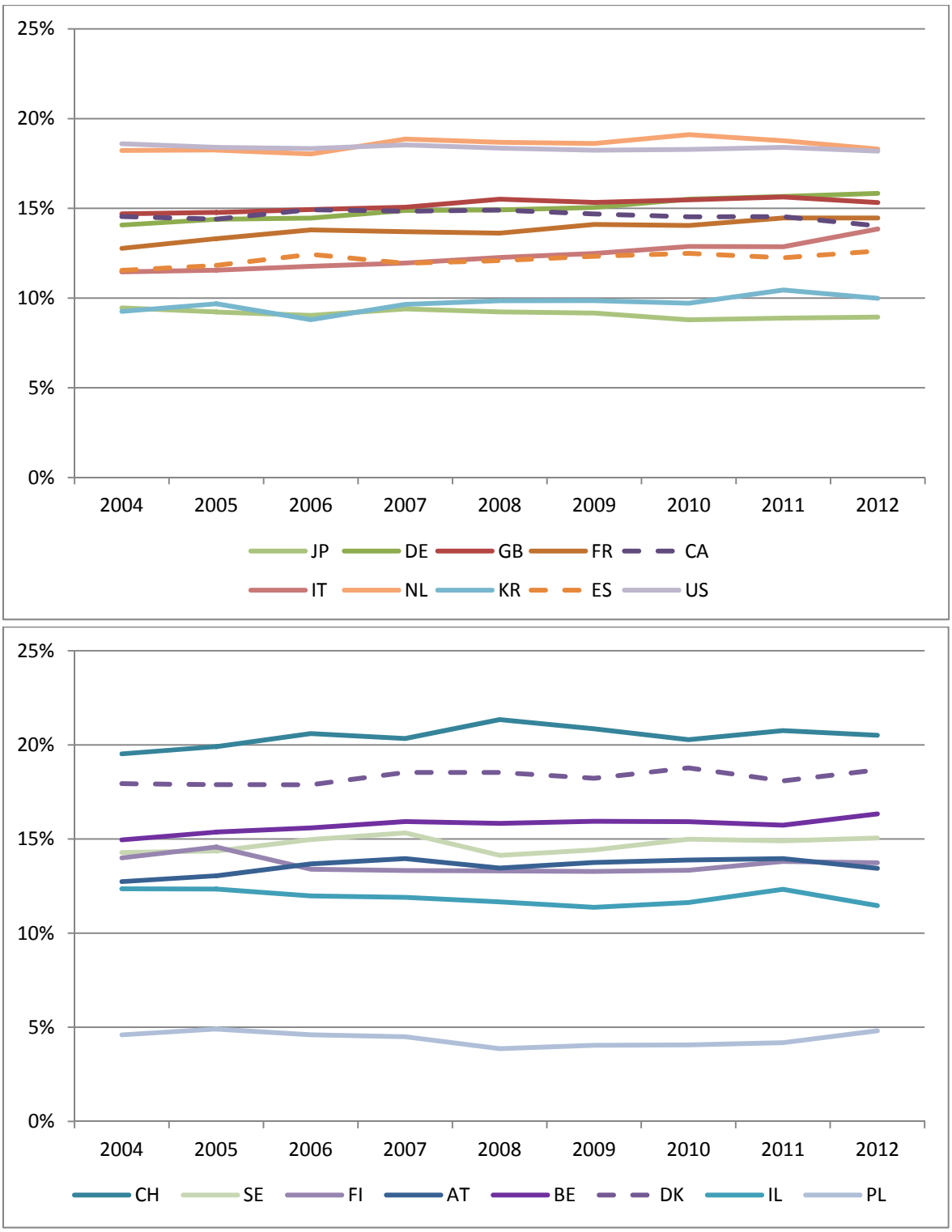
Figure 6 shows the Excellence Rate for a selected set of industrialized countries. Only three of them (Poland, Japan and South Korea) do not reach the reference value of 10%, which we would expect if the quality of publications (indicated by the citations they receive) is evenly distributed across all countries. Only about 4-5% of the Polish publications belong to the most highly cited publications in the world. Japan and South Korea, however, are close to the 10% mark. Switzerland is at the top also in this indicator (see lower panel). More than 20% of their publications belong to the top 10% cited publications. The Netherlands, Denmark and the US also perform very good in this indicator, reaching levels of 18-19%.

Germany reaches a level of 16% in 2012. The overall positive trend that was found based on the citation based indicators of Scientific Regard and International Alignment,

which both target the total range of publication activities, can also be confirmed when look at the top cited publications in the world. Germany is well beyond the 10% we would expect by an equal distribution of quality. In addition, the German Excellence Rate even increased in the past 11 years.

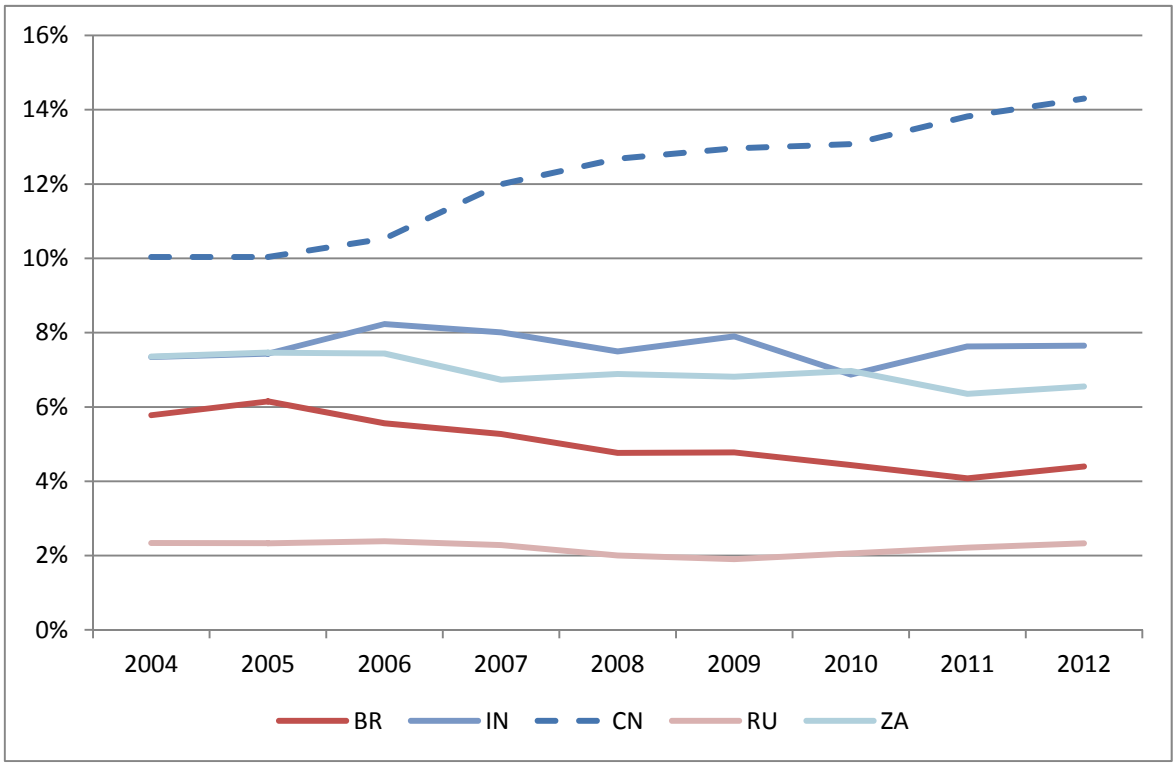
In comparison, the BRICS countries have – again with the exception of China - relatively low Excellence Rates (Figure 7). China achieves shares far higher than the other BRICS countries and shows a steep increase after 2006 up to 14% in 2012 and is thereby on a similar level like Finland, Italy or Austria.

Figure 6: Excellence Rate for the industrialized countries according to fractional counting for the years 2004 to 2012



Source: Web of Science, queries and calculations by Fraunhofer ISI

Figure 7: Excellence Rate for the BRICS countries according to fractional counting for the years 2004 to 2012



Source: Web of Science, queries and calculations by Fraunhofer ISI

2.5 Number of publications and citations per FTE of German Universities and non-university research institutions

The German research landscape is differentiated following a mission orientation. While the large number of German universities is responsible for both, research and education, the large public research organizations (PROs) usually only conduct research. Their teaching obligations are restricted and mainly result from co-affiliations or individual career paths. However, the role in doctoral students' education is considerable. Many research institutes employ doctoral students and these students considerably contribute to the publication output of the research institutes. It needs to be stressed that in Germany students can only graduate from universities and not from research institutes. Only the universities have the right to grant a PhD diploma. Essentially, all doctoral students at PROs are also somehow affiliated to a university.

The PROs have very different missions, which can, first of all, be characterized by basic research (Max Planck) and applied research (Fraunhofer). In addition, several missions like energy and large-scale research (Helmholtz) occur. Both the Helmholtz Association and the Leibniz Association conduct applied as well as basic research. The Helmholtz Association developed its profile in medical research, running medical centers in collaboration with universities, in different locations in Germany. The Leibniz Association

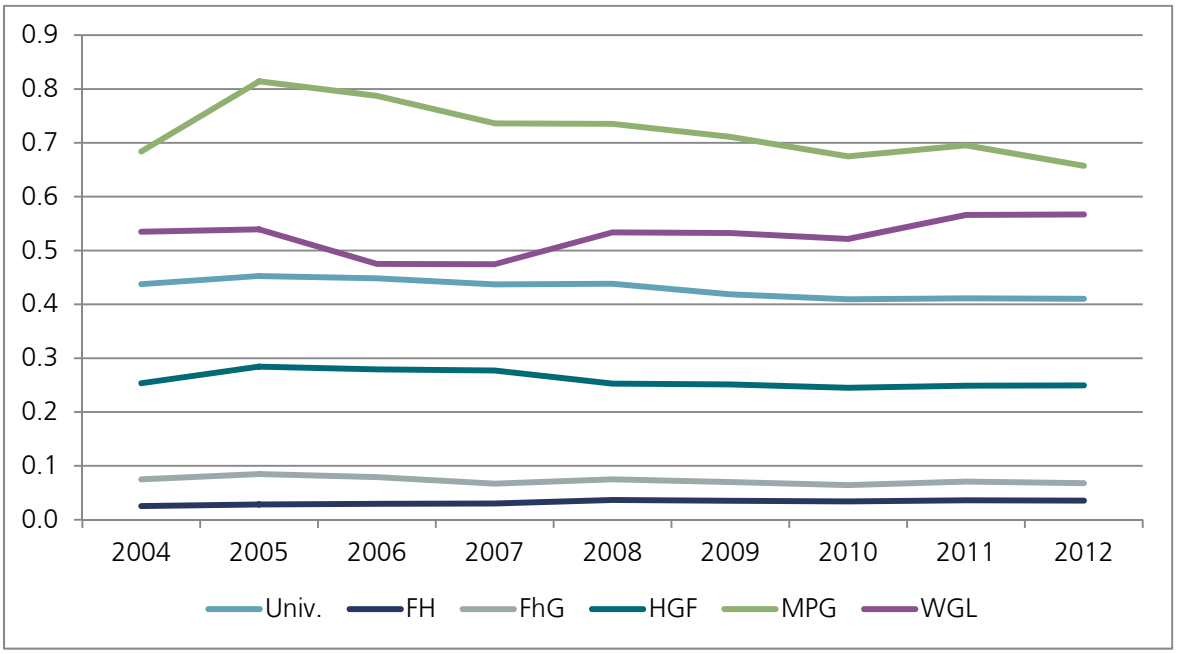
covers research at museums and also several particular topics (e.g. marine research), but also a number of institutes of the social sciences.

These are very different conditions for a comparison of the publication output of the universities and the public research organizations. In the following we will only report a small number of indicators that will not allow a complete picture of the publication activities and their assessment. We focus on the absolute number of publications and the absolute number of citations per full-time equivalent (FTE) researcher.

As Figure 8 shows, the largest publication output per FTE researcher is achieved by Max Planck. Each researcher – on average – publishes 0.7 papers per year, with a decreasing trend in the recent years. It has to be mentioned here that the absolute number of researchers does not take into account the large number of scholarship and external visitors. This group, however, is taken into account in the case of publication output, if they put their Max Planck affiliation on the paper. This also holds for all the other PROs and also the universities, but the effect is largest in case of Max Planck due to large numbers of external and visiting scholars.

In the Leibniz Association each researcher published about 0.6 papers per year, with an increasing trend. The other groups are rather stable in their publication output. A researcher at a German university published about 0.4 papers per year and at Helmholtz it is about 0.25 papers. The lowest publication intensity can be found in Fraunhofer (0.10 papers) and in the universities of applied sciences (0.05 papers).

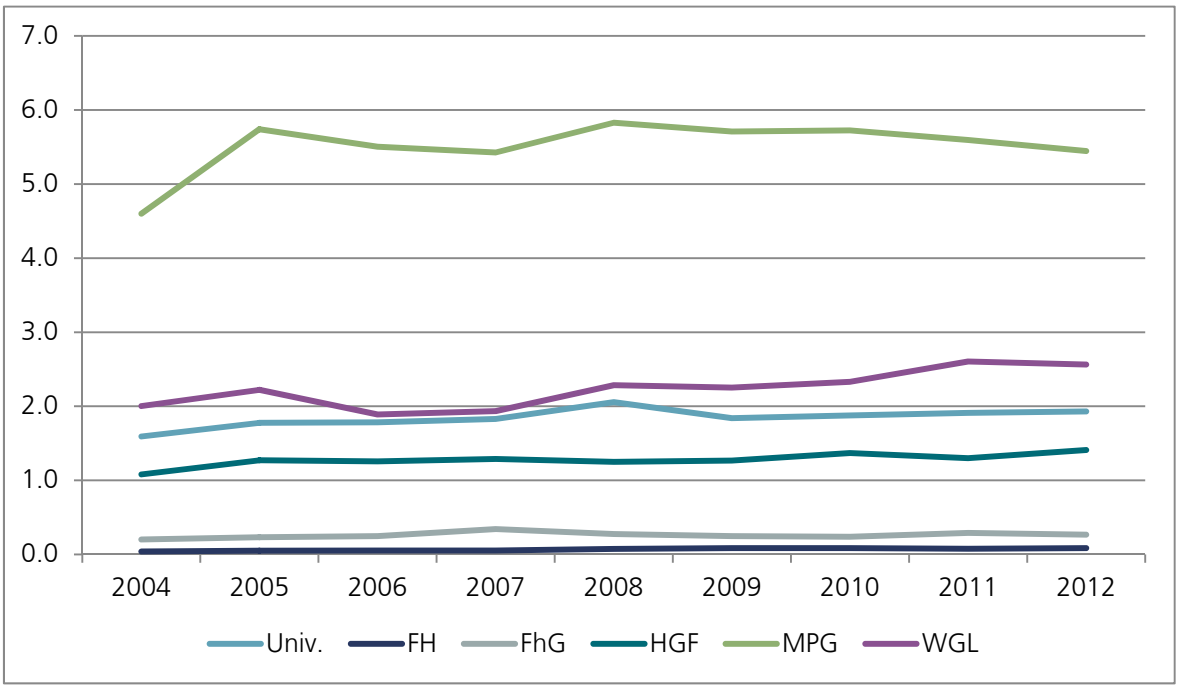
Figure 8: Number of publications per FTE of German Universities and non-university research institutions for the period 2004-2012



Source: Web of Science, queries and calculations by Fraunhofer ISI

As Figure 9 shows, Max Planck also receives the most citations per FTE – almost 6 citations per researcher. Researchers from the Leibniz Association receive 2.5 citations and from universities about 2 citations. Helmholtz reaches a value of 1.5, Fraunhofer of about 0.25 and the universities of applied sciences of about 0.1.

Figure 9: Number of citations per FTE of German universities and non-university research institutions for the period 2004-2012



Source: Web of Science, queries and calculations by Fraunhofer ISI

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Appendix: Country Code list

Country	Country code
Austria	AT
Belgium	BE
Brazil	BR
Canada	CA
China	CN
Denmark	DK
Finland	FI
France	FR
Germany	DE
The United Kingdom/United Kingdom	GB
India	IN
Israel	IL
Italy	IT
Japan	JP
Netherlands	NL
Poland	PL
Russian Federation	RU
South Africa	ZA
South Korea	KR
Spain	ES
Sweden	SE
Switzerland	CH
United States	US

Region EU-28	Country code
Austria	AT
Belgium	BE
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czech Republic	CZ
Denmark	DK
Estonia	EE
Finland	FI
France	FR
Germany	DE
The United Kingdom/United Kingdom	GB
Greece	GR
Hungary	HU
Ireland	IE
Italy	IT
Latvia	LV
Lithuania	LT
Luxembourg	LU
Malta	MT
Netherlands	NL
Poland	PL

Region EU-28	Country code
Portugal	PT
Romania	RO
Slovak Republic	SK
Slovenia	SI
Spain	ES
Sweden	SE

Region EU-15	Country code
Austria	AT
Belgium	BE
Denmark	DK
Finland	FI
France	FR
Germany	DE
The United Kingdom/United Kingdom	GB
Greece	GR
Ireland	IE
Italy	IT
Luxembourg	LU
Netherlands	NL
Potrugal	PT
Spain	ES
Sweden	SE

Region EU-13	Country code
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czech Republic	CZ
Estonia	EE
Hungary	HU
Latvia	LV
Latvia	LT
Malta	MT
Poland	PL
Romania	RO
Slovak Republic	SK
Slovenia	SI