Research and development in China compared to other selected countries – viewed through the lens of bibliometrics

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Introduction

The present work presents the results of a bibliometric analysis investigating research and development in China compared to other selected countries (see also Leydesdorff, Wagner, & Bornmann, 2014; Wagner, Bornmann, & Leydesdorff, 2015; Zhou & Bornmann, 2015). The bibliometric data used in this paper are from the Max Planck Society's bibliometric in-house database. The database is developed and maintained in cooperation with the Max Planck Digital Library (MPDL, Munich). It is derived from the Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI) prepared by Clarivate Analytics, formerly the IP & Science business of Thomson Reuters (Philadelphia, Pennsylvania, USA).

The analyses considered publications of the document types "Article" and "Review". The citation window relates to the period from publication until the end of 2017. Many analyses are based on so-called "fractional counting": a publication is assigned to a country proportionately – depending on the number of further countries listed for a publication. Only publications from so-called "Mainland China" are taken into account; publications from Hong Kong, Macau, and Taiwan were excluded (with the exception of publications in collaboration with "Mainland China"). The following results relating to the publication output refer to the countries China, Germany, India, United States, UK, Japan, and Switzerland. In order to make the figures better readable, the analyses used a reduced country set for the impact of the publications (only China, Germany, India, and the United States are considered). In one analysis, the European Union (EU 28) is considered. Fields are defined in the following by a certain set of journals; the subject matter of journals in such a set are all (very) similar.

Results

A) Subject-independent analysis

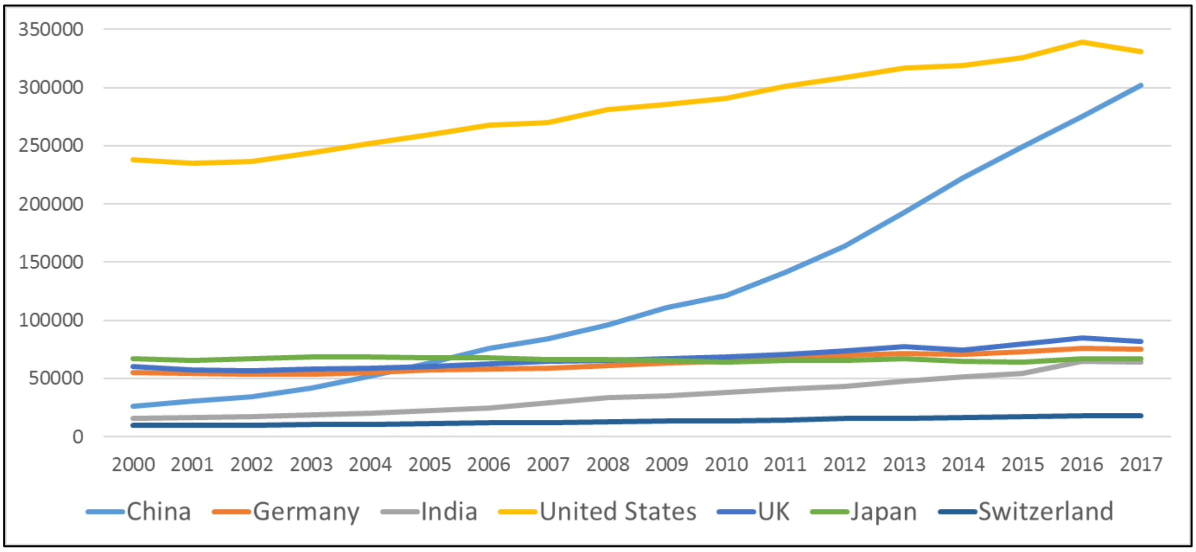

Figure 1: Number of papers published by the countries between 2000 und 2017

Figure 1 shows that the number of publications in the USA went up (across all subject categories) between the years 2000 and 2017 in nearly a straight line by 39%. By comparison, the number in Germany increased similarly by 37%, and in the UK by 35%. The same period in China sees an almost exponential growth by approx. 1050% overall. India records a no less impressive growth of approx. 310%. Japan is the odd one out: There, publication numbers remain constant. Publication numbers in Switzerland increased at a lower level during the observed period by 73%.

Additional information: Globally, publications went up in the period from 2000 to 2017 by 114% from 793,000 to 1,700,000 publications

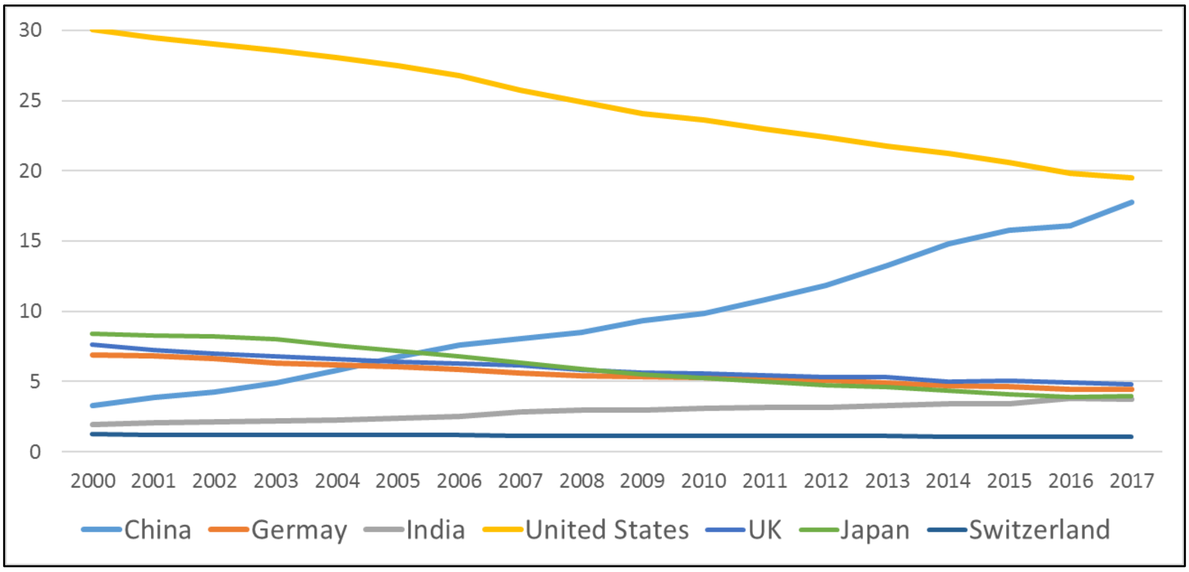

Figure 2: Proportion of global publications covered by the countries between 2000 and 2017

The proportion of global publications covered by the countries investigated in this study varies during the period from 2000 to 2017: the proportion of developing countries increased (India from 2% to 3.8%; China from 3.3% to 17.8%). The other countries saw a decrease: Germany falls from 6.9% to 4.4%, the USA from 30% to 19.5%, the UK from 7.7% to 4.8%, Japan from 8.4% to 3.9% and Switzerland from 1.3% to 1%.

Conclusion: Publication numbers in developing countries, especially in China, are increasing rapidly, as do their corresponding proportions of overall publications.

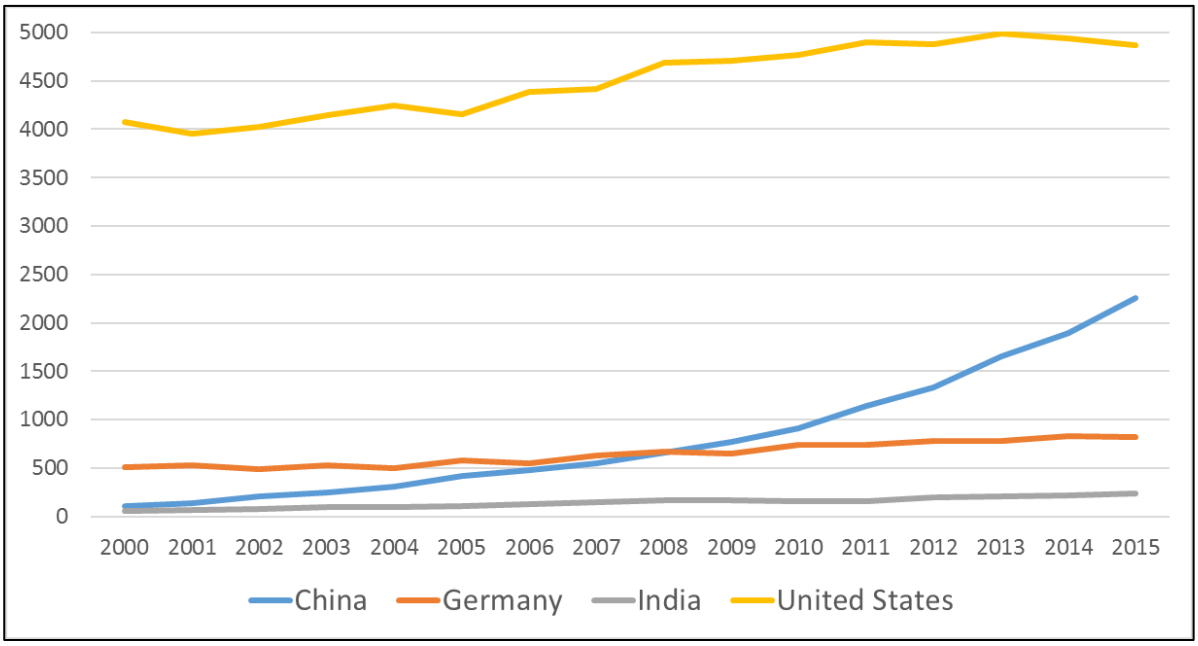

Figure 3: Number of national publications in the period from 2000 to 2015 belonging to the top 1% of most-cited publications in their subject category and year of publication [P(top-1%)]

Looking at the number of publications in the period from 2000 to 2015, which make up the 1% most-cited publications in their subject category and year of publication, the USA clearly dominates, but China is rapidly catching up. The increase in the number of these highly-cited publications was 62% in Germany, 309% in India, and only 19% in the USA owing to the already high level. China raised the number of these highly-cited publications during the period from 2000 to 2015 by **more than 20 times**.

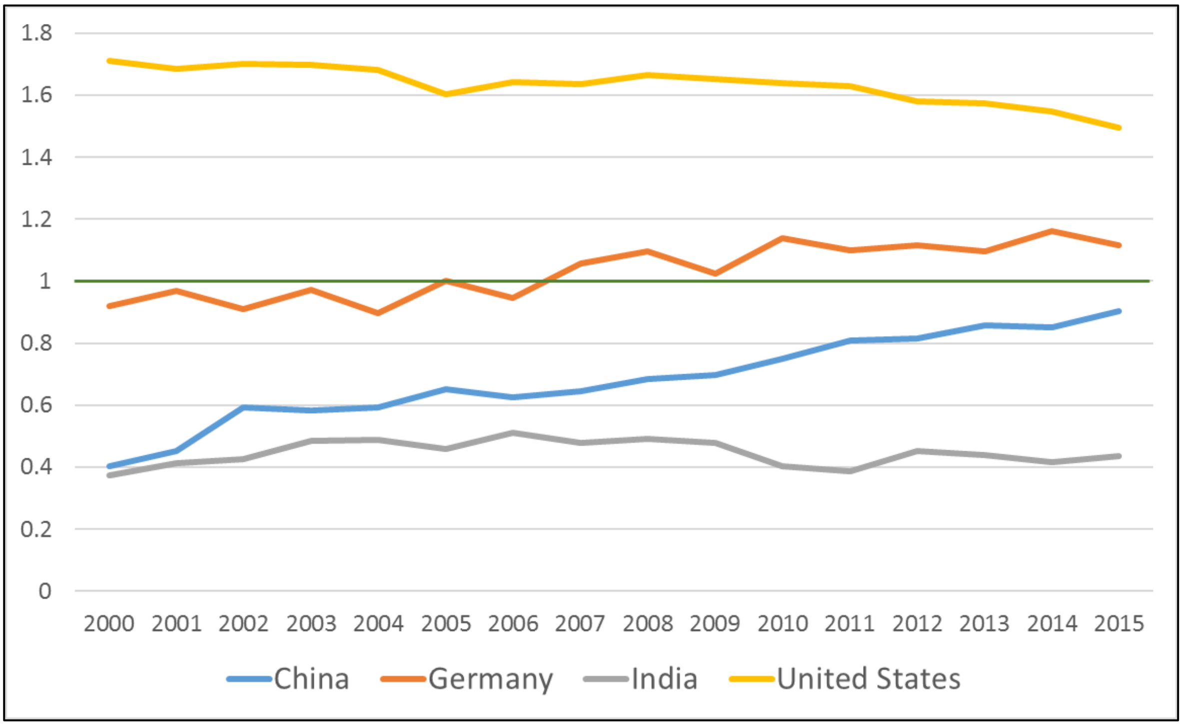

Figure 4: National proportion of papers belonging to the 1% most frequently-cited publications [PP(top-1%)] between 2000 and 2015 (the green line is the world-wide expected value)

Looking at the proportion of papers for a country, which make up the 1% most-frequently cited publications in corresponding subject categories and publication years, the USA dominates (proportion of 1.4% in 2015). Germany achieves a just above-average value of 1.1%. The expected value for this indicator is 1% (see the green line in the figure). China remains below average at 0.9%, and India is far below average at 0.4%.

Conclusion: Proportionately, China is catching up in relation to excellent papers, but the country's overall performance is still slightly below average.

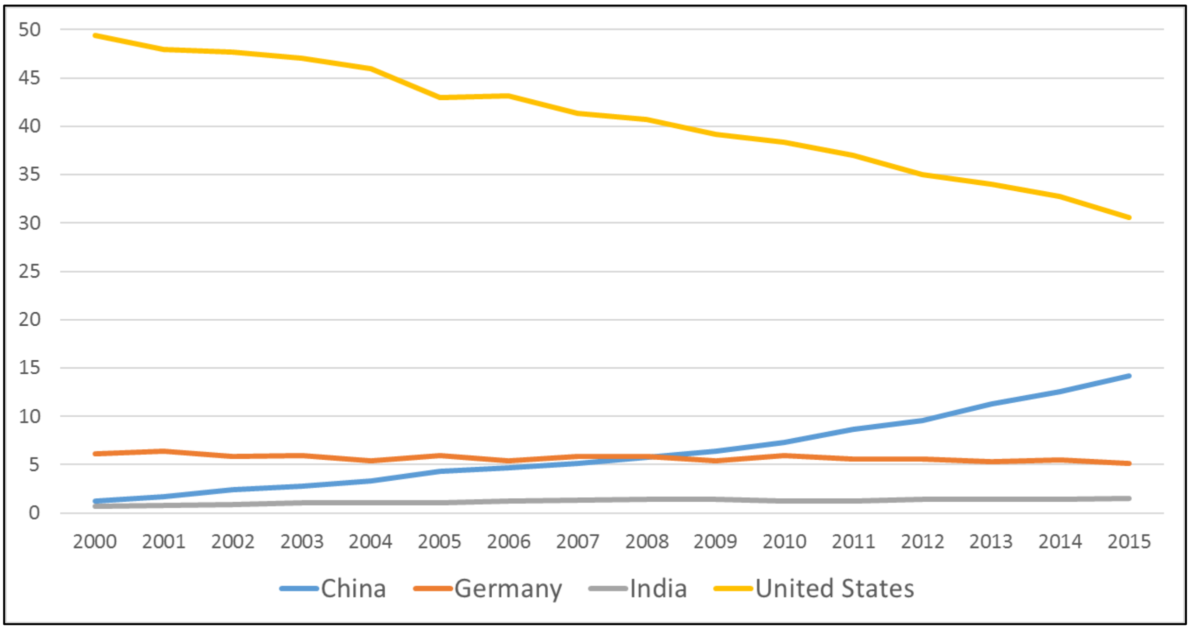

Figure 5: Proportion of global publications belonging to the 1% most frequently-cited publications [P(top-1%)] covered by the countries between 2000 and 2015

The results differs if we look at the proportion of each country in the global total of the top 1% of most-cited publications. While the USA still dominates, their proportion fell from 49% to 31% during the period from 2000 to 2015, and the proportion of China went up from 1.3% to 14%. The proportion of Germany dropped from 6.1% to 5.1%, while that of India went up from 0.7% to 1.5%.

Conclusion: Developing countries, especially China, are increasing their proportion of publications overall, including of the top 1% of publications. These countries are also sites of excellent research.

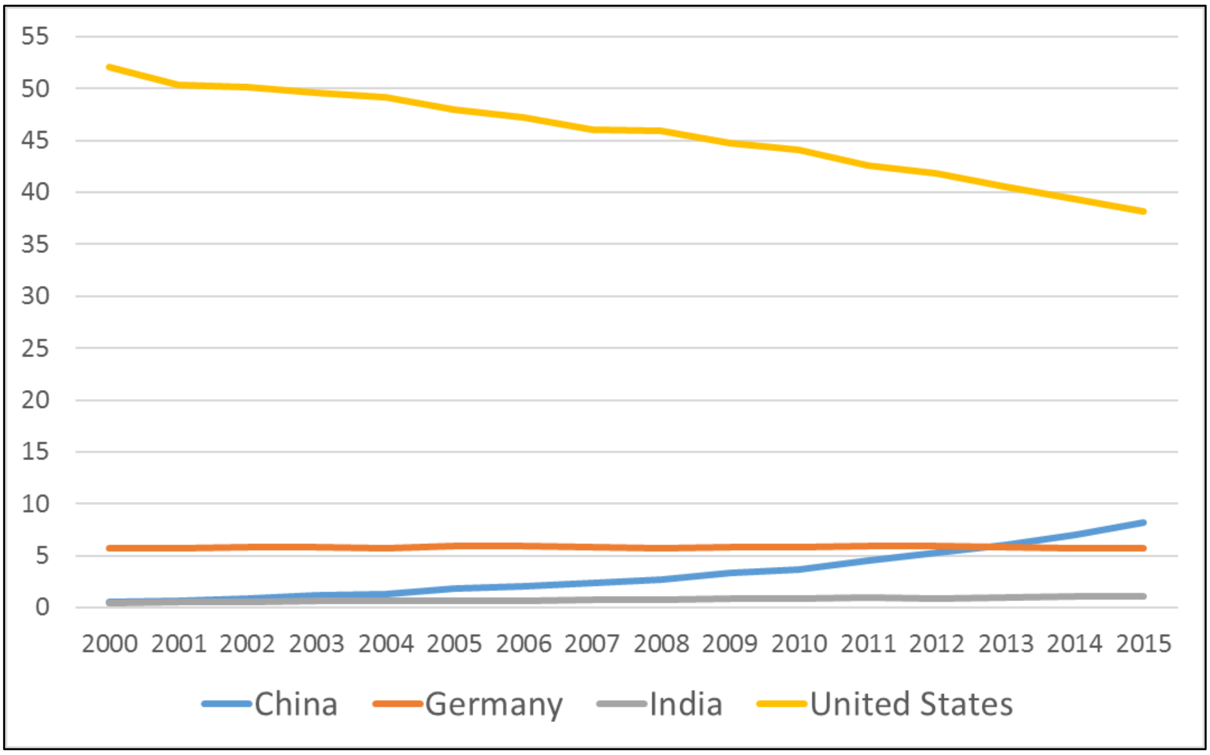

Figure 6: National proportions of papers which have been cited in the 1% most-cited publications published between 2000 and 2015 [P(top-1%)]: on the shoulders of which countries stands the excellent research worldwide?

Figure 6 looks at the national origin of the papers cited by the top 1% of most-cited publications (considering subject category and publication year of publications). In 2015, 38.2% of the papers referenced by the top-cited publications were from the USA, 8.2 % from China, 5.7% from Germany, and 1.1% from India.

Conclusion: The USA still dominates with 38.2% in 2015. China sees an increase between 2000 and 2015 of 8.2%, and the value for Germany remains constant during this period at 5.7%. India grew from 0.4% in 2000 to 1.1 % in 2015.

B) Subject-specific analyses

1) The universal base map

The subject-specific analysis is based on approximately 250 fields (Web of Science subject categories, Clarivate Analytics), each of which is defined by a set of journals. The journals in a set have a similar subject focus.

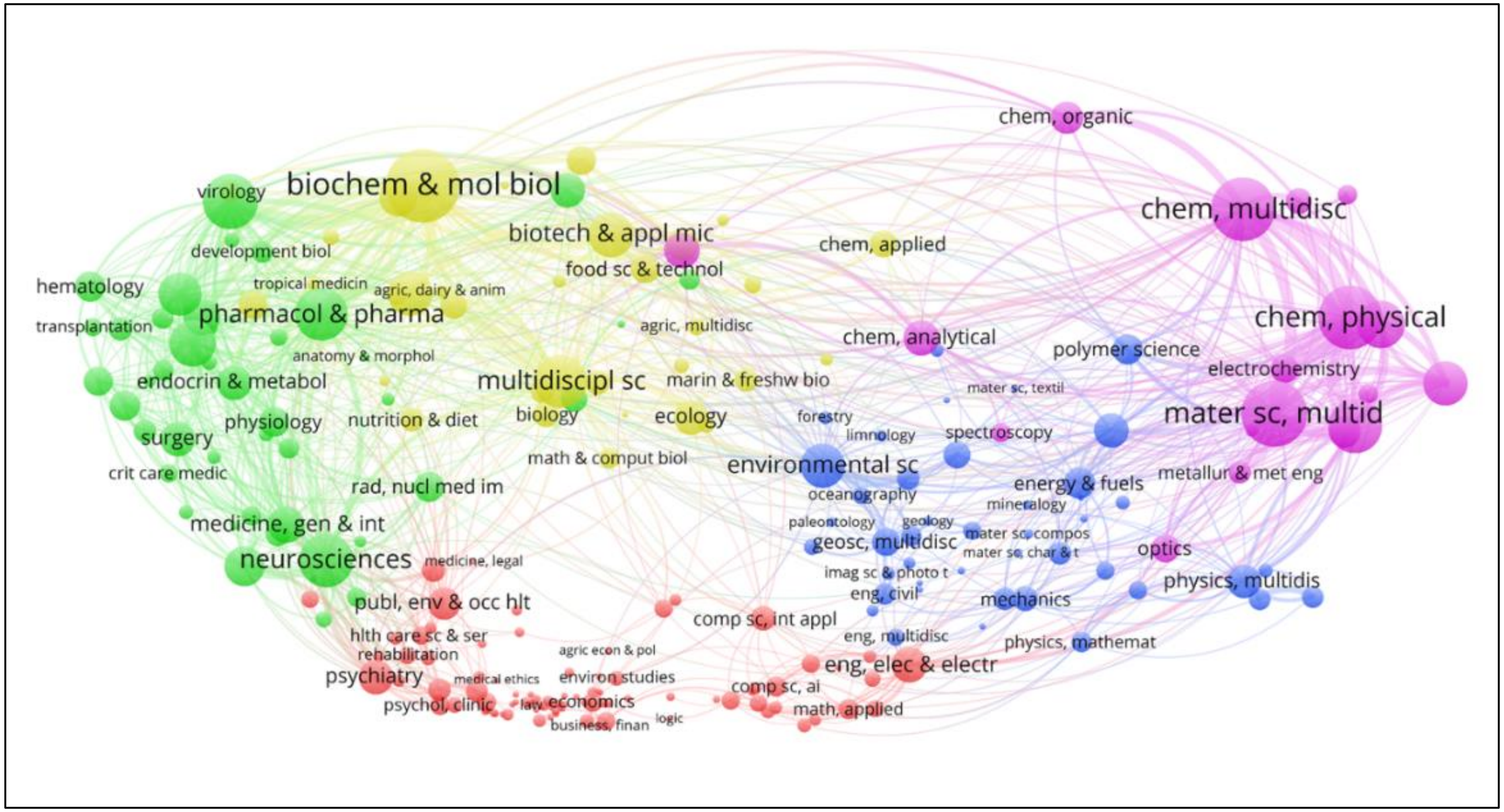

Figure 7: Base map visualizing citation relations between subject categories

The base map is based on citation relations between publications from different subject categories. Publications (with document types “article” and “review”) from the years 2003 to 2013 were taken into account. The more closely two fields are positioned, the more frequent are mutual citations. The colours are the result of a cluster algorithm (grouping subject categories based on the frequency of citation relations) (Waltman & Eck, 2013). The size of the circles reflects the number of publications in the given subject categories.

2) China compared with other countries

The next figures in this section are overlay maps which have been produced using the base map in Figure 7 (see Bornmann & Haunschild, 2016). The overlay maps use the positions of the subject categories defined by the base map.

The following three figures compare China with Germany and the USA. **Subjects in which the respective countries have published more than 10% of global highly-cited publications** (10% of the most cited papers) in this field **are highlighted in red**. Each red circle thus represents a proportion of at least 10 percent of global highly-cited publications for the respective field.

The size of the circles is a measure of the country's activity level in the relevant field (subject category): **The activity index (AI) used here** shows the proportion of a research field in a country's publication output relative to the proportion of this research field in the global publication output. Therefore, AI=2 means that the proportion of publications in a field for a country's own publication output is twice that of the proportion of publications in the field for global publication output.

Conclusion (based on the interpretation of the figures on the next page):

China has numerous subject categories highlighted in red, which often also have an AI of significantly more than 1 (see Figure 8): in the areas Computer science, Physics, Astronomy, Material Sciences, Electrochemistry, Nanotechnology, Biotechnology, and Biomedicine. The general medical fields – except for Medicine, Research & Experimental and Integrative & Complementary Medicine – are covered very little.

Compared to this, **Germany** has a strong presence in Astronomy, Astrophysics, Geosciences (in the centre of figure 9), Social Sciences, Neuromedicine, and Clinical Medicine (see Figure 9).

Many fields across the entire scope are represented in the **USA** (see Figure 10). Greater density can be identified e.g. in Social Sciences, Medicines, Life Sciences, Earth System Sciences, and Computer Science. Only Social Sciences have fields with an activity index of close to 2.

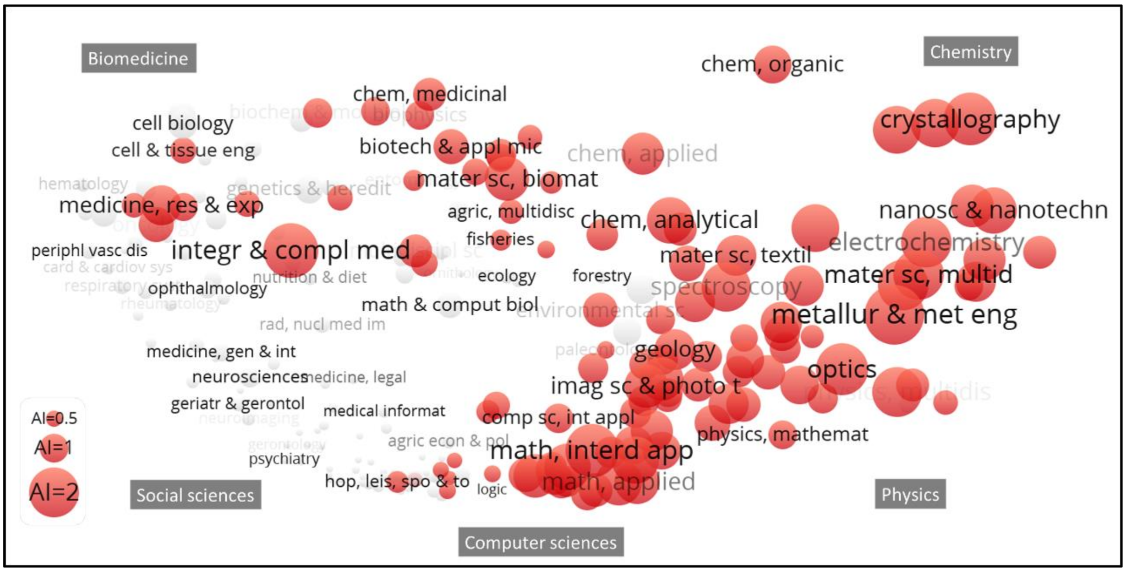

Figure 8: Fields are highlighted in red if China published a proportion of more than 10% of all highly-cited publications in this field in the period from 2010 to 2015

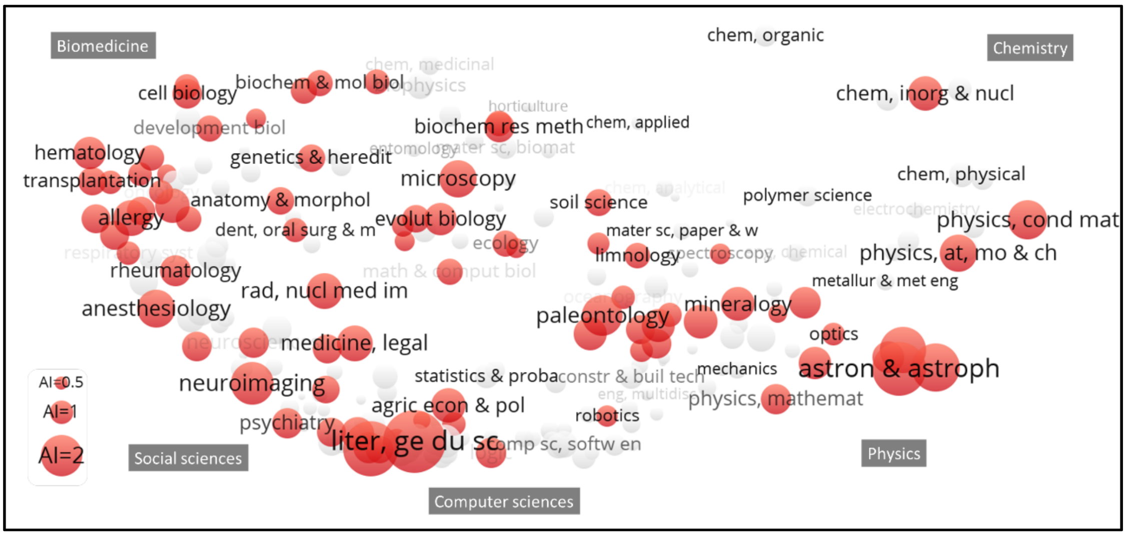

Figure 9: Fields are highlighted in red if Germany published a proportion of more than 10% of all highly-cited publications in this field in the period from 2010 to 2015

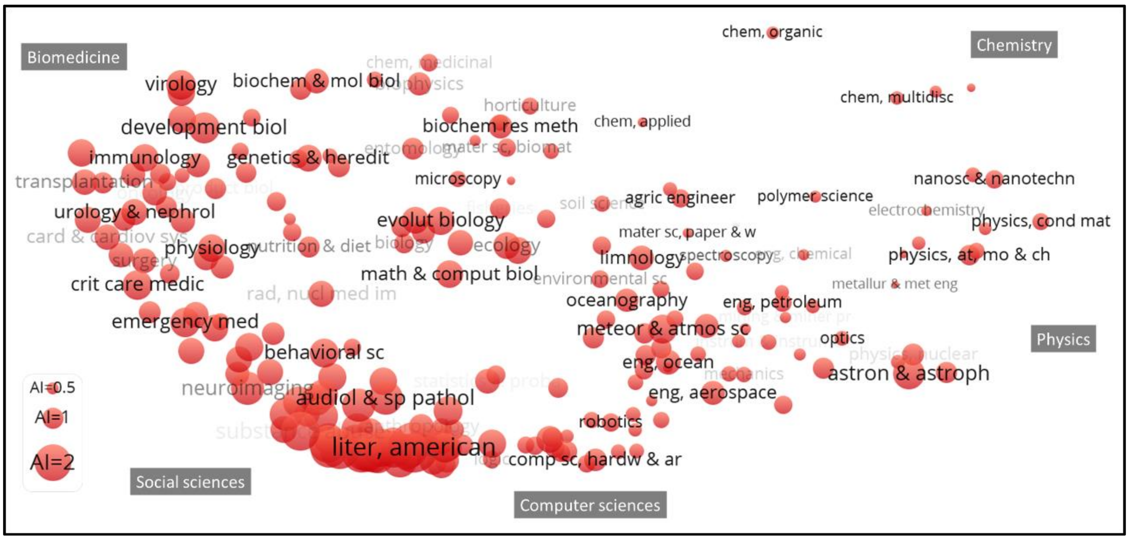

Figure 10: Fields are highlighted in red if the USA published a proportion of more than 10% of all highly-cited publications in this field in the period from 2010 to 2015

3) Fields in which China exceeds the global mean: chronological sequence of normalized citation impact from 1999 to 2015

The field-normalized citation impact standardize the number of citations for a paper in relation to the number of average citations in the relevant subject category and publication year (Bornmann, in press). The citation window ranges from the time of publication until the end of 2017. The colour in the following overlay maps (Figures 11-14) reflects the **normalized citation impact score**:

1 = global citation average for the subject category;
<1/>1: the citation impact is below/above average;
>= 1.5: the citation impact is excellent;
white nodes reflect scores of less than 1;
purple nodes reflect scores of more than 1.5.

The size of the circles shows a country's activity level in a field. The **activity index (AI)** reflects a country's proportion in a specific field to own publication output relative to the proportion of this field to global publication output (see above).

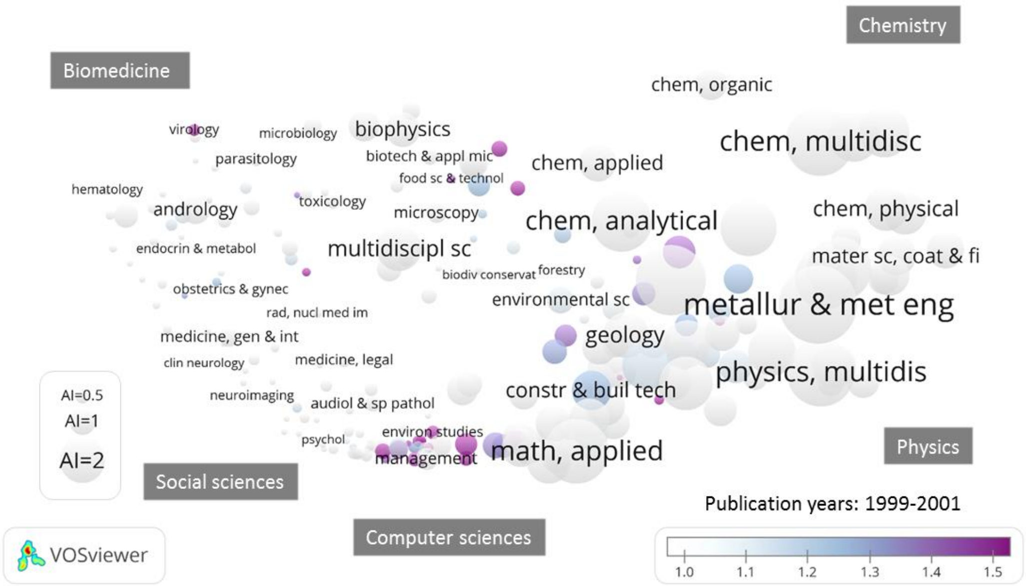

Figure 11: Field-normalized citation impact (publication years 1999-2001)

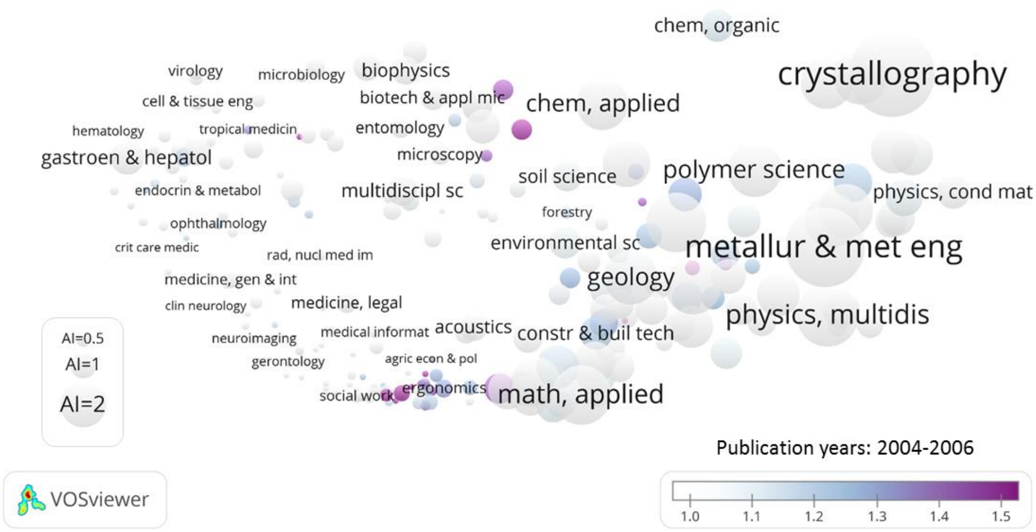

Figure 12: Field-normalized citation impact (publication years 2004-2006)

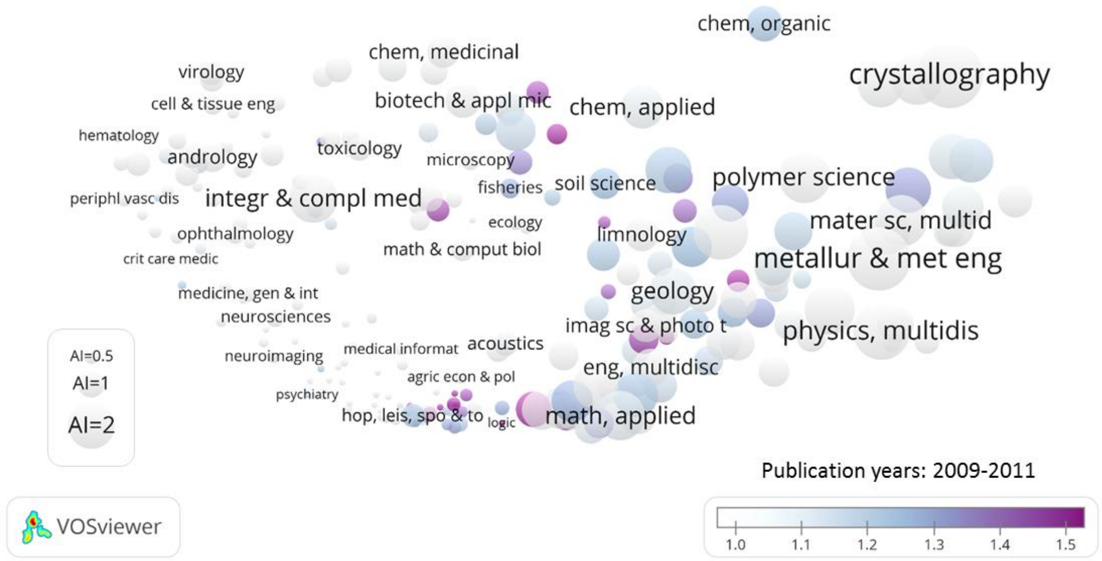

Figure 13: Field-normalized citation impact (publication years 2009-2011)

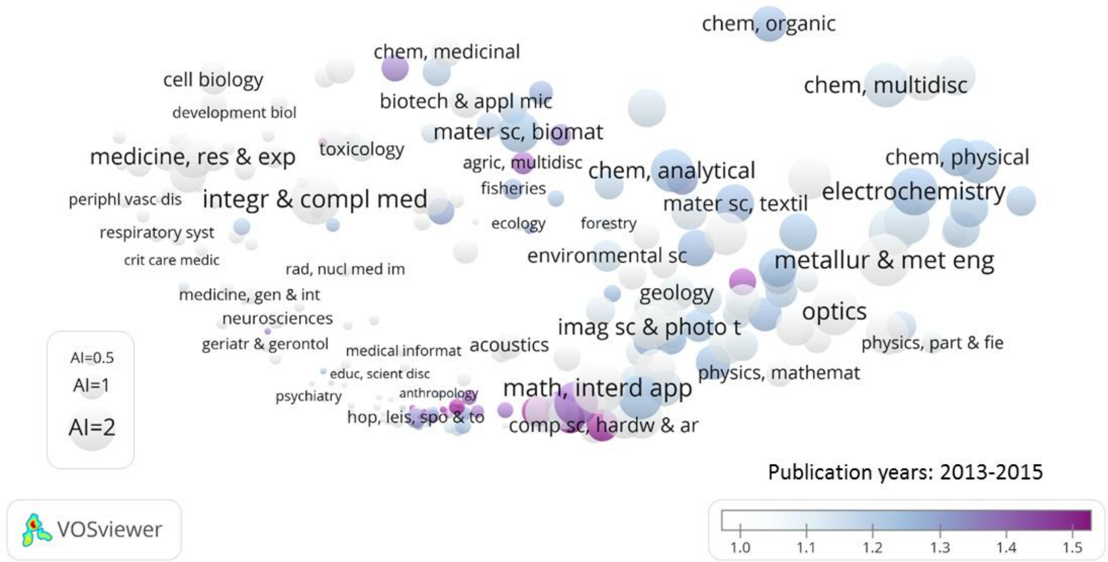

Figure 14: Field-normalized citation impact (publication years 2013-2015)

Conclusion: From 1999 to 2015, the maps for China become gradually darker and more homogeneous. This signifies a broader, less focused subject orientation overall as well as an increase in the citation impact in the fields represented by darker colouration.

4) Comparison with Germany, the USA, and India

4a) Germany

Fields in which Germany exceeds the global mean: chronological sequence of normalized citation impact from 1999 to 2015 (Figures 15-18)

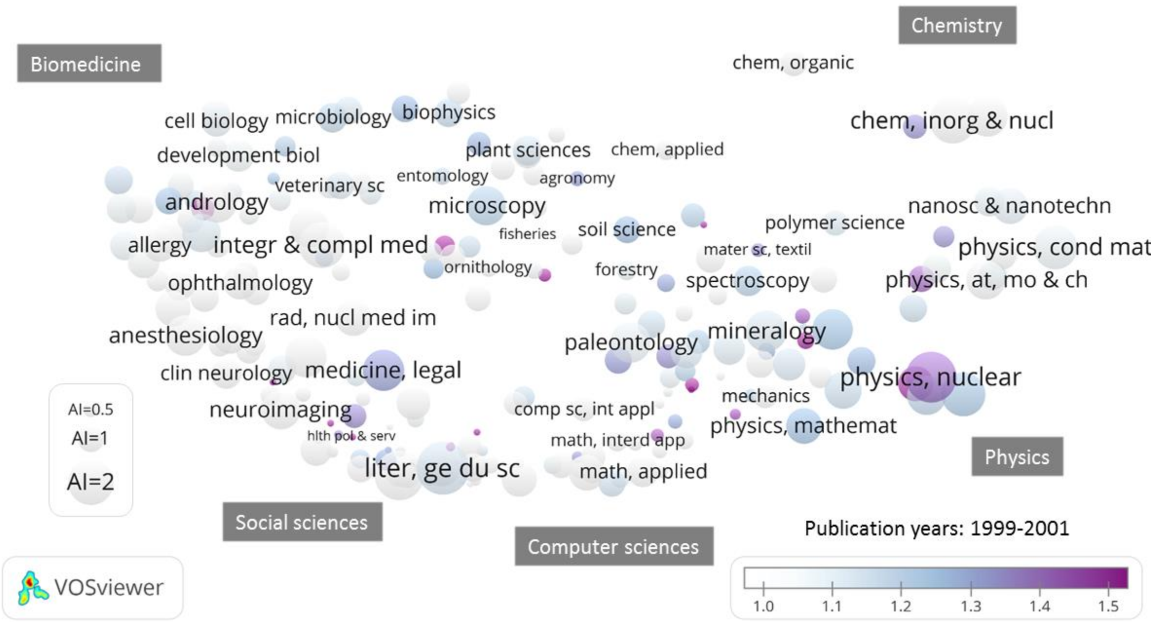

Figure 15: Field-normalized citation impact (publication years 1999-2001)

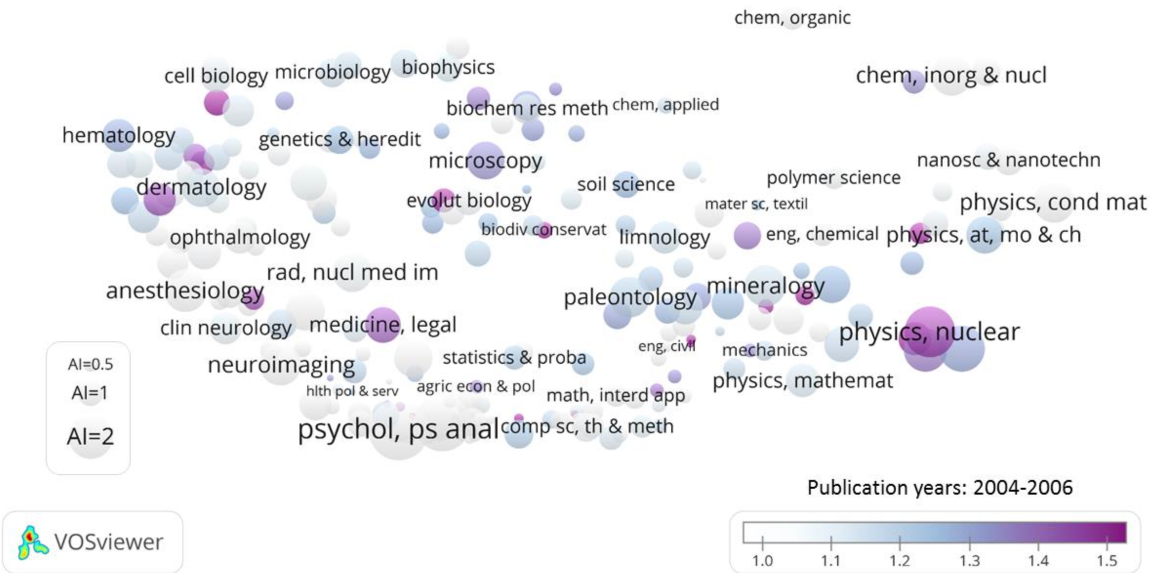

Figure 16: Field-normalized citation impact (publication years 2004-2006)

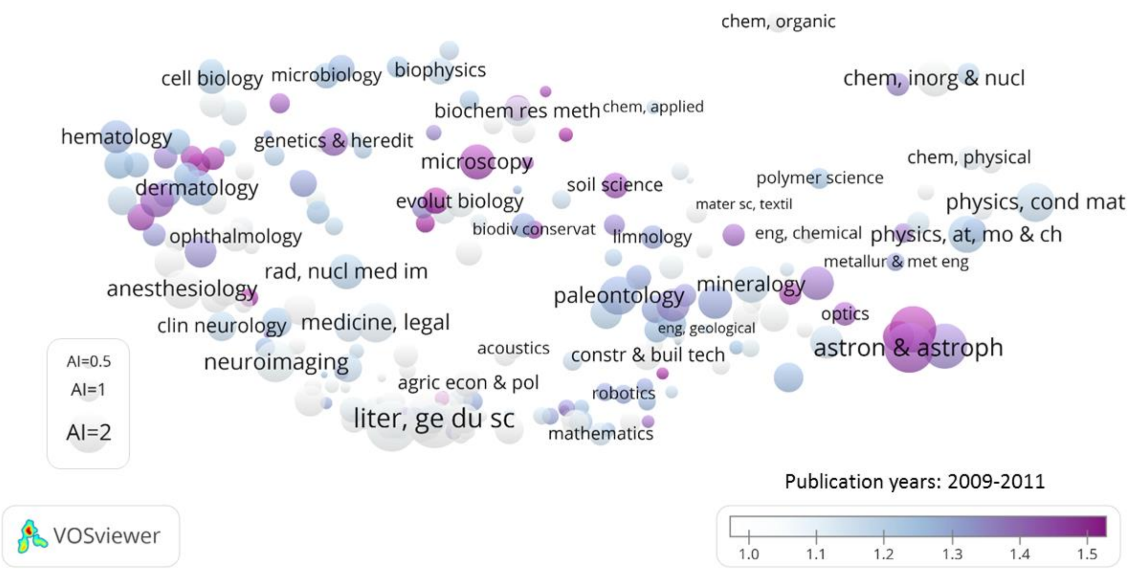

Figure 17: Field-normalized citation impact (publication years 2009-2011)

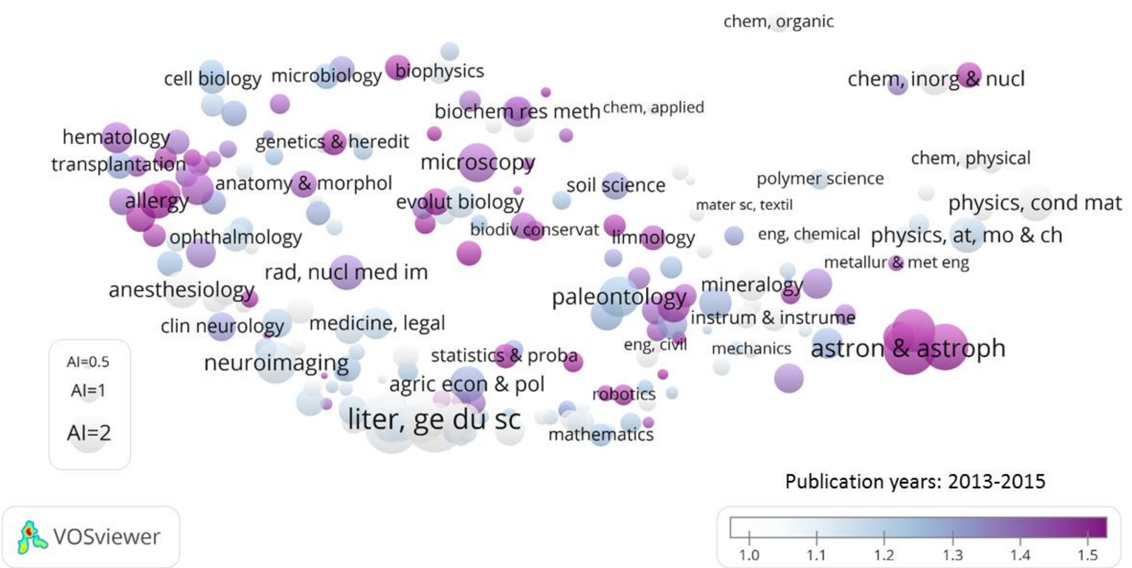

Figure 18: Field-normalized citation impact (publication years 2013-2015)

Conclusion: In Germany, in the period under review from 1999 to 2015, particularly the fields Medicine, Life Sciences, Astronomy, Astrophysics, Physics as well as Robotics have become excellent fields with a high normalized citation impact.

4b) USA

Fields in which the United States exceeds the global mean: chronological sequence of normalized citation impact from 1999 to 2015 (Figures 19-22)

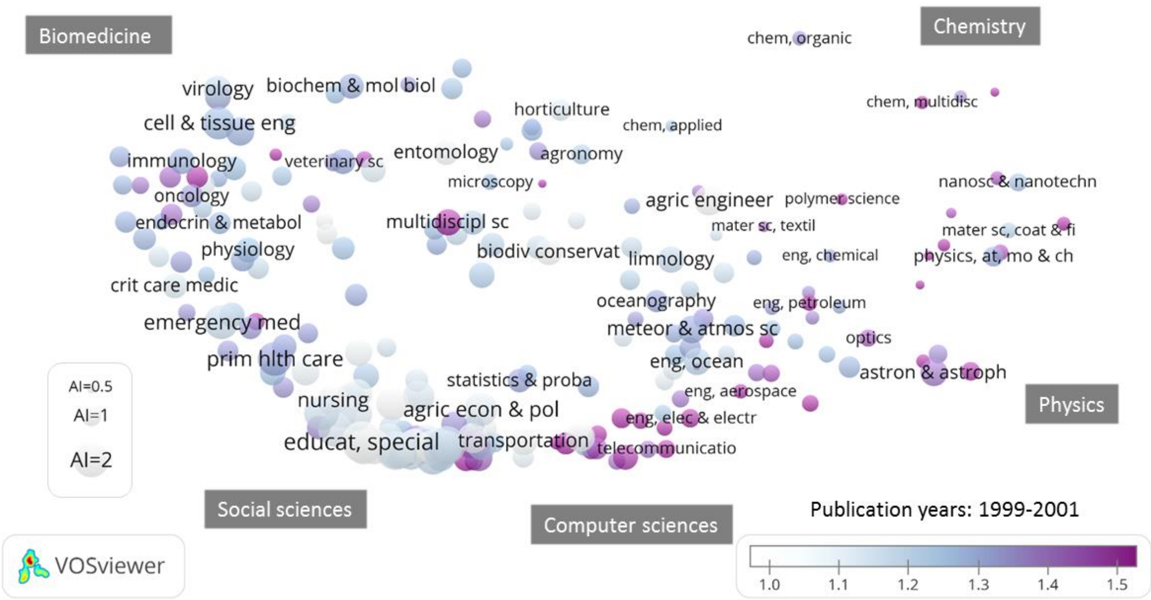

Figure 19: Field-normalized citation impact (publication years 1999-2001)

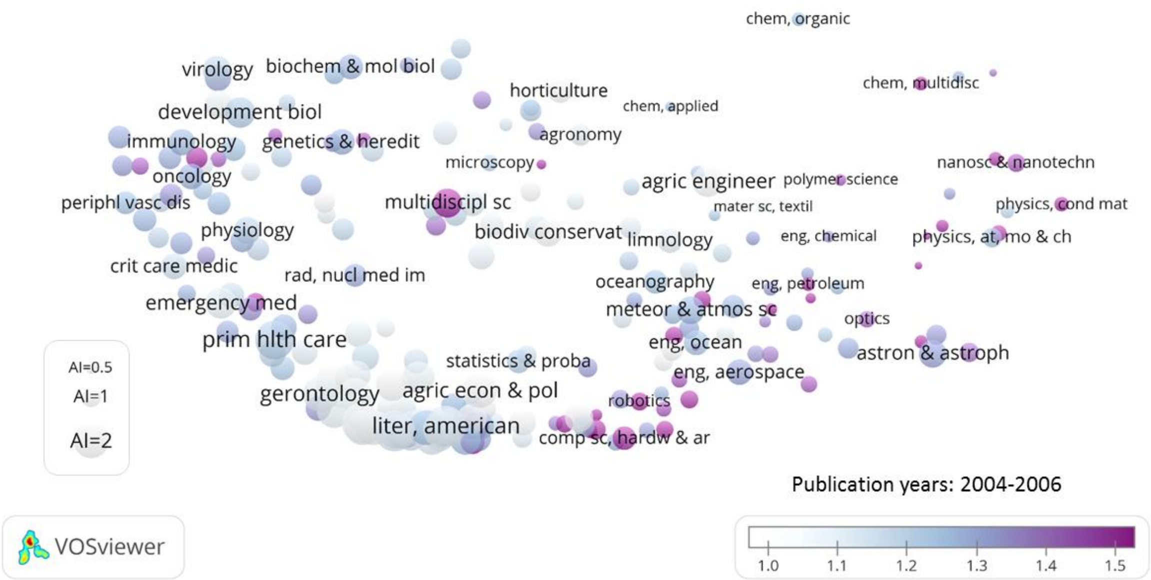

Figure 20: Field-normalized citation impact (publication years 2004-2006)

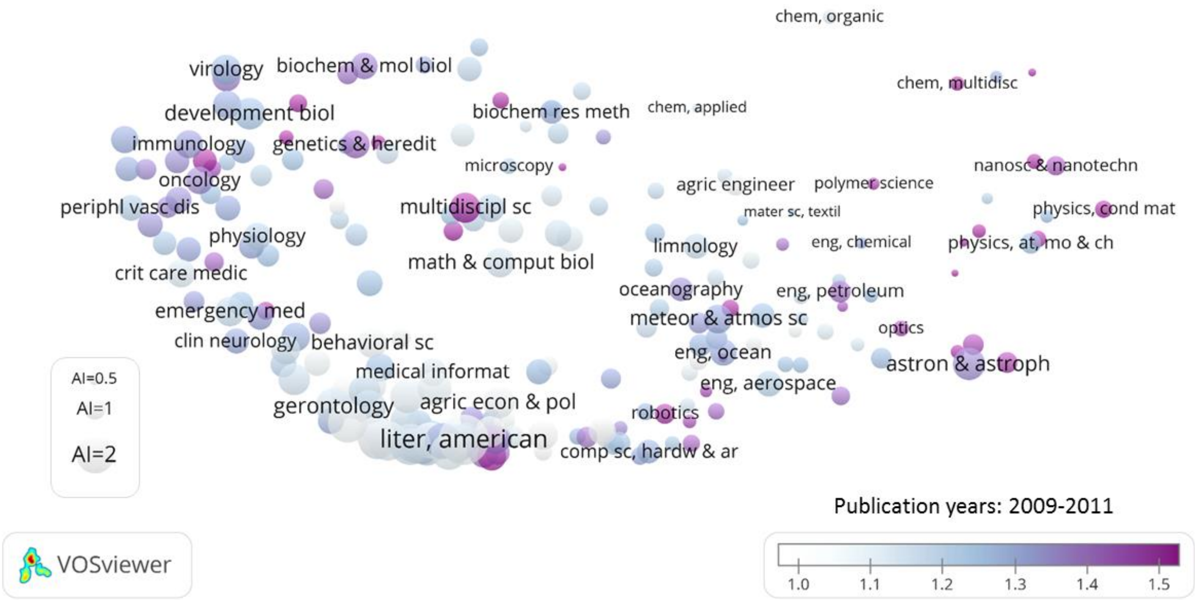

Figure 21: Field-normalized citation impact (publication years 2009-2011)

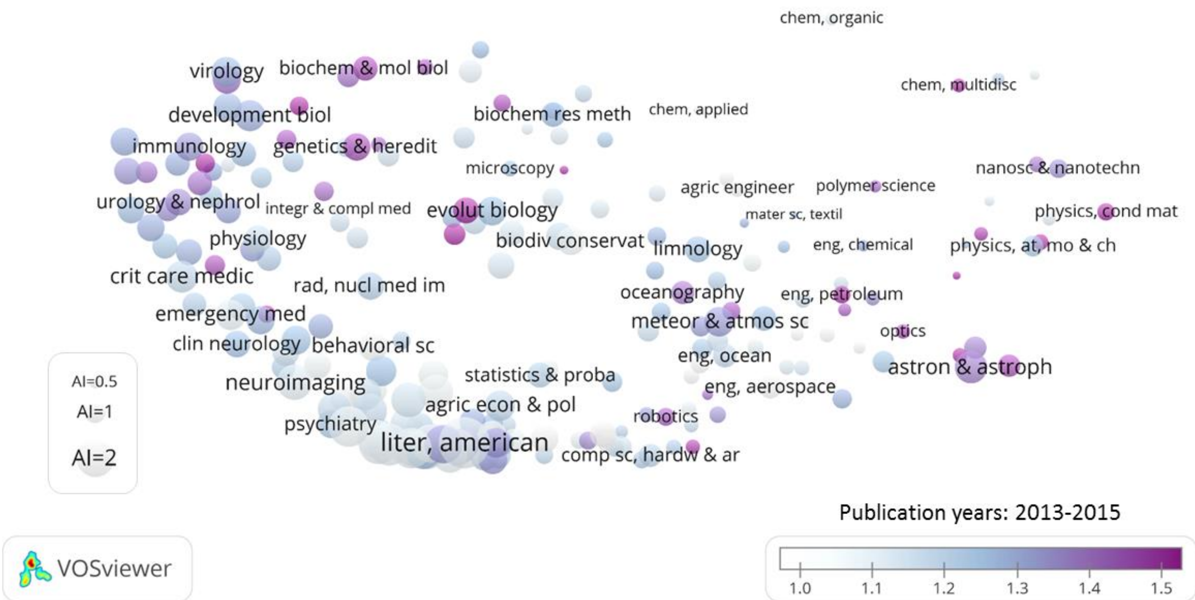

Figure 22: Field-normalized citation impact (publication years 2013-2015)

Conclusion: In the first window from 1999-2001, the USA have high normalized citation impact values for numerous fields. The fourth window, 2013-2015, sees a broad distribution of medium to high values for the normalized citation impact, primarily in the following areas: General Medicine, Geosciences, Computer Science and Life Sciences, Physics, Astronomy and Astrophysics.

4c) India

Fields in which India exceeds the global mean: chronological sequence of normalized citation impact from 1999 to 2015 (Figures 23-26)

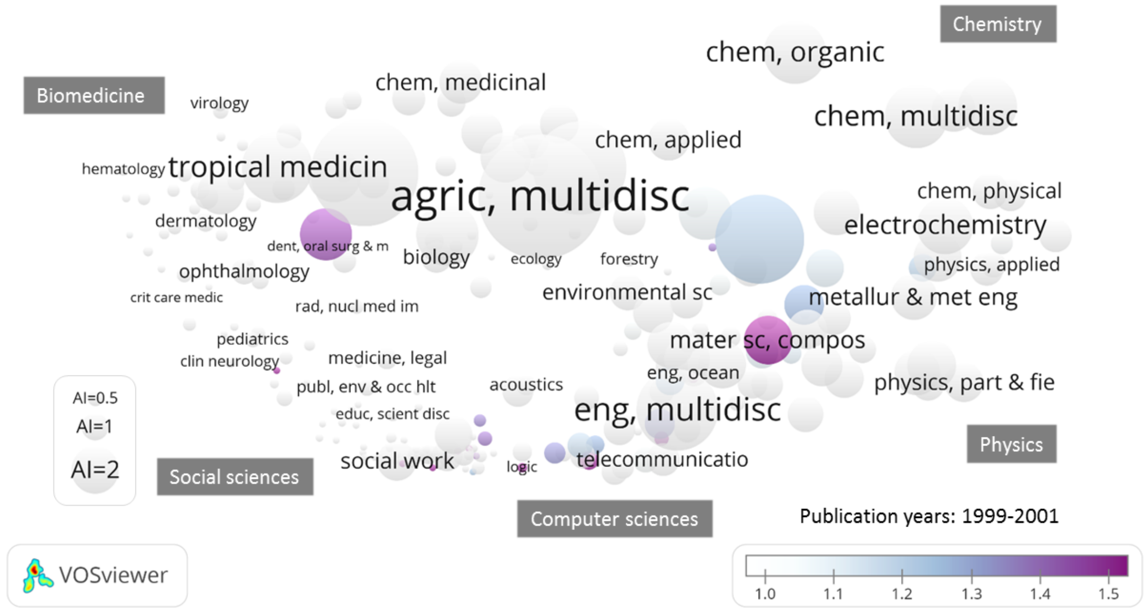

Figure 23: Field-normalized citation impact (publication years 1999-2001)

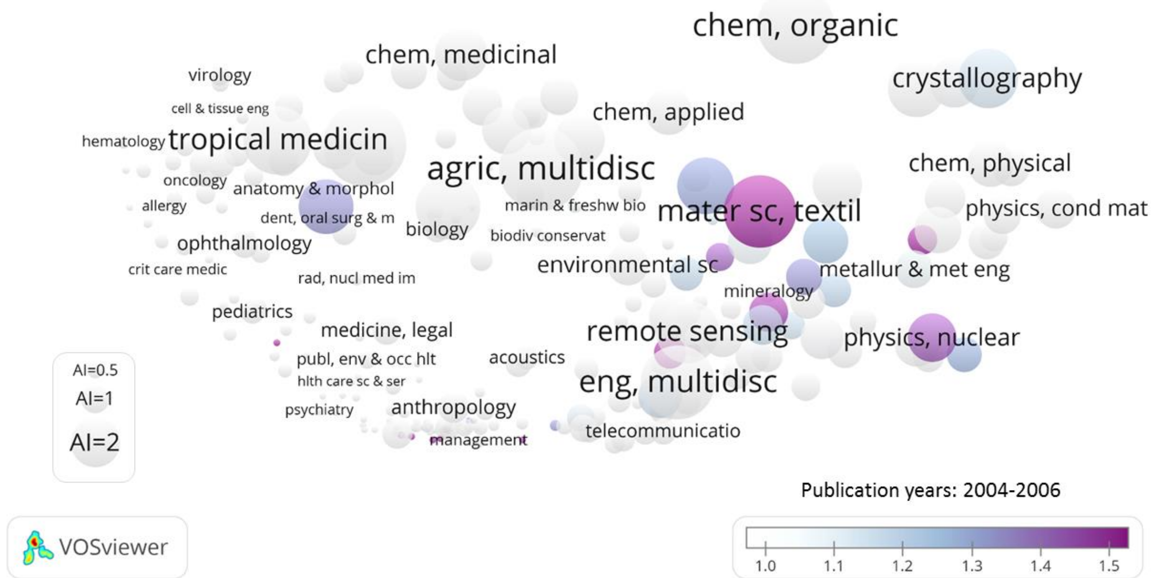

Figure 24: Field-normalized citation impact (publication years 2004-2006)

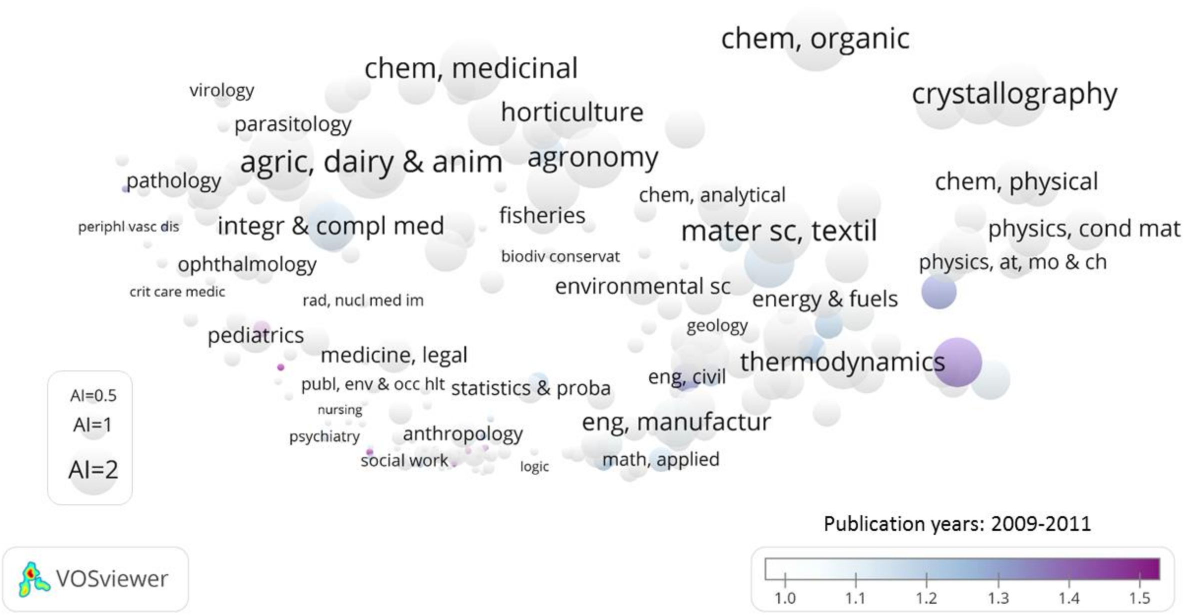

Figure 25: Field-normalized citation impact (publication years 2009-2011)

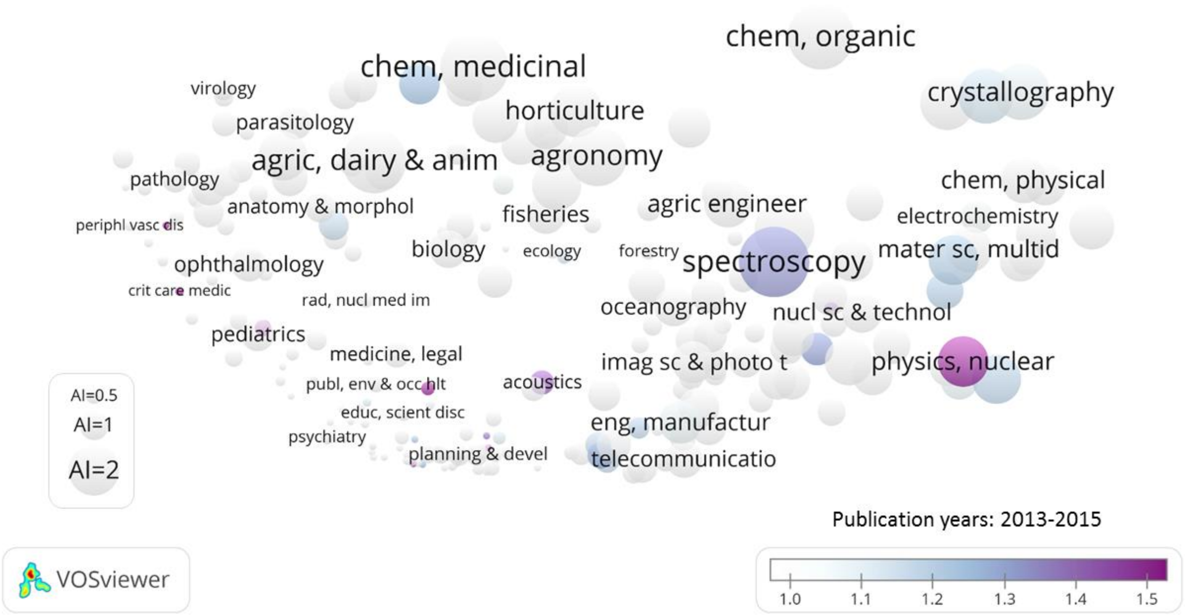

Figure 26: Field-normalized citation impact (publication years 2013-2015)

Conclusion: In the first window from 1999-2001, India has a concentration of high activity values for the areas Agriculture, Tropic Medicine, Material Sciences and Engineering. During the course of the fourth window, 2013-2015, activities in the fields homogenize. In each window, there are some fields with a relatively high normalized citation impact.

5) Analysis of the fields in which Chinese publications were represented with more than 1000 highly-cited papers [P(top-10%), i.e. papers which belong to the 10% most-cited papers in the field and publication year] for the period 2011 to 2015

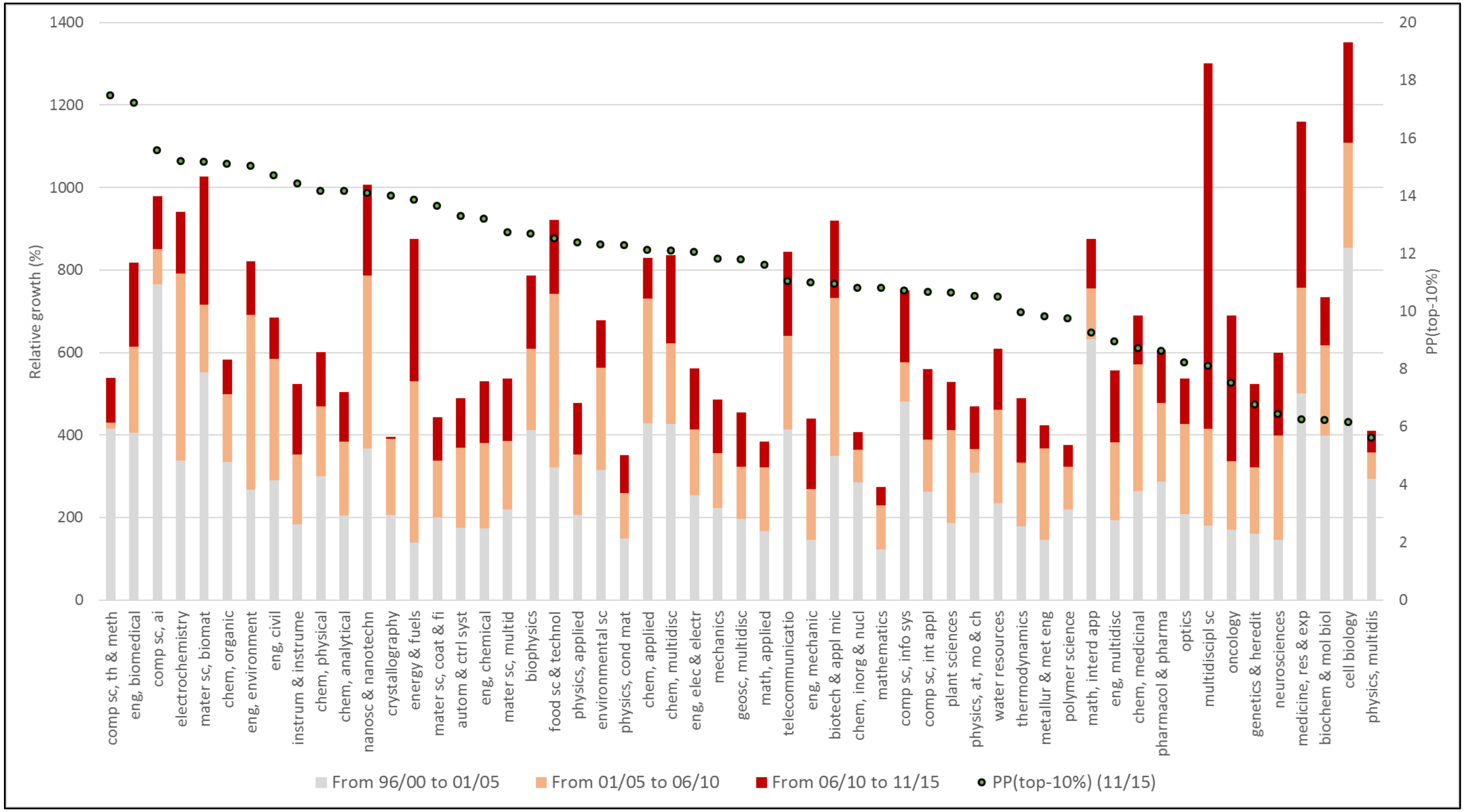

Figure 27: Relative growth (%) of highly-cited publications in fields with high publication activity in the window 2011-2015 [sorted by the proportion of papers belonging to the 10% most-cited papers in the field and publication year, PP(top-10%)]

Figure 27 shows the fields in which there were more than 1000 highly-cited publications from China (i.e. publications belonging to the 10% most-cited publications in the field and publication year) in the period 2011-2015 [P(top-10%)]. The fields are sorted by ascending proportions of highly-cited Chinese publications in the respective field (green dotted line, belonging to the right axis). The relative growth in the number of highly-cited papers from China was determined based on the number of papers in the fields from the four intervals (1) 1996 to 2000, (2) 2001 to 2005, (3) 2006 to 2010, (4) 2011 to 2015. The three resulting growth rates from 96/00 to 01/05 (grey), from 01/05 to 06/10 (orange), and from 06/10 to 11/15 (red) are shown as (stacked) bar charts.

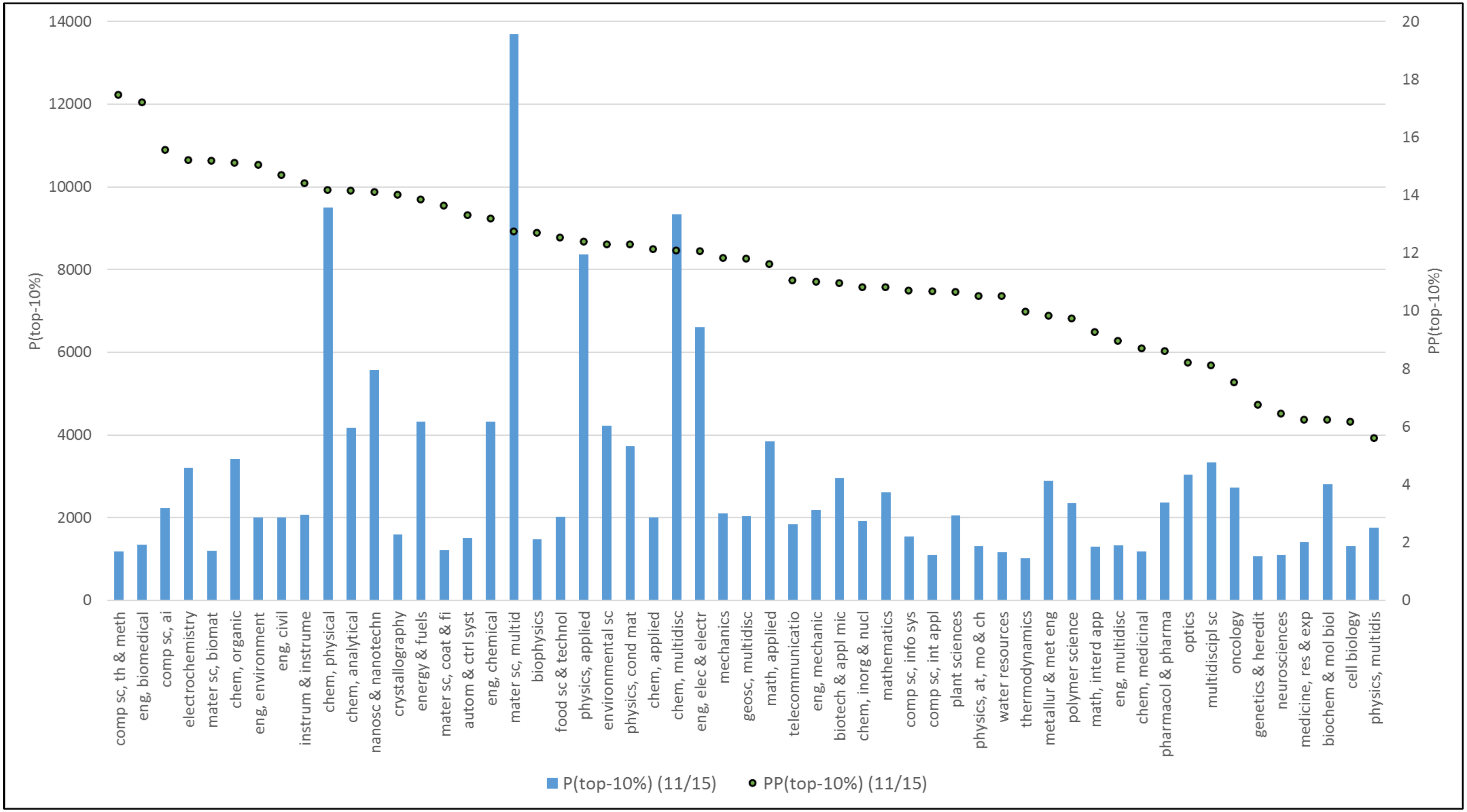

Figure 28: Number and proportion of publications belonging to the 10% most-cited publications in the field and publication year [P(top-10%) and PP(top-10%)]

Figure 28 shows the fields in which there were more than 1000 highly-cited publications from China [P(top-10%), i.e. publications belonging to the 10% most-cited publications in the field and publication year) in the period 2011-2015. The fields are sorted by ascending proportions of highly-cited Chinese publications in the respective field (green dotted line, belonging to the right axis). The blue bar shows the absolute number of highly-cited papers for the respective field [P(top-10%)].

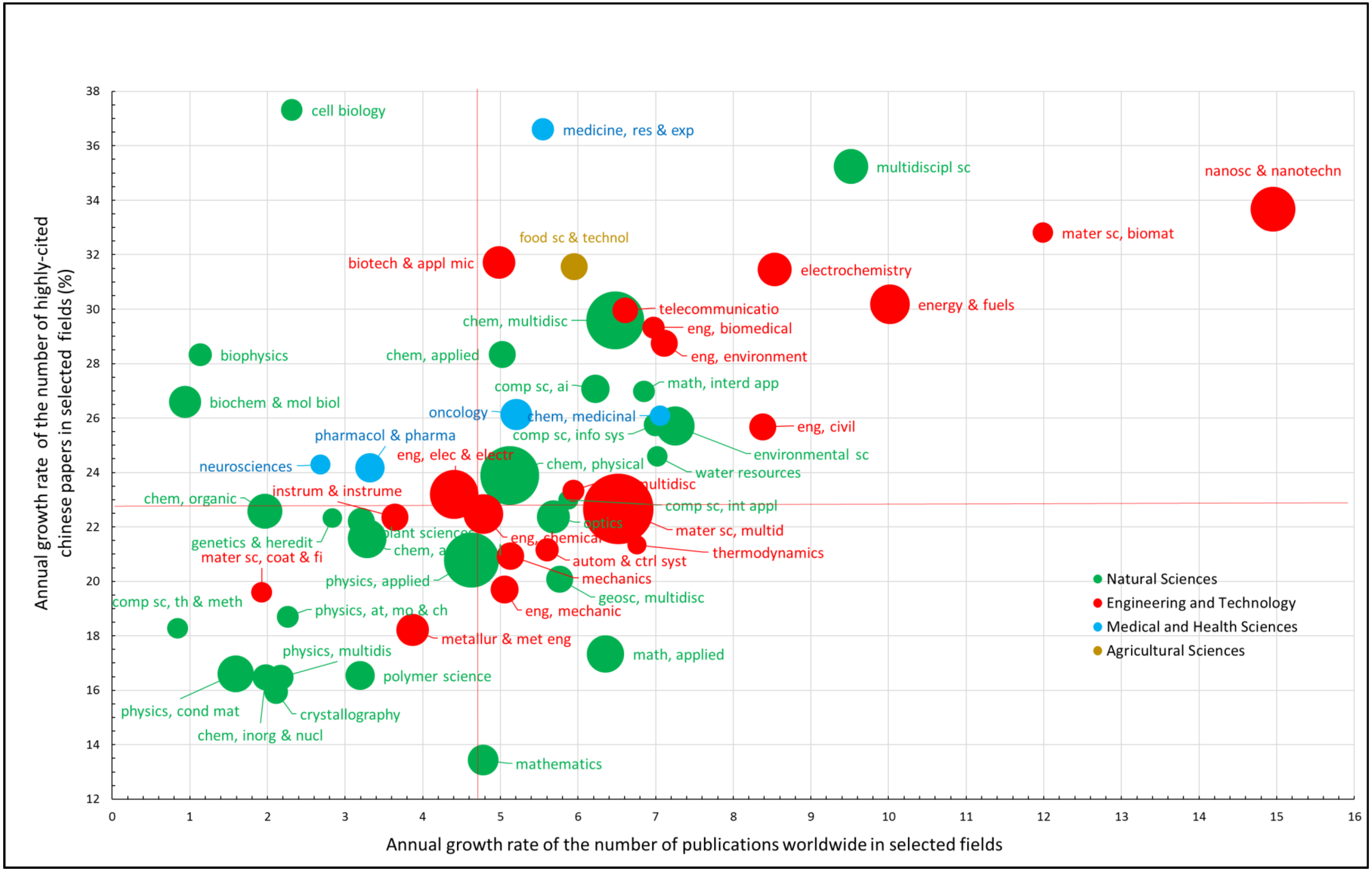

Figure 29: Annual growth rate of the number of publications in selected fields (fields in which China has at least 1000 papers in the period from 2011 to 2015). The red lines in the figure show the annual average growth rates over the growth rates of all evaluated fields

The annual number of scientific publications in a field is a very good measure of research activity in a field. Science is progressing more rapidly in those fields that have high growth rates in their annual publication numbers. In the following figures, the fields are colour-coded and assigned to the following areas: *Natural Sciences*, *Engineering and Technology, Medicine and Health Sciences, Agricultural Sciences, Social Sciences,* and *Humanities.*

Figure 29 shows an analysis of the fields in which China had at least 1000 frequently cited publications (publications belonging to the 10% most-frequently cited in their field and publication year) in a given year in the period between 2011 and 2015. The annual growth rates in publication numbers were evaluated for the period from 2001 to 2015. The horizontal axis shows the annual growth for the overall number of publications in a field; the vertical axis shows the annual growth in the number of highly-cited Chinese publications in a field. The two red lines in the figure mark the average (4.7% and 22.8%) of the annual field-specific growth rates. The area enclosed by the circles reflects the number of the highly-cited Chinese publications in the period from 2011-2015 in each field.

The results in Figure 29 show that the growth rates in the number of highly-cited Chinese publications is more than double that of worldwide publication output **in all evaluated fields**. The difference is especially pronounced in fields that are in the top half of the diagram (and to the left), such as *cell biology*, *artificial intelligence*, *energy and fuels*, *electrochemistry*, *biomaterials, nanoscience*, and *nanotechnology*.

Highly-cited Chinese publications as a proportion of highly-cited global publication output is evaluated by field in the following two figures (30 and 31). For comparison, the figures 32, 33, 34 and 35 show the results of the same analysis for the U.S., Germany, and the European Union (EU28).

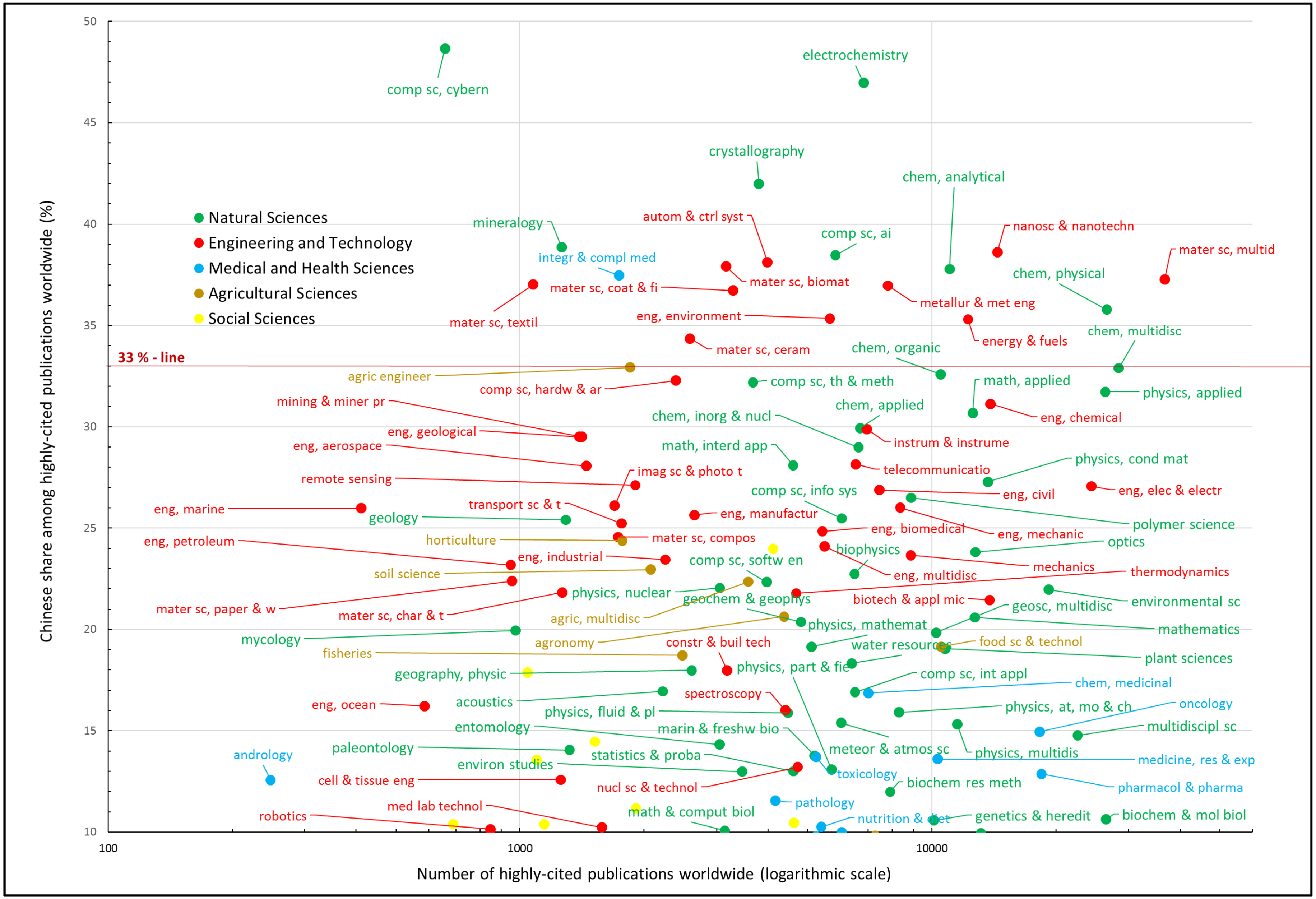

Figure 30: Chinese share among highly-cited publications [PP(top-10%)] in fields for which the highly-cited Chinese publications represent more than 10% of the highly-cited global publication output.

Figure 30 shows highly-cited Chinese publications as a proportion of the total number of highly-cited publications in each field for the 2011-2015 period. Many fields have a relatively high proportion: For instance, about 19 fields that are above or near the red line in Figure 2 can be identified. For these fields, at least one third of the entire global highly-cited publication output comes from China: *electrochemistry, cybernetics, crystallography, analytical chemistry, physical chemistry, applied chemistry, mineralogy, coatings and films, automation and control systems, metallurgy and metallurgical engineering, biomaterials, textiles, ceramics, artificial intelligence, nanoscience and nanotechnology, environmental engineering, agricultural engineering, energy and fuels,* and *organic chemistry.*

Overall, the *Natural Sciences* (green) and *Engineering and Technology* (red) fields have the highest proportion of Chinese publications (the yellow data points for *Social Sciences* are not labelled).

The proportion of China's publications is more than 30% in almost all chemistry fields; *electrochemistry* is especially worthy of mention at 47% (the U.S. proportion is 16%, the EU proportion is 19%, and Germany's is 5%, see Figures 32, 34and 35). Focuses of Chinese research in this field are lithium batteries and catalysts. In almost all materials science fields, China's publications make up more than 20% of the overall number. Its highly-cited publication proportion of 39% in the field of *nanoscience and nanotechnology* puts China even with the U.S.; EU is at 21% and Germany at 7% in this field. Here, Chinese research is focused on nanomedicine and catalysis (see also O'Meara, 2018).

In the field of *artificial intelligence,* highly-cited Chinese publications are not only growing strongly (see Figure 29), but also make up a comparatively large proportion of global output of highly-cited publications at 38% (the EU is at 31%, the U.S. is at 21% and Germany at 6%).

In *Engineering and Technology* (red), highly-cited German publications as a proportion of those in a given field are ahead of Chinese only in the fields of *microscopy* (Germany: 21%, China: 3% – EU: 58%, U.S.: 30%), *nuclear science and technology* (Germany: 16%, China: 13% – EU: 46%, U.S.: 27%), *robotics*, (Germany: 13%, China: 10% – EU: 41%, U.S.: 40%), and *communication* (Germany: 6%, China: 3% – U.S. 57%, EU: 36%). The result for *robotics* (China's relatively low proportion) underscores the fact that Industry 4.0 could mean potential for China.

China leads in *integrative and complementary medicine* (37% against the U.S. at 10%, the EU at 18%, and Germany at 5%), probably because traditional Chinese medicine is so widespread there. In the field of *oncology,* China is ahead of Germany (15% to 11%), but trails far behind the U.S. (53%) and the EU (40%).

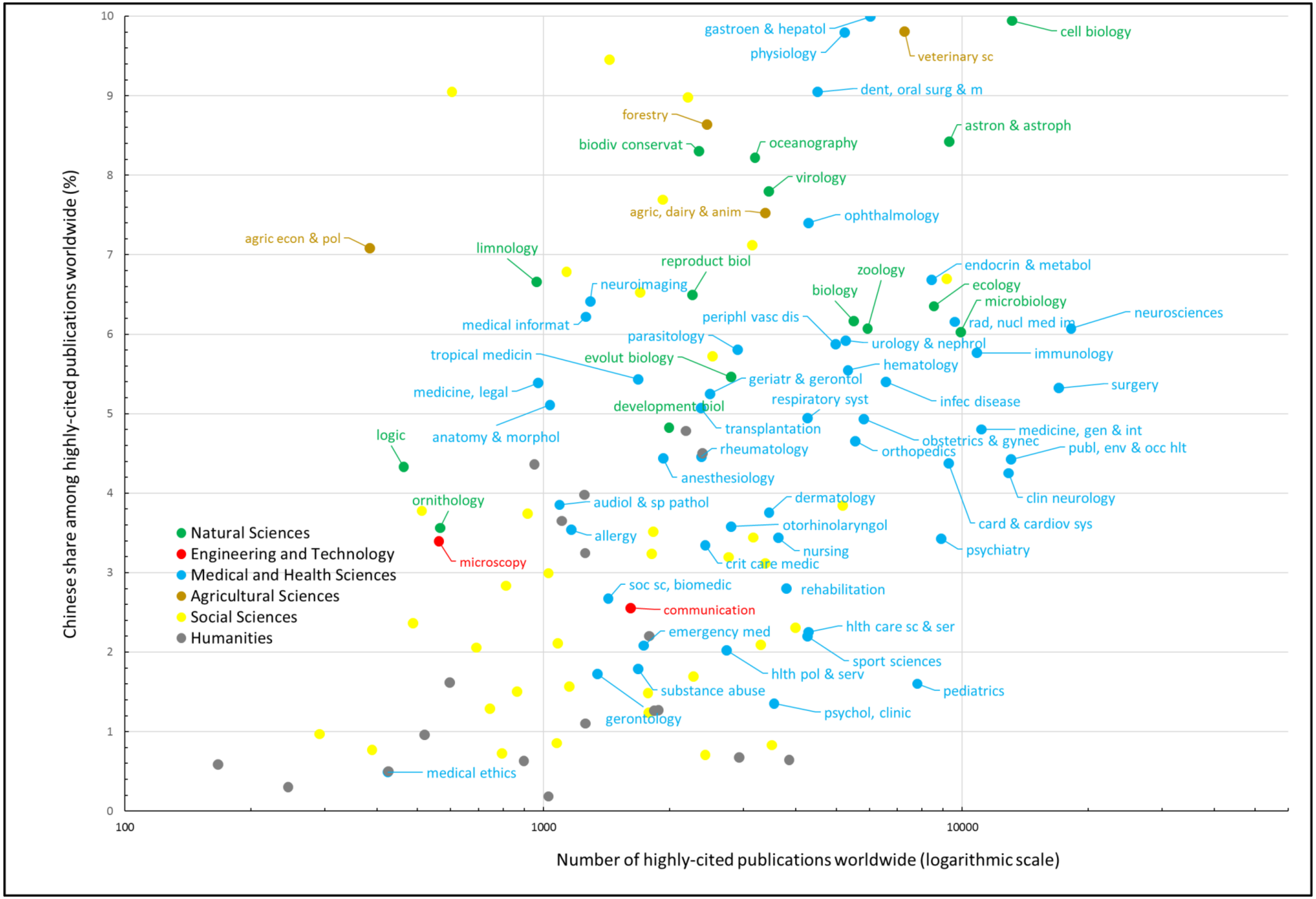

Figure 31: Chinese share among highly-cited publications [PP(top-10%)] in fields for which the highly-cited Chinese publications represent <u>less</u> than 10% of the highly-cited global publication output.

Figure 31 shows the fields in which Chinese activity can be considered minor: Fields for which the *highly-cited Chinese publications represent* less than 10% of highly-cited global publication output. These fields are primarily in *Social Sciences*, *Humanities,* and *Medical and Health Sciences* (the data points for *Social Sciences* and *Humanities* are not labelled). In *Engineering and Technology,* only *microscopy* and *communication* have a relatively low share of Chinese highly-cited publications.

The highly-cited publications from the U.S. make up at least 30% in *Medical and Health Sciences* fields. In the six *Medical and Health Sciences* fields in which Germany's proportion of highly-cited publications is the highest, China has potential with which to close the gap. The fields are: *allergy* (Germany: 22%, China: 4% – EU: 58%, U.S.: 46%); *neuroimaging* (Germany: 19%, China: 6% – U.S.: 54%, EU: 52%); *dermatology* (Germany: 18%, China: 4% – EU: 51%, U.S.: 39%); *haematology* (Germany: 17%, China: 6% – U.S.: 57%, EU: 52%)*; radiology, nuclear medicine, and medical imaging* (Germany: 17%, China: 6% – EU: 49%, U.S.: 48%)*;* and *cardiac and cardiovascular systems* (Germany: 17%, China: 4% – U.S.: 55%, EU:52%).

In *physics and astronomy,* China's proportion of highly-cited publications is only 8% (U.S.: 68%, EU: 67%, Germany: 33%). The 33% in *physics and astronomy* makes it the field in which Germany achieves its best result. China is planning extensive research infrastructures in the field, some of which are already under construction, so the Chinese proportion will probably rise greatly in future.

Comparing the EU with the U.S. as an aside, the EU has a higher proportion of highly-cited papers in the fields materials science and engineering sciences in general, as well as specifically in mathematics and particle physics. The U.S. on the other side has the lead in almost all fields of medical and health sciences.

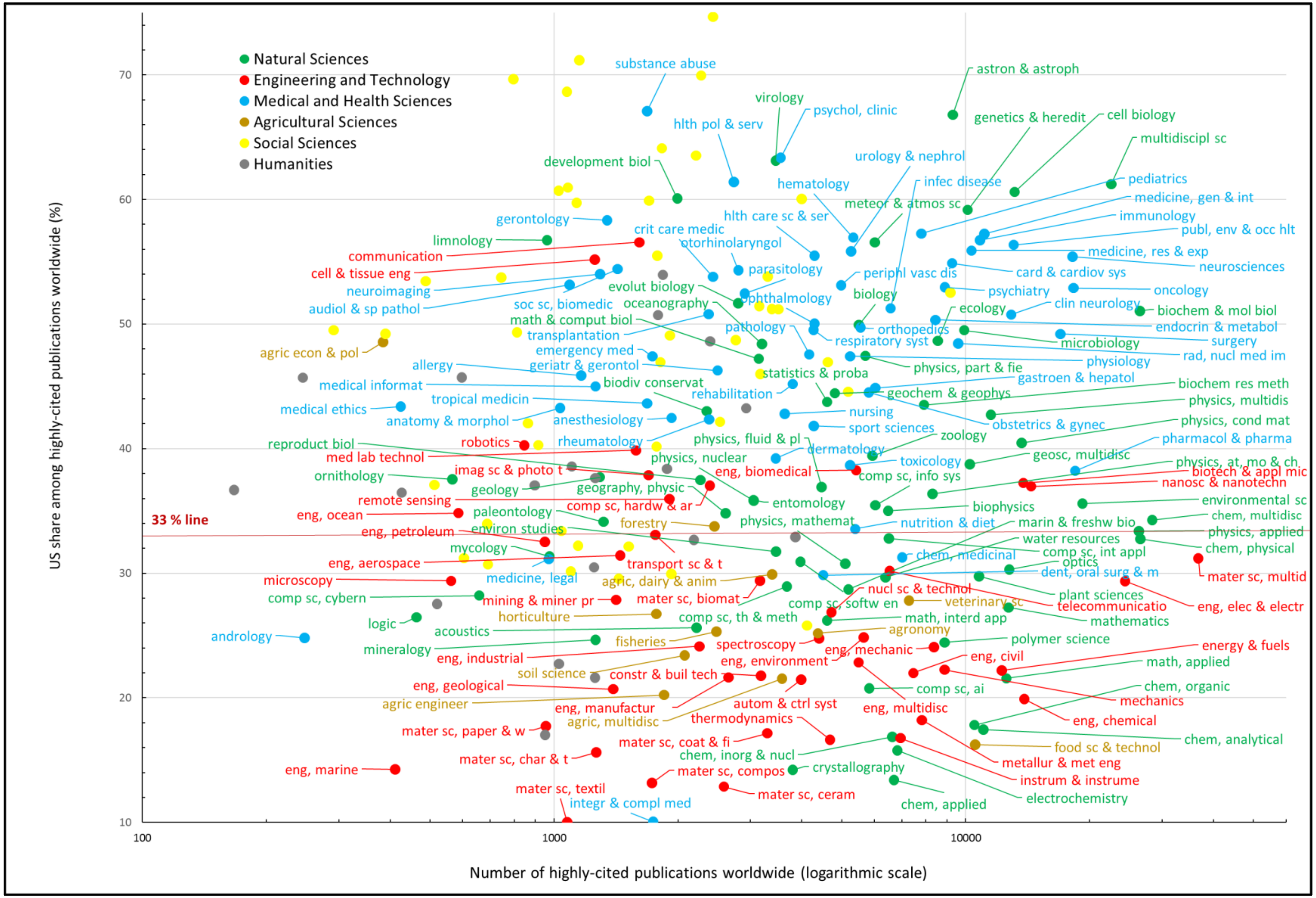

Figure 32: US share among highly-cited publications [PP(top-10%)] worldwide in all fields.

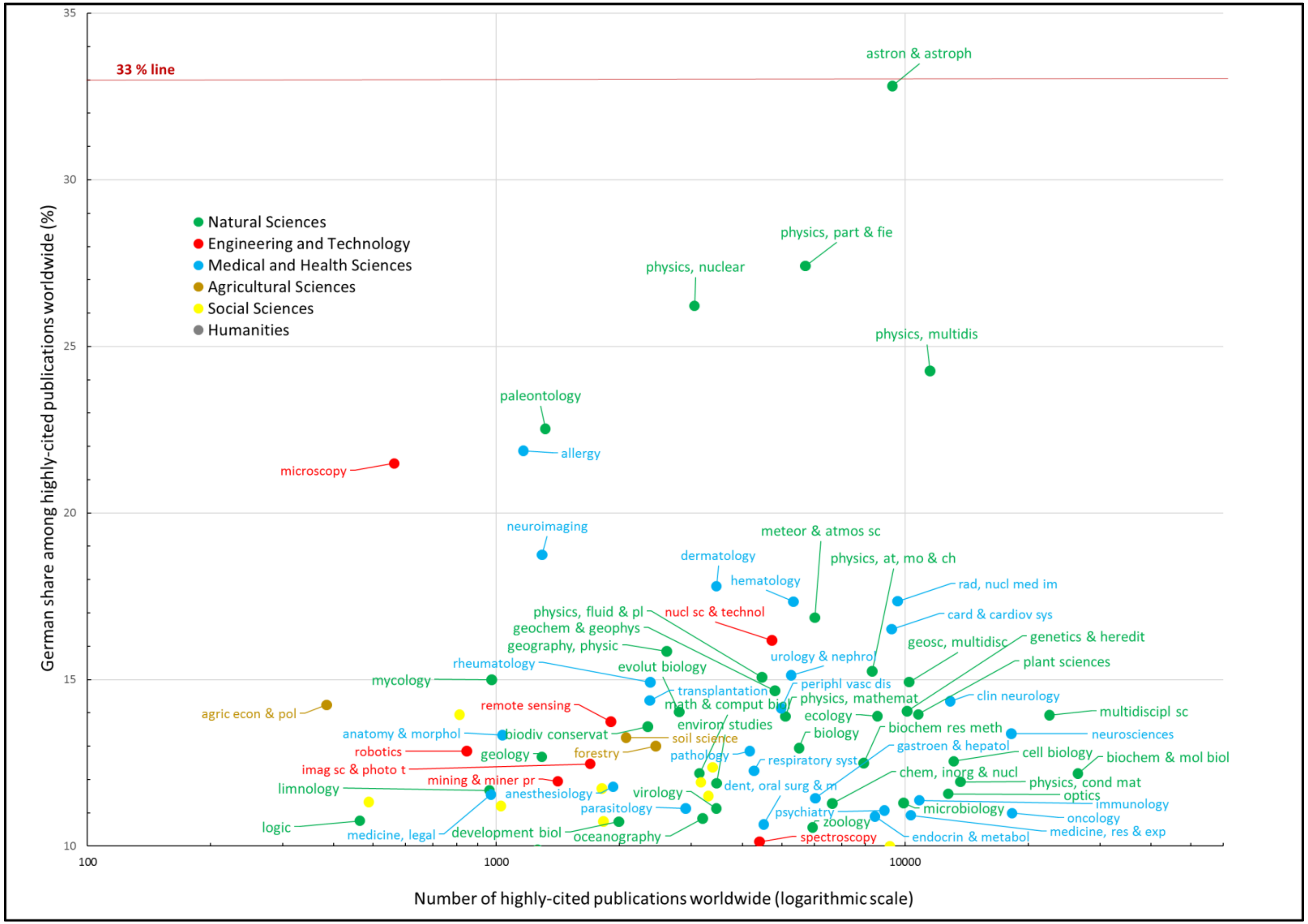

Figure 33: German share among highly-cited publications [PP(top-10%)] in fields for which the highly-cited German publications represent more than 10% of the highly-cited global publication output.

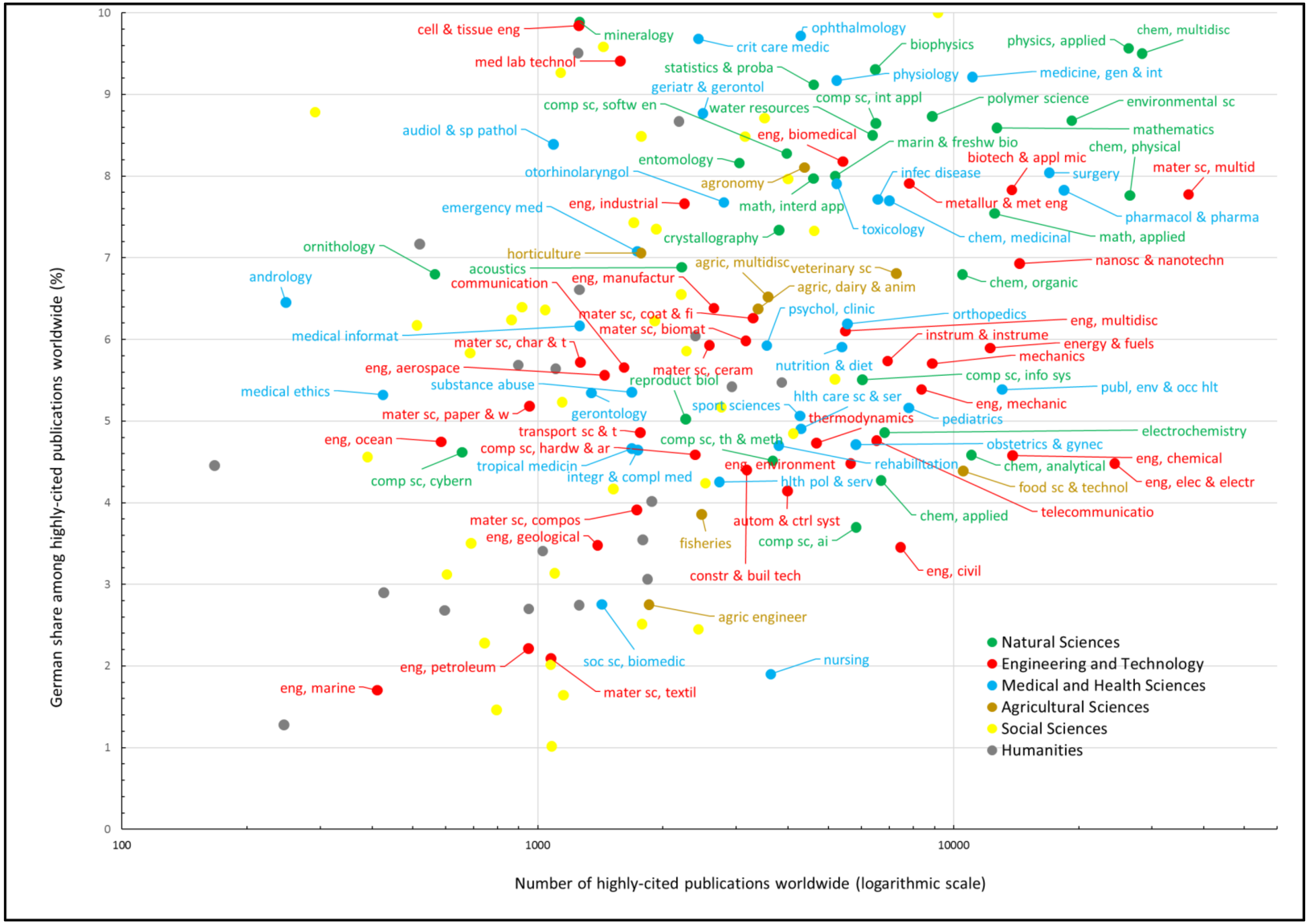

Figure 34: German share among highly-cited publications [PP(top-10%)] in fields for which the highly-cited German publications represent <u>less</u> than 10% of the highly-cited global publication output.

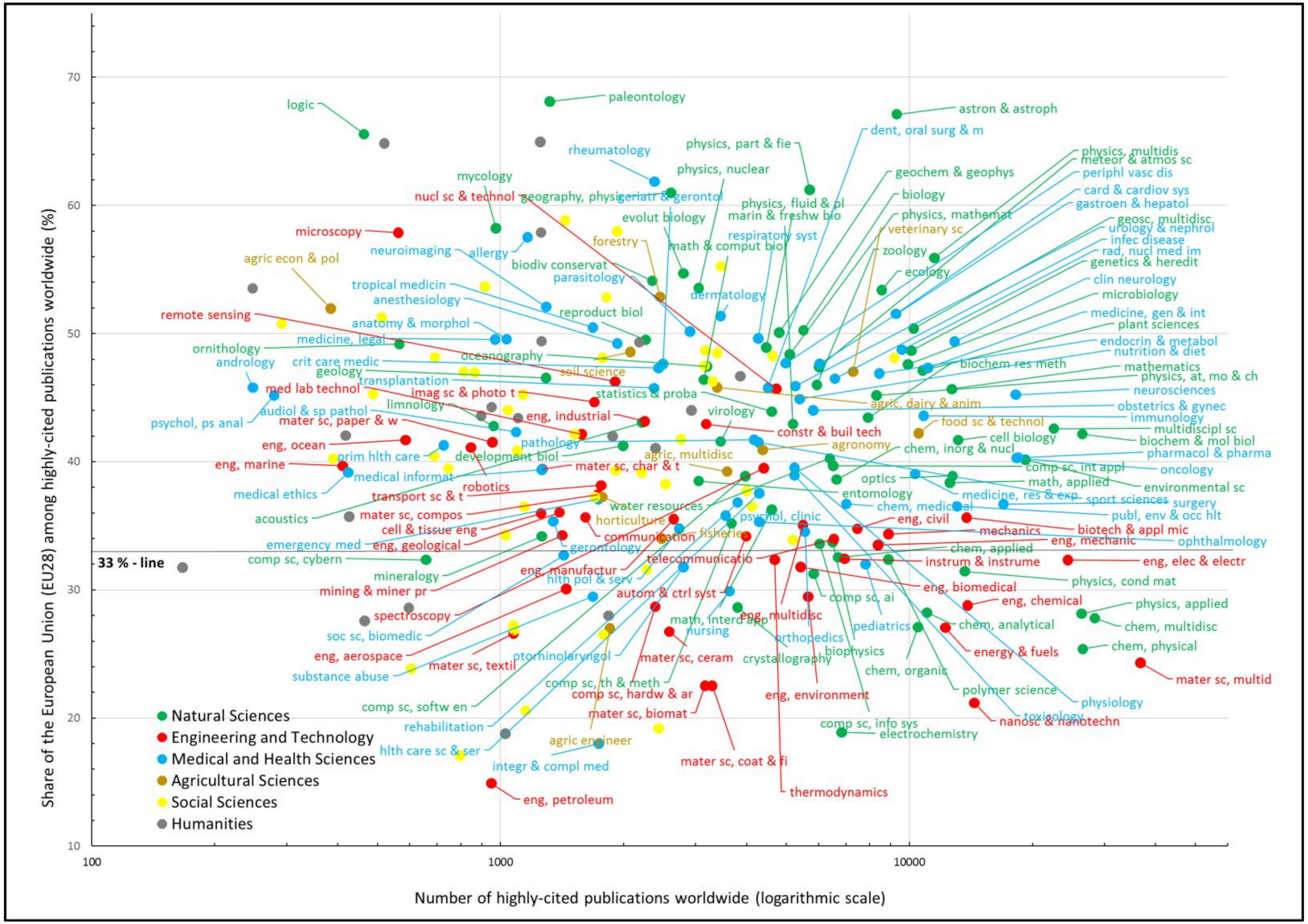

Figure 35: Share of the European Union (EU 28) among highly-cited publications [PP(top-10%)] in fields for which the highly-cited EU 28 publications represent <u>more</u> than 10% of the highly-cited global publication output.

Recently, Wu, Wang, and Evans (2019) introduced the disruption index (DI) which is conceptually based on a dynamic network measure for technological change which has been introduced by Funk and Owen-Smith (2017). The DI has been explained by Azoulay (2019) as follows: "when the papers that cite a given article also reference a substantial proportion of that article's references, then the article can be seen as consolidating its scientific domain. When the converse is true – that is, when future citations to the article do not also acknowledge the article's own intellectual forebears – the article can be seen as disrupting its domain". Wu et al. (2019) undertook some empirical analyses (e.g., a comparison of the DI with expert assessments of disruption and development) to validate whether the DI does in fact measure what it intends to measure. The analyses seemed to reveal that the index is able to measure new insights, methods or ideas which may have disrupt the usual cumulative development in a scientific field. However, it should be considered in the interpretation of the following results that the new disruption index has been controversially discussed in two recent papers (Wu & Yan, 2019; Wu & Wu, 2019).

Table 1: Highly-cited papers (belonging to the 0.1% in the corresponding subject category and publication year) and the absolute and relative numbers of disruptive and developmental papers among the highly-cited papers for countries having published more than 1000 highly-cited papers. The numbers of papers are fully counted (and not fractionally).

Country	Highly-cited papers		Disruptive papers: Highly-cited papers with DI >= 0.2		Developmental papers: Highly-cited papers with DI <= -.05	
	n	%	n	%	n	% cases
USA	12457	63.07	701	63.44	980	61.33
UK	2939	14.88	162	14.66	214	13.39
Germany	2221	11.25	67	6.06	207	12.95
Canada	1600	8.1	81	7.33	126	7.88
France	1589	8.05	65	5.88	146	9.14
China	1310	6.63	16	1.45	110	6.88
Netherlands	1153	5.84	41	3.71	76	4.76
Australia	1119	5.67	39	3.53	80	5.01
Italy	1091	5.52	25	2.26	107	6.7
Japan	1082	5.48	45	4.07	112	7.01
Switzerland	1010	5.11	49	4.43	80	5.01
N	19750		1105		1598	

In this part of the study, we used the DI to investigate how disruptive or cumulative the highly-cited research from China is in comparison with other countries. In the calculation of the DI, only articles with at least 10 cited references are considered to facilitate reliable DI calculations. Table 1 shows the national numbers of papers (articles) belonging to the 0.1% in the corresponding subject category and publication year (column: highly-cited papers). Only countries with at least 1000 highly-cited papers published between 1980 and 2010 are shown. The table further shows the national distributions of disruptive and developmental among the highly-cited papers. The thresholds for identifying both paper types are shown in the table. For example, China has a percentage of 6.63% highly-cited papers. The country's share among the developmental papers is similar (6.88%). However, its share among the disruptive papers is much lower (1.45%). Thus, China is oriented more strongly towards developmental than disruptive research.

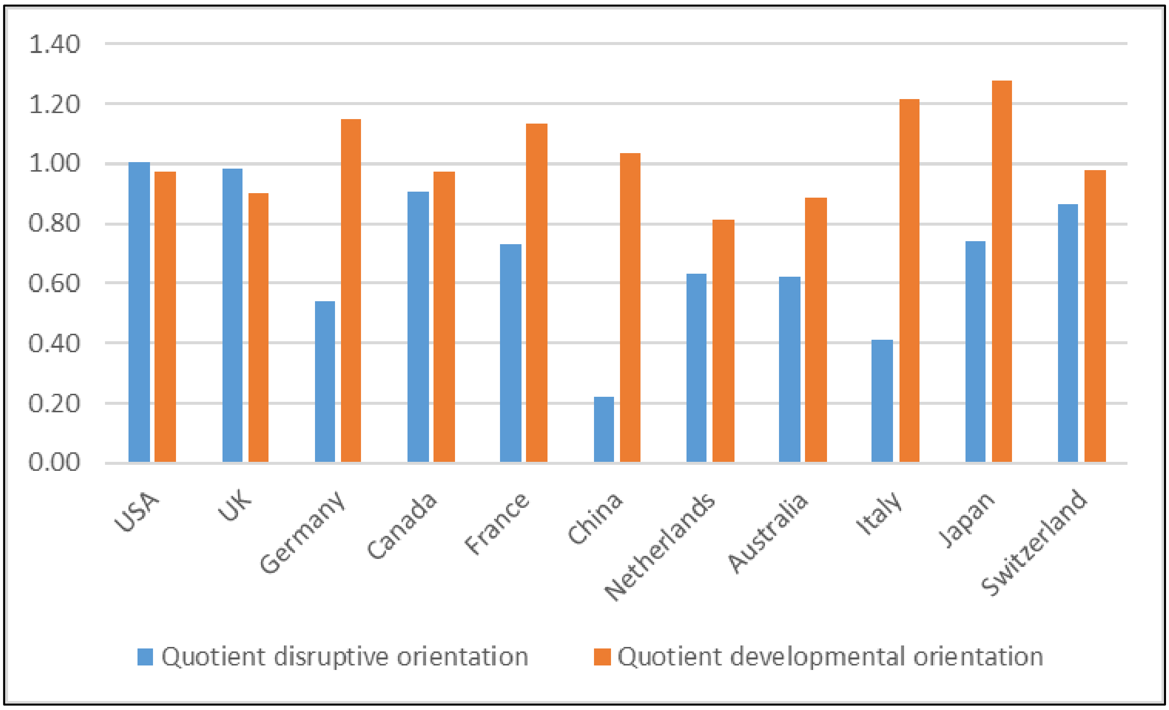

Figure 36: National orientation towards disruptive and developmental research

Figure 36 reveals the quotients from national shares of papers among disruptive / developmental research and national shares of papers among highly-cited papers. Quotients nearby 1 point out that the country's research is not biased towards disruptive / developmental research which is the case for the USA. China meets expectations according to developmental research, but has the lowest quotient among the eleven countries according to disruptive research (0.22). Other nations with low disruptive orientation quotients are Italy (0.41) and Germany (0.54). Japan has the highest quotient concerning the share of developmental papers (1.28).

Figure 37 shows the annual distribution of highly-cited and disruptive papers by country. For every country (and all highly-cited and disruptive papers), the share of papers has been calculated of being published in one of the publication years between 1980 and 2015. The results in the figure reveal clearly that disruptive papers are rather early papers published in the 1980s or 1990s. Bornmann and Tekles (2019) speculate that it needs time to be acknowledged as a landmark paper in the corresponding community. The comparison of the country distributions in the figure shows expectedly that China has published rather younger disruptive papers than the other countries.

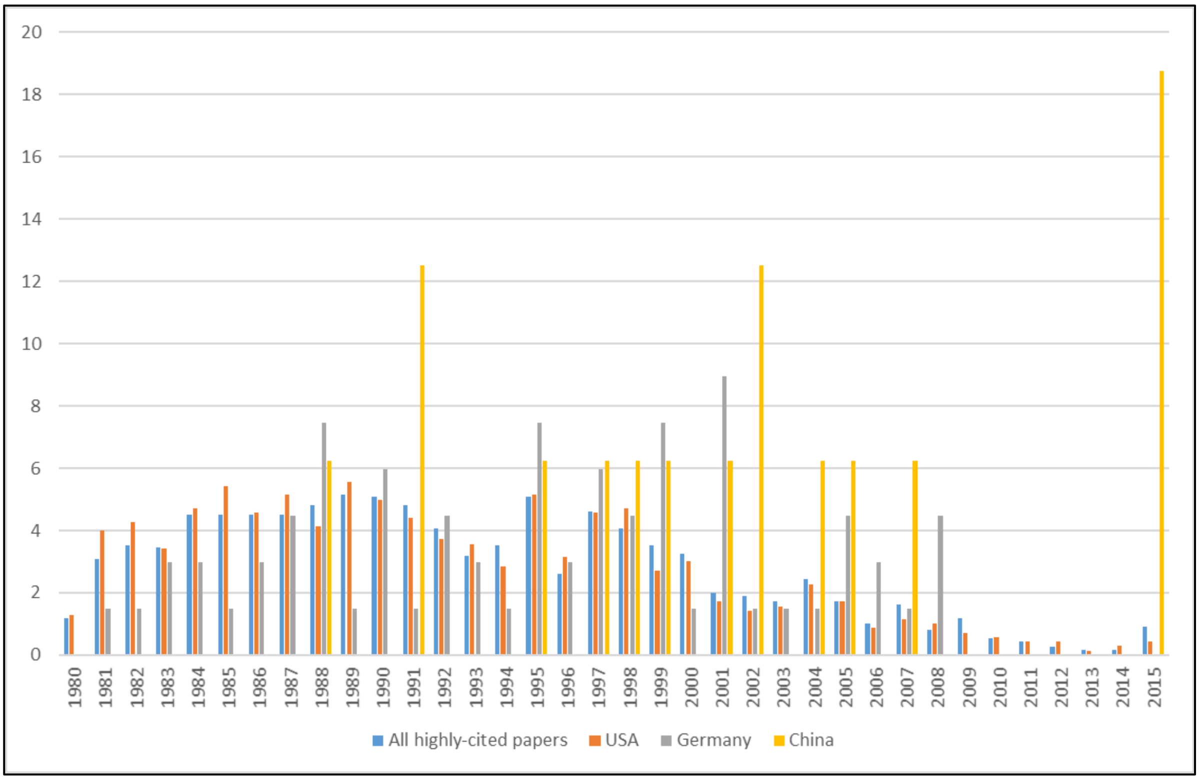

Figure 37: Annual distribution of disruptive papers by country (in percent)

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We thank Alexander Tekles for implementing the disruption index introduced by Wu et al. (2019) in our MPG in-house database (based on the Web of Science).

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