International Research Collaboration by DFG Leibniz Prize Winners

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1 Introduction

The Gottfried Wilhelm Leibniz Prize is an excellence prize awarded each year by the German Research Foundation, DFG, to 10 researchers who showed persistent world level research performance in their field. It is considered one of the most prestigious research grants in Germany. The preconditions include that candidates are affiliated to a home institution and have an outstanding academic research record. The winner receives a research grant of 2.5 million Euro to be spent over 7 years. The grant can be used to expand the research team by attracting new staff or to facilitate research working conditions. The Leibniz prize was initiated in 1985. Candidates cannot apply, but are put forward by their peers. A final decision on the prize follows the recommendation by the Leibniz nomination committee established within DFG. During its 25 years existence 303 winners were granted, of which 81 % in exact sciences and 19 % in social sciences and humanities.

Katz and Marin (1997) define research collaboration as 'the working together of researchers to achieve the common goal of producing new scientific knowledge'. Worldwide, the level of international cooperation has grown substantially over the past decades and it is generally considered as one of the driving forces in achieving scientific excellence. Multiple studies therefore treated the relationship between the degree of collaboration and research productivity (De Solla Price and Beaver 1966; Lawani 1986; Narin and Withlow 1990; Bozeman and Boardman 2003). At the same time, positive correlations have been established between international cooperation levels on the one side and citation impact on the other (Figg et al. 2006; Inzelt et al. 2009).

Collaboration between researchers can take on many forms such as international exchange, common use of material or joint participation in a research project (Van Raan 1998; Laudel 2002). The majority of studies on collaboration however focuses on the realisation of research output through joined publication, which will also be the perspective of this study. Although partial in nature, co-authorship analysis is considered as a stable and verifiable approach (Katz and Martin 1997). Co-authorship studies can be roughly divided in four types. First, studies detecting patterns/evolutions in collaborative networks. Connected to the first group are studies providing indicators that measure the strength of the collaboration patterns. A third group are papers searching for reasons and motives of collaboration. Finally, an important set of articles focuses on the effects of collaboration on research performance.

The aim of this note is to present collaboration patterns by German Leibniz prize winners. The question to be answered is to what extent prize winning scientists publish in cooperation with other partners, both national and international, and which partner countries are most preferred. Secondly, publications will be linked to their respective domains in order to further investigate what areas of research steer international collaboration.

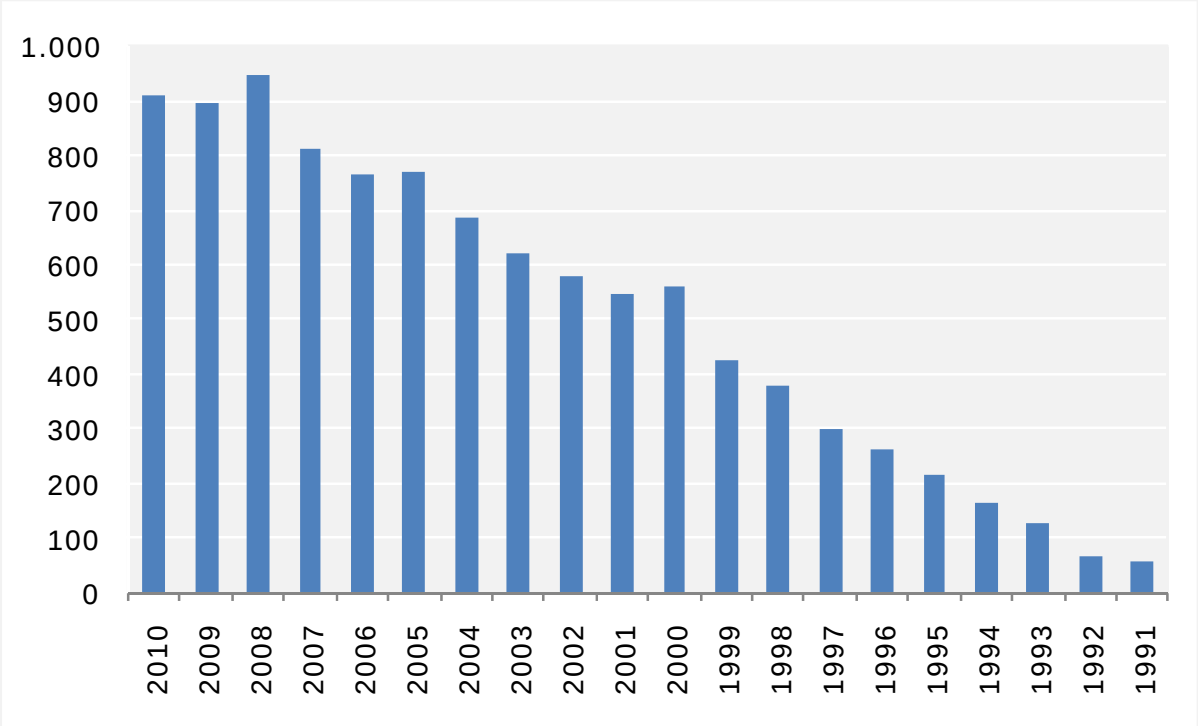
2 Data sources and data processing

The analysis is carried out on a publication data set of 88 Leibniz winners over the ten year granting period 2000 till 2009. The publication data are taken from the Science Citation Index Expanded, Social Science Citation Index and the Arts and Humanities Citation Index sets of the Thomson Reuters Web of Science (WoS) database. Only winners in the exact sciences disciplines are considered for the reason that social sciences and humanities publications are less covered by the Web of Science. The publication types are restricted to the so-called citable items: articles, letters, notes and reviews.

The publications for each author are taken from 10 years before winning the prize to 2010. This implies that the set used for study covers publications in a time frame 1991 until 2010. In total, the analysis was performed on a database of 10096 individual publications.

FIG1 shows the distribution of the number of publications in the considered set ordered by year of volume of the publication. It is clear from the graph that more recent publications are more frequent. This is mainly caused by the fact that the publications of all authors are taken until 2010. It implies that later publications by older winners are combined with papers of recent prize winners. Additionally, the increased representation of titles in the Web of Science strengthens the rising pattern in publication counts.

FIG1: Distribution of publications by year in number of publications



Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

One of the key challenges of this study was to obtain adequate publication lists of the respective authors. The issues at stake are threefold. A first consideration is completeness. Although databases allow detailed combined queries to be executed, results do miss a vast percentage of a researcher's publication set. This can be due to misspelling of names, translations and errors/absence of addresses. A second problem in running name/address queries is that individual researchers change institutions in the course of their careers. A complete publication list can therefore only successfully be composed if the curriculum of the author is well known. Finally, a trustworthy publication set has to be adequately cleaned for namesakes. The problem of homonyms is an essential one. Since bibliographic databases such as the Web of Science merely use the author's surnames and initials, it is in some cases very difficult to disentangle an individual's true publication set. Aksnes (2008) showed that in a Norwegian set of over 30000 researchers, about 14% homonymous authors could be traced in the WOS database. Author identification facilities offered by the databases provide some support, but are shown to be incomplete and not always up to date (Amez and Rons 2008).

Therefore the publication list of Leibniz winners are here composed merging three sets. First, the data retrieved using the distinct author set facilities of the Web of Science. Second, by extracting bibliographic records from the WOS database using a query containing the name of the author, combined with a filter of all the cities where the author worked in the course of his/her career. The career path information is taken from the CV's published by DFG after the winning of the prize. Finally, an internet search was performed for publication lists of the respective authors, allowing to complete the publication dataset and to determine the author's certainty set. An additional 5% of publications were collected in that way.

Although research is being performed on systems of automated author identification (D'Angelo et al. 2011; Wooding et al. 2006), most systems yet have to prove their validity and are not always straightforward to implement. Therefore the choice was made here to screen the resulting publication lists manually for homonyms, starting from the author's certainty set, co-author certainty set and the list of addresses drawn from the CV.

3 Domestic versus international cooperation

Nationality of the publishing authors is tracked using the affiliation field connected to the publications in the Web of Science. Nationality is determined by the institution where the author is active and can therefore change during career. The affiliation field contains concatenated information of the organization, the department, city and country respectively. From this field, the country names were extracted. Generally, country names appeared to be well standardised.

The descriptive statistics are shown in table 1. The large majority of publications published by Leibniz winners is realised under some form of cooperation. Only 290 publications in the sample set, or about 3 percent of the considered items, are single authored. This means that more than 97% of publications realised by Leibniz winners result from collaboration.

A further division can be made between domestic collaboration and international collaboration. The first group refers to a set of non-single authored publications where all the addresses are within one country. Publications are labeled international if at least two participating countries can be identified. Over 53% of the publications, or 5234 in number, are fully domestic. Of that, 4999 are fully German. Despite the fact that the analysis focuses on German Leibniz winners, some publications are domestic/non-German. These are publications attached to a German author who worked abroad for a substantial period. The level of domestic cooperation by Leibniz winners is significant and confirms the hypothesis by Frame and Carpenter (1979) that international collaboration is smaller if the national science base is larger. A total of 4572 publications were realised under international cooperation, representing 46% of the total. When establishing a single link between a publication and the distinct countries involved, publications on average mention 1.4 different countries in their affiliation addresses, Germany exclusive. Leibniz Prize winners co-published with authors from 79 different countries (see appendix).

Table 1: Descriptive statistics of Leibniz Prize winners' co-publication behavior

		Count	Percentage
Publications		10096	100%
Single author		290	3%
Multiple author		9806	97%
Multiple author			
	German domestic	4999	51%
	Foreign domestic	235	2%
	German international	4465	46%
	Foreign international	107	1%
		9806	**100%**

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

4 The profile of international co-authorship

To analyse patterns of international cooperation, various indicators can be employed and different ways of counting can be applied (Zitt et al. 2000 for an overview). In this study, a country link is counted once. In case of 4 co-authors, with 2 authors coming from German institutions and 2 authors connected to USA institutions, the link Germany-USA is counted once. At the same time, the publication is fully attributed to each country. No fractional counting is done which implies that the counts are not additive in the sense that the total number of links equals the total number of publications. The collaboration analysis is performed from the German perspective, seeking an answer to the question with what countries other than Germany do Leibniz Prize winners cooperate. For that purpose, the collaboration profile will be analysed using the Affinity Index (Zitt et al. 2000). The affinity index between country i and country j is defined as:

$$AFI(i,j) = n(ij)/n(i)$$

where $n(i,j)$ = number of co-authorship links between country i and j

$n(i) = \sum_j n(i,j)$ total co-authorship links of country i

The indicator expresses the attractiveness of a collaborative partner. It measures the degree of collaboration between a given country, Germany in this case, and other partners, normalized by the total collaboration of that country. For this analysis, the denominator will be represented by the total co-authorship linkages between Germany and other countries within the set of publications realised by Leibniz Prize winners.

Results are shown in table 2. The third column shows the absolute number of links between Germany and the dominant collaborative countries. Only the 10 most important countries are represented. The full ranking is added in the appendix. The fourth column shows the affinity index, Germany exclusive.

Table 2: Collaboration of Germany with other countries for Leibniz Prize winner's publications

Rank	Collaborating Country	Number of publications	Affinity Germany Exclusive	World % 95/96 Glänzel	Rank 95/96 Glänzel	Rank 1996 Zitt
1	USA	1794	27.1%	30.0%	1	1
2	UNITED KINGDOM*	615	9.3%	12.1% **	2	2
3	FRANCE	586	8.9%	11.3%	3	3
4	SWITZERLAND	573	8.7%	NA	NA	5
5	ITALY	354	5.4%	7.2%	6	6
6	CHINA	244	3.7%	8.2%	5	15
7	JAPAN	244	3.7%	4.8	8	8
8	SPAIN	201	3.0%	NA	NA	12
9	CANADA	198	3.0%	NA	NA	11
10	NETHERLANDS	187	2.8%	6.23	7	7

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)
**Counts for UK are union of England=488, Scotland=96, Wales=16, N Ireland=15*
*** Figure for England only*

The USA is the most preferential foreign partner representing about 27% of all international co-authorship links. There is a substantial gap between US cooperation and the following group of European countries, United Kingdom, France, Switzerland, and Italy. The results are in line with other studies analysing inter-country collaboration of Germany (Glänzel 2000; Zitt et al. 2000) using worldwide data to calculate both affinity and rank indicators. Their findings are shown in the last columns of table 2. Both studies were performed on data from 1995/1996. Comparison is therefore subject to great caution. Yet, the figures show high similarity of results with 7 of the top 10 collaborating countries the same, their rankings varying only slightly. The largest positional changes are observed with Spain and Canada, appearing in this study as prominent partners without being ranked in the top ten in the other studies considered. The study by Zitt et al. (2000) however places Canada and Spain 11th and 12th respectively. Switzerland, not available in the top ten ranking of Glänzel (2000) is given a prominent position in the study by Zitt et al. (2000), being ranked 5th, second when figures were normalised by the size of the country.

The dominance of the USA is a commonly observed phenomenon. Given that the overall degree of collaboration is increasing with the volume of research, the USA appears at the top of most collaborative rankings. However, the Germany-USA link seems particularly strong for the Leibniz winners. Scrutiny of prize winner's CV's also reveals that quite some researchers have been working in the USA for a substantial period before returning to Germany.

A reason often provided for international collaboration is spatial proximity (Zitt et al. 2000). Cultural drivers are seen as nourishing with respect to the process of researchers engaging in a joined research project. As to the Leibniz winners, spatial proximity seems to play a rather limited role. European countries such as France, Switzerland and the Netherlands are indeed

preferential partner countries, but in general, cooperation seems about equally divided between EC and non-EC links. Apart from the dominance of the US, cooperation with some Asian countries such as China and Japan also appears important.

5 Evolutions in international collaboration

In order to study the evolution in collaborating countries over the last few years, publications were divided in 3 subsets. A ten year period (1991 to 2001), a six year period (2002 to 2007) and finally publications realised in the last 3 years (2008-2010). Because of the increasing number of publications, more recent sets count more publications, despite the limited number of years. Table 3 gives the ranking of the 10 most preferential partners over the different time periods.

Table 3: Collaboration of Leibniz Prize winners ranked by country: division by time period

Rank	1991-2001 n=1187	2002-2007 n=1555	2008-2010 n=1723
1	USA	USA	USA
2	UNITED KINGDOM	FRANCE	SWITZERLAND
3	FRANCE	UNITED KINGDOM	UNTED KINGDOM
4	SWITZERLAND	SWITZERLAND	FRANCE
5	CANADA	ITALY	ITALY
6	ITALY	JAPAN	CHINA
7	NETHERLANDS	CHINA	SPAIN
8	JAPAN	CANADA	JAPAN
9	RUSSIA	NETHERLANDS	NETHERLANDS
10	SPAIN	AUSTRIA	SOUTH KOREA

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Results appear to be quite stable over the 3 time periods, certainly with respect to the top 5 positions. The USA remains the most preferential partner. The ranks of the following European countries (United Kingdom, France, Switzerland, Italy and the Netherlands) switched slightly, but all remain in the top ten. Noteworthy positional changes are the systematic decrease in importance of Canada, and the manifest strengthening of Germany-Asian co-authorship, carried mainly by China and South-Korea. South-Korea rose from position 27 in the period 1991-2001, to places 13 and 10 in the successive periods.

6 Motives for international cooperation

International cooperation can serve different objectives such as increasing specialization of science, the necessity of getting access to methods and equipment (Merlin 2000) or the joint signing into multinational research funding. It has been positively influenced and facilitated by developments in communication technology and the lowered cost of travel. Besides macro effects, also purely individual factors and motives play a crucial role. They include the presence of personal networks, the prestige attached to international cooperation, the wish for bilateral exchange of ideas or the need to join forces in order to tackle a particular problem (Katz and Martin 1997; Beaver 2001; Bordons and Gomez 2000).

Collaboration is also to a large extent dependent on the characteristics of the research field. Frame and Carpenter (1979) state that the fact that most disciplines differ in their epistemological and methodological characteristics makes research collaboration a complex matter. The nature of the discipline can restrain as well as encourage the degree of collaboration. Theoretical work is shown to be generally accomplished with fewer authors than does more experimental research (Smith 1958). Collaboration is widely observed in experimental research using large complex instruments such as telescopes and particle accelerators (Martin and Katz 1997). Newman (2000) for example shows that the average number of international co-authors per paper is substantially higher in energy physics as compared to the biomedical sciences. The reasons can be found in rational optimization of the use of instruments. In forms of what is called ‘big sciences’, such as high energy physics, the research is of such scale that it can only be accomplished by joining expertise and supportive means. The nature of the cooperation is induced by collective data management and data gathering, building of equipment as well as in fund raising or project coordination. When analyzing co-authorship patterns between countries, it is therefore useful to consider the results by domain to get a first insight into the driving forces behind the cooperation.

7 Analysis by domain and country

In order to determine what domains can be associated to the national and international co-publications, the co-author links were divided into their respective domains of specialisation. The classification system used is the ECOOM (Research Center for O&O Monitoring) domain classification system (Glänzel and Schubert 2003). The publications of an individual author are often distributed over different domains, other than the domain the researcher is mainly identified with. Also a journal can be assigned to multiple domains, which implies that the total number of publications over all domains exceeds the total number of publications considered. Like before, no fractional counting is performed.

The results are shown in table 5 and table 6. Division by domain is performed for the 10 most prominent partner countries only. In table 5, shares of each domain are calculated for each country in order to investigate what is the most important area of collaboration for that particular country. The vertical sum of all domain shares adds up to 100%. In table 6, shares are taken horizontally, such that a comparison can be made between foreign and domestic strengths. Table 7 provides the same figures as table 6 having Germany excluded to calculate which countries other than home country are important for that particular domain.

The last column of table 5 shows the general distribution of all publications realised in co-authorship, domestic or in collaboration with the top ten preferential partners, split up over the different domains. Comparing with the first column representing German domestic collaboration reveals that internal collaboration follows the general domain distribution closely. Domestic collaboration seems the highest in those domains where the overall publication volume is highest, with chemistry and physics as the leading domains. Physics is the prime field of collaboration for the top five preferential partners as well as for Spain. Co-publication in chemistry research is highly dominant for China, counting for about 44% of the total. For Japan, collaboration is mainly located in bioscience and geoscience. The latter domain also represents an important share in the collaboration with the UK, France, Italy, Canada and the Netherlands.

Table 6 gives an analysis per discipline and shows the shares taken in by each country. It is clear that for chemistry, engineering, agriculture and medical science II (non-internal), the emphasis is on inter-German collaboration. For engineering and agriculture, domestic co-authorship represents over 70% of the considered publications. Also for chemistry and medical science II shares are over two thirds of the total. The domains where international collaboration is the most pronounced are geo- and space sciences and interdisciplinary science, the first group with only 16 % of the collaborative papers being domestic.

Table 4: Relative importance of sub-domains in the Geo- and Space sciences

Subdomain	Percentage
Astonomy and Astrophysics	50.4%
Geoscience and technology	38.5%
Hydrology/Oceanology	4.0%
Meteorology/Atmospheric and Aerospace Science and technology	2.5%
Mineralogy and Petrology	4.7%
TOTAL	**100%**

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Looking closer at the geo- and space sciences subdomains, table 4 reveals that about half of the papers are contributed to what can be labelled as astro/space science with astronomy, astrophysics, meteorology/atmospheric, aerospace science/technology and the other half to earth science with subdomains like geoscience, hydrology/oceanology, mineraology and petrology. International cooperation within this domain is for 31,56% taken in by the USA, followed by France, the UK and Italy (Table 7). As was mentioned in previous section, due to the scale of the research projects involved and the nature of the equipment needed, this domain is generally characterised by a significant level of international cooperation.

Also interdisciplinary research performed by Leibniz Prize winners is to a high extent internationally orientated. This phenomenon has been mentioned in literature (Katz 1994, Hagstrom 1965). They argue that interdisciplinary research, often applied research, is brought about by joining together capabilities and skills from different fields, which also enhances the chances of there being at least one other foreign institution involved. Interdisciplinarity, by its own nature, implies the composition of research teams rather than working at individual level. However, not all research realised under that ECOOM category label is of an interdisciplinary nature. The classification code also includes journals treating a variety of topics such as the journals ‘Science’ and ‘Nature’. Given the set of researchers under study are top researchers, their presence in this type of journals is likely to be above average. Still, conclusion remains that they heavily rely on international collaboration.

Drawing general conclusions from table 7, one can state that, for the different domains, the contributions by foreign countries outside the top five is very limited. Exception are China for clinical and experimental medicine II and chemistry and Japan for neuroscience and medical II. For the top foreign countries, the contribution of the USA is generally dominant. The top three European countries own significant shares in neuroscience and behaviour (UK 17,9%), chemistry (Switzerland 17,8%), bioscience (France 15,98%) and biomedical research (UK 15,2%).

8 Conclusions

1. Cooperation by Leibniz Prize winners is strong. About 95% of all publication are co-authored
2. Over 50% of cooperation is fully domestic, indicating the presence of a strong home base
3. Domestic collaboration is strongest in the domains of Chemistry, Engineering and Medical Science
4. International cooperation in core domains is realised mainly by the top 5 rather than the top 10 preferential foreign partners
5. The USA is the most preferential partner representing about one third of the non-German collaborative links
6. For Europe, UK, France, Switzerland, Italy and the Netherlands systematically stay in the top ten of collaborating countries
7. There is an increase over the last years in the degree of co-publication with China and South Korea
8. Geo- and space science is the discipline where international cooperation is most pronounced followed by interdisciplinary science, neuroscience and mathematics

Table 5: Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Vertical percentage count

DOMAIN (ECOOM classification)	Germany		USA		United Kingdom		France		Switzerland		Italy	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Chemistry	1643	28.75%	247	12,25%	83	13,54%	76	11,82%	155	23,81%	58	14,65%
Physics	1398	24.46%	443	21,97%	129	20,88%	159	24,73%	167	25,65%	116	29,29%
Biosciences (General, Cellular & Subcellular Biology; Genetics)	959	16.78%	379	18,80%	108	17,29%	148	23,02%	96	14,75%	26	6,57%
Geosciences & Space Sciences	195	3.41%	327	16,22%	126	20,55%	141	21,93%	92	14,13%	112	28,28%
Enginneering	486	8.50%	81	4,02%	21	3,43%	14	2,18%	23	3,53%	11	2,78%
Clinical and Experimental medicine I (General & Internal Medicine)	244	4.27%	74	3,67%	19	3,10%	9	1,40%	16	2,46%	16	4,04%
Interdisciplinary	166	2.90%	140	6,94%	40	6,53%	32	4,98%	42	6,45%	13	3,28%
Biology (Organismic & Supraorganismic Level)	131	2.29%	84	4,17%	20	3,26%	17	2,64%	9	1,38%	2	0,51%
Mathematics	162	2.83%	110	5,46%	16	2,61%	29	4,51%	13	2,00%	27	6,82%
Neuroscience & Behavior	123	2.15%	68	3,37%	33	5,38%	9	1,40%	23	3,53%	8	2,02%
Biomedical Research	118	2.06%	49	2,43%	16	2,61%	7	1,09%	7	1,08%	5	1,26%
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	66	1.15%	10	0,50%	4	0,65%	2	0,31%	5	0,77%	2	0,51%
Agriculture & Environment	24	0.42%	4	0,20%	1	0,16%	0	0,00%	3	0,46%	0	0,00%
TOTAL	**5715**	**100%**	**2016**	**100%**	**616**	**100%**	**643**	**100%**	**651**	**100%**	**396**	**100%**

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Table 5: (continued): Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Vertical percentage count

DOMAIN (by ECOOM classification)	China		Japan		Spain		Canada		Netherlands		**TOTAL**	
	Count	%	Count	%	Count	%	Count	%	Count	%	**Count**	**%**
Chemistry	119	44,07%	32	11,90%	44	20,09%	37	16,74%	21	10,19%	**2513**	**22.57%**
Physics	61	22,59%	47	17,47%	62	28,31%	42	19,00%	41	19,90%	**2650**	**23.80%**
Biosciences (General, Cellular & Subcellular Biology; Genetics)	8	2,96%	58	21,56%	38	17,35%	37	16,74%	36	17,48%	**1872**	**16.81%**
Geosciences & Space Sciences	43	15,93%	65	24,16%	38	17,35%	43	19,46%	49	23,79%	**1199**	**10.77%**
Enginneering	10	3,70%	5	1,86%	2	0,91%	10	4,52%	6	2,91%	**668**	**6.00%**
Clinical and Experimental medicine I (General & Internal Medicine)	3	1,11%	9	3,35%	6	2,74%	13	5,88%	14	6,80%	**421**	**3.78%**
Interdisciplinary	7	2,59%	11	4,09%	10	4,57%	10	4,52%	13	6,31%	**480**	**4.31%**
Biology (Organismic & Supraorganismic Level)	1	0,37%	5	1,86%	7	3,20%	5	2,26%	10	4,85%	**288**	**2.59%**
Mathematics	9	3,33%	3	1,12%	5	2,28%	9	4,07%	3	1,46%	**385**	**3.46%**
Neuroscience & Behavior	2	0,74%	23	8,55%	3	1,37%	5	2,26%	10	4,85%	**303**	**2.72%**
Biomedical Research	1	0,37%	7	2,60%	3	1,37%	9	4,07%	1	0,49%	**222**	**1.99%**
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	5	1,85%	4	1,49%	1	0,46%	1	0,45%	1	0,49%	**100**	**0.90%**
Agriculture & Environment	1	0,37%	0	0,00%	0	0,00%	0	0,00%	1	0,49%	**34**	**0.31%**
TOTAL	**270**	**100%**	**269**	**100%**	**219**	**100%**	**221**	**100%**	**206**	**100%**	**11222**	**100%**

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Table 6: Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Horizontal percentage count Germany inclusive

DOMAIN (ECOOM classification)	Germany		USA		United Kingdom		France		Switzerland		Italy	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Chemistry	1643	65.33%	247	9.82%	83	3.30%	76	3.02%	155	6.16%	58	2.31%
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Mathematics	162	41.97%	110	28.50%	16	4.15%	29	7.51%	13	3.37%	27	6.99%
Neuroscience & Behavior	123	40.07%	68	22.15%	33	10.75%	9	2.93%	23	7.49%	8	2.61%
Biomedical Research	118	52.91%	49	21.97%	16	7.17%	7	3.14%	7	3.14%	5	2.24%
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	66	65.35%	10	9.90%	4	3.96%	2	1.98%	5	4.95%	2	1.98%
Agriculture & Environment	24	70.59%	4	11.76%	1	2.94%	0	0.00%	3	8.82%	0	0.00%
TOTAL	**5715**		**2016**		**616**		**643**		**651**		**396**	

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Table 6 (continued): Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Horizontal percentage count Germany inclusive

DOMAIN (by ECOOM classification)	China		Japan		Spain		Canada		Netherlands		**TOTAL**	
	Count	%	Count	%	Count	%	Count	%	Count	%	**Count**	**%**
Chemistry	119	4.73%	32	1.27%	44	1.75%	37	1.47%	21	0.83%	**2515**	**100%**
Physics	61	2.29%	47	1.76%	62	2.33%	42	1.58%	41	1.54%	**2665**	**100%**
Biosciences (General, Cellular & Subcellular Biology; Genetics)	8	0.42%	58	3.06%	38	2.01%	37	1.95%	36	1.90%	**1893**	**100%**
Geosciences & Space Sciences	43	3.49%	65	5.28%	38	3.09%	43	3.49%	49	3.98%	**1231**	**100%**
Enginneering	10	1.49%	5	0.75%	2	0.30%	10	1.49%	6	0.90%	**669**	**100%**
Clinical and Experimental medicine I (General & Internal Medicine)	3	0.71%	9	2.13%	6	1.42%	13	3.07%	14	3.31%	**423**	**100%**
Interdisciplinary	7	1.45%	11	2.27%	10	2.07%	10	2.07%	13	2.69%	**484**	**100%**
Biology (Organismic & Supraorganismic Level)	1	0.34%	5	1.72%	7	2.41%	5	1.72%	10	3.44%	**291**	**100%**
Mathematics	9	2.33%	3	0.78%	5	1.30%	9	2.33%	3	0.78%	**386**	**100%**
Neuroscience & Behavior	2	0.65%	23	7.49%	3	0.98%	5	1.63%	10	3.26%	**307**	**100%**
Biomedical Research	1	0.45%	7	3.14%	3	1.35%	9	4.04%	1	0.45%	**223**	**100%**
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	5	4.95%	4	3.96%	1	0.99%	1	0.99%	1	0.99%	**101**	**100%**
Agriculture & Environment	1	2.94%	0	0.00%	0	0.00%	0	0.00%	1	2.94%	**34**	**100%**
TOTAL	**270**		**269**		**219**		**221**		**206**		**11222**	**100%**

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Table 7: Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Horizontal percentage count Germany exclusive

DOMAIN (ECOOM classification)	Germany		USA		United Kingdom		France		Switzerland		Italy	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Chemistry	1643		247	28.33%	83	9.52%	76	8.72%	155	17.78%	58	6.65%
Physics	1398		443	34.96%	129	10.18%	159	12.55%	167	13.18%	116	9.16%
Biosciences (General, Cellular & Subcellular Biology; Genetics)	959		379	40.58%	108	11.56%	148	15.85%	96	10.28%	26	2.78%
Geosciences & Space Sciences	195		327	31.56%	126	12.16%	141	13.61%	92	8.88%	112	10.81%
Enginneering	486		81	44.26%	21	11.48%	14	7.65%	23	12.57%	11	6.01%
Clinical and Experimental medicine I (General & Internal Medicine)	244		74	41.34%	19	10.61%	9	5.03%	16	8.94%	16	8.94%
Interdisciplinary	166		140	44.03%	40	12.58%	32	10.06%	42	13.21%	13	4.09%
Biology (Organismic & Supraorganismic Level)	131		84	52.50%	20	12.50%	17	10.63%	9	5.63%	2	1.25%
Mathematics	162		110	49.11%	16	7.14%	29	12.95%	13	5.80%	27	12.05%
Neuroscience & Behavior	123		68	36.96%	33	17.93%	9	4.89%	23	12.50%	8	4.35%
Biomedical Research	118		49	46.67%	16	15.24%	7	6.67%	7	6.67%	5	4.76%
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	66		10	28.57%	4	11.43%	2	5.71%	5	14.29%	2	5.71%
Agriculture & Environment	24		4	40.00%	1	10.00%	0	0.00%	3	30.00%	0	0.00%
TOTAL	**5715**		**2016**		**616**		**643**		**651**		**396**	

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

Table 7 (continued): Distribution of co-authored papers by German Leibniz Prize winners divided by domain for the 10 most prominent countries. Horizontal percentage count Germany exclusive

DOMAIN (by ECOOM classification)	China		Japan		Spain		Canada		Netherlands		**TOTAL**	
	Count	%	Count	%	Count	%	Count	%	Count	%	**Count**	**%**
Chemistry	119	13.65%	32	3.67%	44	5.05%	37	4.24%	21	2,41%	**872**	**100%**
Physics	61	4.81%	47	3.71%	62	4.89%	42	3.31%	41	3,24%	**1267**	**100%**
Biosciences (General, Cellular & Subcellular Biology; Genetics)	8	0.86%	58	6.21%	38	4.07%	37	3.96%	36	3,86%	**934**	**100%**
Geosciences & Space Sciences	43	4.15%	65	6.27%	38	3.67%	43	4.15%	49	4,73%	**1036**	**100%**
Enginneering	10	5.46%	5	2.73%	2	1.09%	10	5.46%	6	3,28%	**183**	**100%**
Clinical and Experimental medicine I (General & Internal Medicine)	3	1.68%	9	5.03%	6	3.35%	13	7.26%	14	7,82%	**179**	**100%**
Interdisciplinary	7	2.20%	11	3.46%	10	3.14%	10	3.14%	13	4,09%	**318**	**100%**
Biology (Organismic & Supraorganismic Level)	1	0.63%	5	3.13%	7	4.38%	5	3.13%	10	6,25%	**160**	**100%**
Mathematics	9	4.02%	3	1.34%	5	2.23%	9	4.02%	3	1,34%	**224**	**100%**
Neuroscience & Behavior	2	1.09%	23	12.50%	3	1.63%	5	2.72%	10	5,43%	**184**	**100%**
Biomedical Research	1	0.95%	7	6.67%	3	2.86%	9	8.57%	1	0,95%	**105**	**100%**
Clinical and Experimental Medicine II (Non-Internal Medicine Specialties)	5	14.29%	4	11.43%	1	2.86%	1	2.86%	1	2,86%	**35**	**100%**
Agriculture & Environment	1	10.00%	0	0.00%	0	0.00%	0	0.00%	1	10,00%	**10**	**100%**
TOTAL	**270**		**269**		**219**		**221**		**206**		**5507**	

Data sourced from Thomson Reuters Web of Knowledge (formerly referred to as ISI Web of Science)

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10 Appendix

Rank	Count	Country Link	Rank	Count	Country Link
1	4465	GERMANY	35	14	BULGARIA
2	1794	USA	36	11	LITHUANIA
3	615	UNITED KINGDOM*	37	11	CHILE
4	586	FRANCE	38	10	SLOVAKIA
5	573	SWITZERLAND	39	9	NEW ZEALAND
6	354	ITALY	40	8	SLOVENIA
7	244	CHINA	41	8	EGYPT
8	244	JAPAN	42	8	MOLDOVA
9	201	SPAIN	43	7	TURKEY
10	198	CANADA	44	7	CROATIA
11	187	NETHERLANDS	45	7	SINGAPORE
12	148	AUSTRIA	46	7	COLOMBIA
13	134	RUSSIA	47	5	SAUDI ARABIA
14	116	SOUTH KOREA	48	5	IRELAND
15	106	DENMARK	49	5	YUGOSLAVIA**
16	100	AUSTRALIA	50	5	VENEZUELA
17	86	HUNGARY	51	4	PANAMA
18	76	INDIA	52	4	IRAN
19	73	SWEDEN	53	4	SERBIA MONTENEGRO***
20	70	BELGIUM	54	3	CAMEROON
21	70	ISRAEL	55	3	CYPRUS
22	59	NORWAY	56	3	BELARUS
23	55	POLAND	57	3	MOROCCO
24	49	GREECE	58	3	THAILAND
25	49	BRAZIL	59	3	SYRIA
26	45	CZECH REPUBLIC	60	3	PHILIPPINES
27	36	FINLAND	61	3	MALTA
28	35	PORTUGAL	62	2	VIETNAM
29	30	UKRAINE	63	2	TONGA
30	22	ARGENTINA	64	2	BRUNEI
31	21	ROMANIA	65	2	SERBIA
32	19	MEXICO	66	2	PAPUA NEW GUINEA
33	17	SOUTH AFRICA	67	2	KENYA
34	15	TAIWAN	68	2	INDONESIA

Rank	Count	Country Link	Rank	Count	Country Link
69	2	ERITREA	75	1	JORDAN
70	2	ESTONIA	76	1	BOSNIA- HERCEGOVINA
71	1	GABON	77	1	UGANDA
72	1	LATVIA	78	1	ICELAND
73	1	LUXEMBURG	79	1	MONACO
74	1	KYRGYZSTAN			

** Counts for UK are union of England=488, Scotland=96, Wales=16, N Ireland=15*
*** The five publications in Yugoslavia were realised in Serbia*
**** The four publications in Serbia Montenegro were realised in Serbia*

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