Fraunhofer ISI Discussion Papers *Innovation Systems and Policy Analysis* No. 41
ISSN 1612-1430
Karlsruhe, March 2014

Scientific mobility

An analysis of Germany, Austria, France and Great Britain

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Acknowledgments

The research underlying this paper was supported by the German Federal Ministry for Education and Research (BMBF, project number 01PQ08004D). Certain data included in this paper are derived from the Science Citation Index Expanded (SCIE), the Social Science Citation Index (SSCI), the Arts and Humanities Citation Index (AHCI), and the Index to Social Sciences & Humanities Proceedings (ISSHP) (all updated June 2012) prepared by Thomson Reuters (Scientific) Inc. (TR®), Philadelphia, Pennsylvania, USA, USA: ©Copyright Thomson Reuters (Scientific) 2012. All rights reserved.

1 Introduction

A global exchange between scientists is essential to drive progress. Cooperation allows scientists to conduct research that would otherwise be impossible due to lacking necessary means, equipment, know-how, workforce and/or time. All scientists involved benefit from collaborating, no matter which of the aforementioned factors are concerned. Thus, scientists form international networks to promote the exchange of information or means in their research field. For this a personal exchange is indispensable, which is why scientists often travel abroad. One way is to conduct international exchanges and international co-publications are one of the outcomes of international collaboration (Michels et al. 2013). Another means and also an indication of this international exchange of knowledge is the movement or even migration of scientists. This latter output is the subject of this report, while international co-publications are not in the scope of this analysis. International migration, sometimes also called brain drain, is the focal point of this study. Brain drain suggests that there is a loss of knowledge and highly-qualified researchers. Another term is brain circulation, which nowadays is more frequently used than brain drain. It describes the notion of an exchange for the benefit of the host and the home country. This study aims at finding empirical evidence for the concept of brain circulation, therefore applying a methodological approach based on bibliometric data to track the movements of researchers.

The main research question is as follows: do scientists leave Germany for good when they migrate? To answer this question we investigate the countries to which they move, the duration of their stay abroad via bibliometric data from Scopus and other information from an online survey. The latter in particular gives additional information about the motivations for moving.

A second research topic of this study is how scientific mobility in Germany can be measured. Specifically, the second question is: Is bibliometric data of Scopus suited to

investigate scientific mobility? An online survey is used to verify whether the measurement of scientific mobility on the basis of bibliometric data reflects real activities.

The structure of this report is as follows. It starts with a brief review of the literature on international research collaboration, scientific mobility and return migration and a brief introduction to German migration behavior. The introduction to the topic is followed by a description of the data (bibliometric data and data from online survey) and methods used in this report. A bibliometric data set of all German scientists was created to track their movements for a period of 10 years.

In a second step, an online survey of German scientists was conducted that will be presented in chapter 3. It also contains a section on data validation in which the second research question is analyzed. The data from the online-survey was used to determine whether the scientists identified in the Scopus database are indeed German scientists and whether their travel behavior is consistent with the Scopus data.

The fourth chapter presents the research results regarding scientific mobility in Germany. As a focus of this study is on German scientists' movements, this is the most extensive analysis. It contains a country analysis and in particular analyzes which proportion of German scientists migrates and returns within 10 years. The same data analysis based on Scopus was conducted for the countries Austria, France and Great Britain. The results are compared to Germany to discover patterns of scientific mobility. Additionally a Scopus analysis of co-publications shows differences between scientists with international and national experience. A regression analysis shows effects on the amount of publications and citation rates of scientists with national or international experience.

The results of the online survey provide additional information about reasons and motivations for staying abroad and networking through scientific mobility.

Finally the research results are discussed in the concluding section.

2 Literature

This chapter provides an overview of previous research on scientific mobility and describes the concepts of "brain drain", "brain gain" and "brain circulation" in relation to scientific mobility.

2.1 Brain drain versus brain circulation

The concept of "Brain drain" is used to refer to scientists who migrate from one country to another with no intention of returning (Grubel 1994) – an action that has international, economic and political impacts, especially in developing countries (see e.g. Lowell 2002). The brain drain approach argues that countries lose human capital if scientists go overseas to study or work, as they might decide to remain there. Some studies deal with this phenomenon with empirical data (see e.g. Beine et al. 2001; Mountford 1997). The emigration of highly skilled scientists results in a human capital loss ("brain drain") for the former home country and human capital earning ("brain gain", Hunger 2003) for the respective host country. Baruffaldi and Landoni (2012) report a "brain war" among countries to attract foreign scientists. At a time when national borders are increasingly dissolving and travel barriers for scientists are disappearing, countries need to present themselves as attractive as possible to foster "brain gain". At the same time, they try to build a network with researchers abroad to obtain an inverse knowledge network and promote their return. This is particularly important as scientists, who return to their homeland, increase the scientific and social capital. In Germany there are several return programs that have the aim to link German scientists abroad with each other and facilitate their return from abroad. The most popular German programs are German Scholars Organization[1] (GSO) and specifically in the US the German Academic International Network[2] (GAIN). Despite an awareness of a general problem of brain drain and the lack of attractiveness of the domestic science and technology systems or insufficient access to world class knowledge, few countries develop an integrated policy strategy to address these issues (Edler/Boekholt 2001). Ciumasu (2010) stated that especially developing countries have difficulties in reversing brain drain and creating brain circulation.

Cao (1996) observed an early trend towards brain circulation. He argued that globalization leads to mobility of highly skilled persons that could be viewed as "brain circulation" – which stimulates national development. He defined four major perspectives on globalization - 1. political, 2. economic, 3. cultural and 4. science and technology – and assigns international mobility to the international labor movement which belongs to the global economy. The definition of brain circulation is that highly skilled persons visit foreign countries for a limited period only and then return after a while to their home country, while brain drain is used to describe long-term or even permanent emigration (Ette/Sauer 2010). The terms brain drain and brain gain can therefore be used as a

1 www.gsonet.org, last accessed in Jan. 2014

2 www.gain-network.org, last accessed in Jan. 2014

description of brain circulation between countries. There is a connection between scientific mobility and international collaboration of researchers which results from brain circulation. While host countries may loose human capital when scientists return home, they may also gain in terms of collaborative scientific linkages between countries and knowledge exchange (Jonkers/Tijssen 2008; Velema 2012). Both countries can benefit from the expansion of the scientific network. Sjaastad (1962) speaks of migration as an "investment increasing the productivity of human resources", which has costs and benefits. Costs can be monetary in form of travel costs or non-monetary, for example living without family.

2.2 Empirical studies

There are many empirical studies on scientific mobility. Some studies examine the countries to which scientists preferentially migrate or the duration of their stay. Others deal with motivations and consequences of scientific mobility.

Baruffaldi and Landoni (2012) conducted an analysis of foreign researchers (via an online-survey) in Italy and Portugal and investigated the impact of their home contacts on return mobility choices and scientific productivity. They concluded that maintaining contact to the home country directly benefits both countries in addition to the indirect benefit of expanding the scientific networks. On the other hand, their descriptive statistics show that, even when the stay in the host country is temporary, many researchers do not return to their country of origin. The same trend was stated by Van Bouwel (2010), who found that half of the foreign PhD students settled permanently in the US after they had finished their thesis. Of those who return, one third returns to their home country and two thirds take up a job in a third country. The duration and frequency of German scientists' visits in foreign countries affect their knowledge and technology transfer. According to Edler and Boekholt (2001) longer visits lead to the promotion of knowledge and technology transfer in the host and home country and more frequent visits result in knowledge and technology exchange only in the home country.

There are different types of motivations which drive scientists abroad. The incentive to move abroad is mostly career driven. Gibson and McKenzie (2011) explored the motivation of highly skilled emigrants and found that the decision to migrate is strongly associated with preference variables like risk aversion and patience, as well as the choice of subjects and not strongly linked with a potential gain in income. The decision to return is strongly linked to family and lifestyle reasons and not to income opportunities in different countries. Especially in Italy, family ties are very strong and keep Italian researchers in their home country (Monteleone/Torrisi 2012). There is evidence that the amount of scientific mobility varies considerably by research fields. A study by Zafira

and Walters (2008) shows that the largest part of scientific migration from Canada to the USA is heavily concentrated on only a few fields of the knowledge economy. Chinese brain drain to the USA mostly affects the research fields biology, medicine and computer science (Wang et al. 2013).

A comparison between countries regarding the mobility of scientists can shed new light on an assumed brain drain or gain. Allmendinger and Eickmeier (2003) performed a qualitative study of the migration incentives of German scientists and identified the US, Great Britain and Switzerland as the most popular destinations for German scientists. This was confirmed by Janson et al. (2006), who compared the career opportunities for scientists in the United States and Germany and showed that the US have a work situation which is perceived to be better than in Germany. According to Franzoni et al. (2012), for many countries, 'neighbors' are the most likely source of immigrants. They found that Germany is the most likely country of origin of immigrant scientists in the Netherlands, Belgium, Denmark, Sweden, and Switzerland. Contrarily, the top source country for the United Kingdom is Germany and just around 12% of all emigrating German scientists do not return to Germany. In a study by Büchtemann (2001), the migration of German scientists to the US was analyzed using different databases such as the "Current Population Survey" (CPS), the "National Survey of College Graduates" (NSCG), the "Science & Engineering Statistic Database" (SESTAT), the "Foreign Scholars Survey" and the "Survey of Earned Doctorates" (SED). He found that Germans living in the US are often employed in research, development and teaching, particularly in the technical and natural sciences and in medicine. Furthermore, the number of German doctoral recipients increased over time as did the number of those intending to stay in the US.

The literature shows that the actual extent of brain drain is difficult to measure, because there are no official records capturing exactly how many skilled workers migrate, which countries they prefer, for how long they stay or when and if they return (OECD 2001). One possible way to track scientists is by their CVs. Cañibano et al. (2011) studied the mobility behavior of Spanish scientists via their CVs. They found significant differences in mobility profiles in terms of frequency, duration and destination of visits, disciplines, career stages and time periods. According to this study, scientists are more likely to visit foreign countries up to an age of 40 years and they tend to mostly work in the research field of social sciences and humanities. Another way to track scientists over time is with the help of bibliometric data. Laudel (2003) carried out a study of comparing three bibliometric databases (Web of Science, PubMed and INSPEC) in terms of their usability of studying brain drain on a micro level. Mobility was measured by using the address information of the publication databases. When comparing these data with the CV data the results showed that bibliometric data reflected the move-

ments of scientists usually with a time lag of one year. Problems of bibliometric data are listed, such as homonyms or the lack of addresses. Roberge and Campbell (2012) conducted an analysis of Canadian researcher migration on Scopus data, which reveals a net migration flow on a very low level. Recently, Moed et al. (2013) also showed that it is possible to trace scientists and their mobility using Scopus data. According to their study, language similarities are a more important basis for international migration than for international co-authorship. However, German scientists migrated most frequently to the USA, UK, Switzerland, France, Austria and the Netherlands.

3 Data

This study is based on two different data sets. On the one hand, bibliometric data from Scopus is used to build four data sets of authors, one for each country: Germany, Austria, France and Great Britain.

The second data set results from an online survey of German scientists who were extracted from Scopus.

The first section describes the selection of the bibliometric data and the content of the data. The second section gives information about the data of the online survey. In Section 3.3., the Scopus data are validated and evaluated.

3.1 Bibliometric Data by Scopus

In the context analyses in this study, bibliometric data allow tracking scientists by the affiliations on their publications. Bibliometric databases capture meta data about publications and their respective sources and authors, i.e. their name as well as their affiliation's address and name. With the help of this data, it is possible to track single authors over time. In that way, movements from organization to organization and thereby from country to country can be monitored. Because of its already implemented author ID, Elsevier's Scopus, one of the biggest bibliometric databases worldwide, was chosen for this study.

In the following, the creation of the German data set is explained exemplarily. In a first step, all authors in Scopus with a German affiliation in 2000 were identified. To exclude the chance of introducing visiting researchers in the data set, those with no German affiliation in 1998 or 1999 were excluded from the data set. Also, there had to be at least 5 publications in the time period 2000 to 2010.

As Scopus is known for merging errors in case of homonyms (Moed et al. 2013), all authors, whose total publication number for 2000 to 2010 lay in the fourth quartile of the overall data set, were excluded. This was based on the assumption that such high publication numbers were rather the result of wrongly aggregated author data, i.e. multiple authors which were recorded as one author in Scopus.

For all authors, publication data was collected for the years 2000 to 2010. Not all authors showed continuous publication activity and thus country data. By assuming that an author stayed in the same country of his last known residence if no other information was available, missing country information of a year was filled with the information from the previous year. However, this was only done if at a later point in time, country or publication data was available. The following fictitious example (Table 1) of two German authors illustrates this procedure. Automatically filled in information is marked in italics, all other information stems from the data base.

Table 1: Example for completed data

Author	Country										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
#1	DE	*DE*	DE	DE	*DE*	*DE*	*DE*	FI			
#2	DE	DE	DE	DE	DE	US	*US*	*US*	GB	*GB*	DE

Source: Calculations of Fraunhofer ISI.

There have been many cases where authors have published from different countries in one year. Then those countries were weighted, for example if an author published in two foreign countries, each country counted one half.

All in all, for each author, the following data was collected:

- Author ID,
- last and first name,
- Country in the years 2000 to 2010,
- Email addresses,
- Main research field(s),
- total publication number in the period 2000 to 2010,
- Citation count for the years 2000 to 2010,
- the "scientific age" as an indicator for the number of years since the first activity recorded in Scopus,
- the "longest stay" as the maximum number of years the scientist spent abroad.

Table 2 provides a brief overview of the variables of the data set and their description.

Table 2: Scopus dataset

Name	Definition
auid	The auid is a personal identification number for each author assigned by Scopus.
Author's first and last name	The author's first and last name was selected for data validation purposes only (i.e. not for individual analyses). The analyses in this report are all on a cumulative and not an individual level, so that anonymity was guaranteed.
Email	The 3 most recent email addresses of one author were selected, as contact information for the online survey.
Country	The variable country covers the countries per year for each author during 2000-2010. The starting point was the year 2000, in which all authors have by definition published in Germany.
Longest stay	The longest stay is the maximum number of years one author spent in one single country that was not his country of origin.
Scientific age	The scientific age is the difference of years between current year (in this case 2013) and first publication year. This serves as an indicator of how many years one author has actively published in his career. For this data set the maximum scientific age is 18 years, because the first registered publication of this group was in 1995.[3]
Number of publications in total	The number of publications includes all publications per author from 2000 to 2010. To reduce the error of falsely merged or separated author data[4] in the dataset, we cut down the data below the minimum publication number of 4 and above 75% of the publication.
Number of citations by publication year	The number of citations is the total number of citations per publication in a three year window after the publication year.
Research field	Each author was assigned to the Scopus research field(s) in which he published most of his publications. This is a binary value which is 1 for fields with the maximum amount of publications and 0 otherwise. The Scopus data includes the following research fields: • Agricultural and Biological Sciences • Arts and Humanities • Biochemistry, Genetics and Molecular Biology • Business, Management and Accounting • Chemical Engineering • Chemistry • Computer Science • Decision Sciences • Dentistry • Earth and Planetary Scienes • Economics, Econometrics and Finance • Energy • Engineering • Environmental Science • Health Professions • Immunology and Microbiology • Materials Science • Mathematics • Medicine • Multidisciplinary • Neuroscience • Nursing • Pharmacology, Toxicology and Pharmaceutics • Physics and Astronomy • Psychology • Social Sciences • Veterinary

3 In general, the Scopus database is not well covered before 1996.

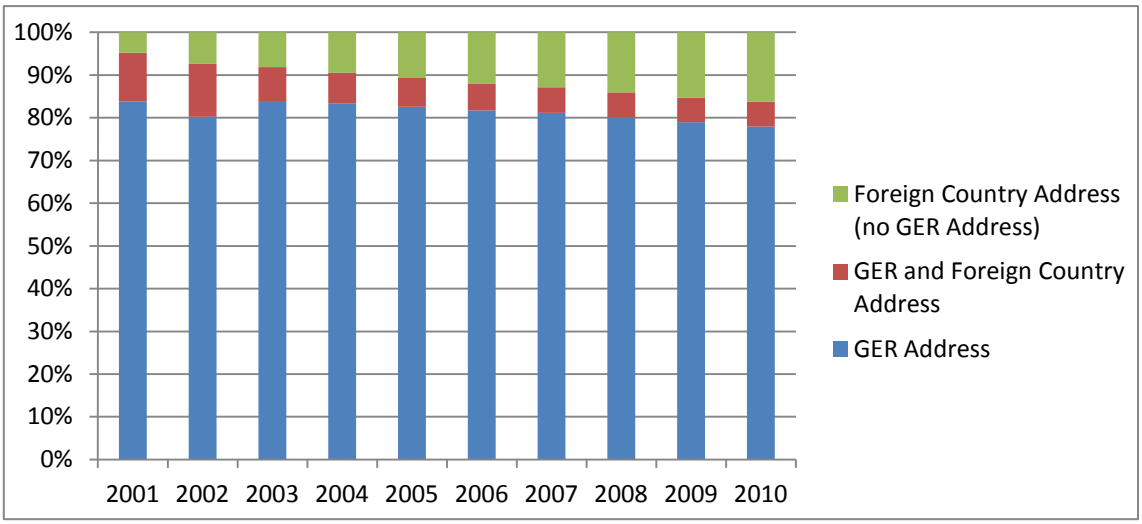
4 See chapter 3.3.1

The same data selection procedure was made for other countries like Austria, France and Great Britain. This procedure allows comparing scientific mobility of Germany with those of other countries.

3.1.1 Description of the data set

Movements of scientists are analyzed on the basis of the respective countries of publications in the period 2000 to 2010. Figure 1 shows that the number of scientists publishing with a foreign address (no German address) is at the beginning rather small (5%) but increased during the time period up to 16%. In 2004, it even exceeded the number of scientists with a German and a foreign address. This means that especially scientists with double addresses (German and foreign) gradually give up their German address.

Figure 1: Author addresses 2000-2010.



Source: Calculations of Fraunhofer ISI.

Table 3 provides an overview of the data set for Germany. Of the 37,293 identified authors, on average 82% published between 2001 and 2010 only with German addresses, 8% with a German and an additional foreign address and 10% published unambiguously with only a foreign address (migratory scientists).

The authors publishing with a foreign address while keeping their German address are more likely to publish more than 4 publications per year than those who publish with only a German address or only a foreign address. This effect may be due to authors with multiple affiliations or merge errors (homonyms); it seems as if many author IDs aggregate data for more than one author. This would explain how one author could publish in one year with many different affiliations and why this group has much higher

publication rates. These observations were the foundation for the data validation (chapter 3.3.2).

In order to measure differences between research fields, we count the authors' main research field of the three groups (authors published with German address, German and foreign address or only with foreign address) and in total (Table 3). There is no observable distinction for the different migration behaviors except for four fields, which are also among the best represented fields in the dataset: Physics and Astronomy, Medicine, Biochemistry, Genetics and Molecular Biology and Earth and Planetary Sciences. There are notably fewer authors in Medicine who publish with a foreign address (15%) than with a German address (33%). In contrast to that, in Physics and Astronomy, authors publish more frequently with a foreign address than with a German address (22% and 12% respectively). The same holds for the fields Biochemistry, Genetics and Molecular Biology (18% foreign address and 13% German address) and Earth and Planetary Sciences (7% foreign address and 4% German address).

Table 3: Description of data set (2001-2010) % of authors (n=37,293)

	Total data set	GER address	GER and foreign address	Foreign address
authors per year (2001-2010)	100%	82%	8%	10%
Average number of Publications per year (2001-2010):				
1	34%	36%	9%	38%
2	24%	24%	23%	24%
3	16%	16%	21%	15%
4	10%	10%	17%	9%
5	6%	6%	11%	6%
6 to 10	8%	8%	17%	7%
11 to 20	0%	0%	1%	0%
Main research fields:				
➢Agricultural and Biological Sciences	5%	5%	5%	4%
➢Biochemistry, Genetics and Molecular Biology	13%	13%	16%	18%
➢Chemistry	6%	6%	6%	7%
➢Earth and Planetary Sciences	4%	4%	6%	7%
➢Engineering	6%	6%	4%	5%
➢Materials Science	4%	4%	3%	4%
➢Medicine	31%	33%	23%	15%
➢Physics and Astronomy	15%	12%	21%	22%

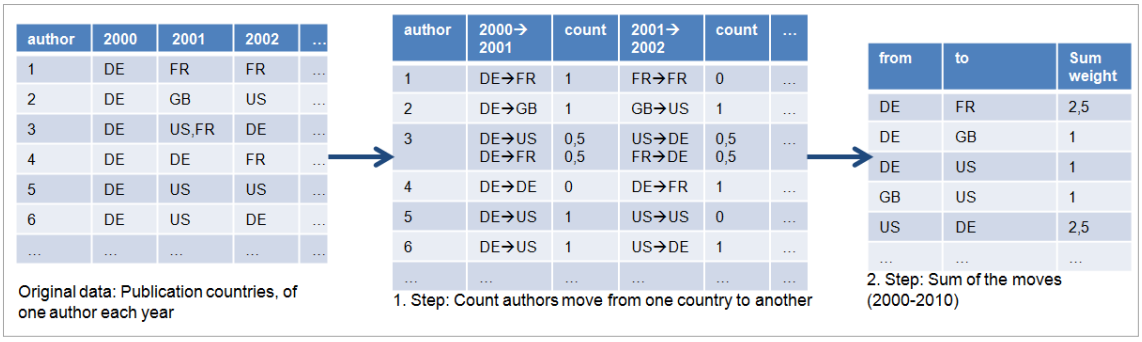
Source: Calculations of Fraunhofer ISI.

For the further analyses, the scientists with German and German or foreign addresses are grouped together. These are regarded as the comparison group to the migrating scientists who publish only with a foreign address.

3.1.2 Country network of scientific mobility

For an illustration of a network of scientific mobility the data were prepared specially for this purpose. The aim of this procedure is to show how scientists move around from one country to another. The original dataset was used to create a new dataset which includes the cumulated number of authors who changed their publication country from one year to another in the time period of 10 years. If there is more than one country information per author per year, this information was weighted. For example, one author (No. 3 of the example in Figure 2) published in 2000 from Germany, 2001 from the US and France and 2002 again from Germany. The move from 2000 (Germany) to 2001 is assigned to the US and France each with a weight of 0.5 (Figure 2). In the end, the number of moves from one country to another is added up, so that all moves are included in one table.

Figure 2: Data processing for tracking scientific mobility from one country to another



Source: Calculations of Fraunhofer ISI.

This data classification allows a cumulative view of the data. The sum of weights tells us how many authors switch from one country to another in the time period. In the example, there are 2.5 moves from Germany to France and one from the US to Germany etc. Using this classification of data it is possible to do a graphical illustration of scientific mobility with the program Gephi[5] (see for example chapter 4.1.2, Figure 16).

5 Gephi is an open-source software for visualizing and analyzing large networks graphs. https://gephi.org/, last checked in November 2013.

3.2 Online-Survey

The online survey was conducted for two reasons. On the one hand, it should determine the motivations of scientists to go abroad. On the other hand, it makes it possible to compare the results of the survey with publication data from Scopus to find out if they lead to similar results concerning the moves or the changes of affiliation, respectively.

All authors who had at least one address abroad or have no full information about their residence because of missing publications in the time period were selected from the data set (see 3.1.1). For Germany, this corresponded to 16,220 authors for which there are in total 31,840 email addresses in Scopus (a maximum of three latest mail addresses per author was collected).

Table 4 provides a brief overview of the questionnaire.

Table 4: Overview of the Questionnaire[6]

Number of visits abroad (min 6 month)
Information about each of the visits abroad: • year • duration in month • destination country • organization type • occasion of the visit • motivation of the visit
General opinion: • Intention of returning to Germany and conditions of returning • Intention of moving or leaving Germany for good • Preferred countries and attractiveness of countries as a destination • Evaluation of international vs. national publications
Statistics: • Graduate degree / title and year of achievement • Number of publications • Change of name • Organization • Research field • Native country • Nationality • Languages • Age • Gender

6 The complete questionnaire can be found in the appendix (in German).

After a preceding pre-test phase, we started the survey in two waves. The first wave started on 17/09/13 with 600 email addresses. We decided to interview a small group first so that we had the option of adapting the questionnaire, but as no issues occurred, the survey was not changed and the second wave started on 24/09/2013 with all other selected authors. Until the reminder was sent out on 10/10/2013 about 1,000 authors had already participated. By the end of the survey, there was a net total of 1,531 authors. A relatively high number of people (442) aborted the questionnaire.

3.2.1 Description of the data set

By the end of the survey, there was a net total of 1,531 authors. According to the target group the respondents was divided into three groups: 1. researchers with international experience (German nationality and at least one stay abroad for more than six months), 2. researchers with only national experience (no stay abroad for more than six months) and 3. researchers without German nationality (Table 5). The most relevant group for our research question is the first group, which encompasses scientists who have German nationality and studied or worked abroad for more than 6 months. This applied to 742 scientists or 48% of all respondents respectively. They are called "Researchers with international experience". The second group is the control group. It contains authors who did not study or work abroad for more than 6 months and accounts for 46%. These researchers are defined as "Researchers with only national experience". Those without German nationality (93 in total) were excluded from this part of the analysis.

Table 5: Data classification by target groups

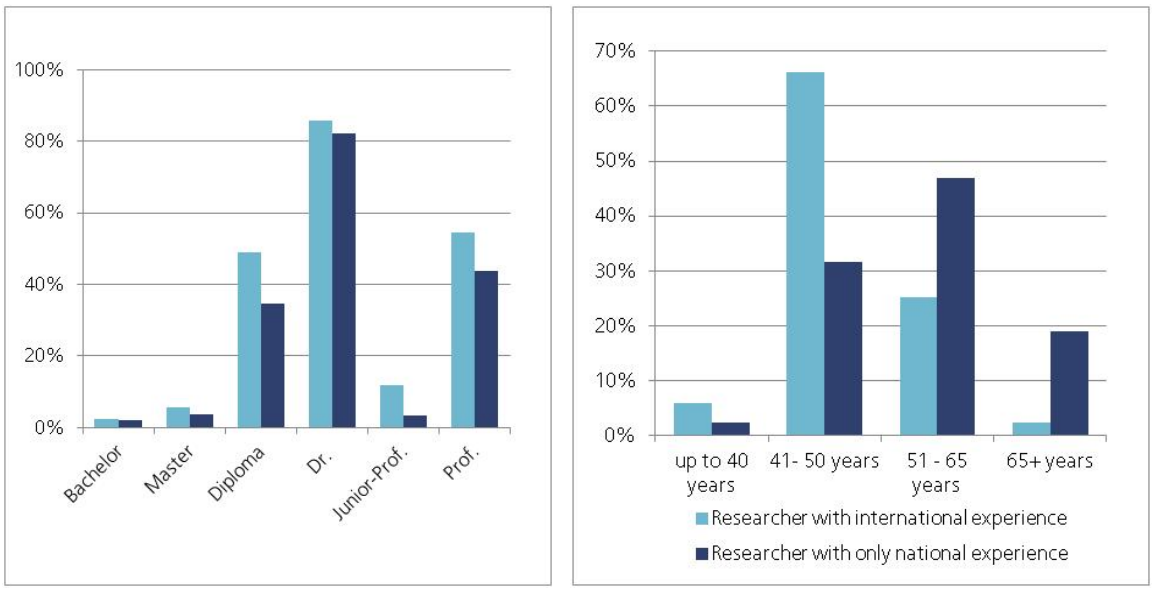
Target group	count	%
1. GER nationality + stay abroad (6+ month) → Researcher with international experience	742	48%
2. no stays abroad (6+ month) → Researcher with only national experience	696	46%
3. no GER nationality (stays abroad 6+ month)	93	6%
Total	1531	100%

Source: Calculations of Fraunhofer ISI

In the following, the first two groups are analyzed and compared. In both groups most of the respondents are male (about 80%). Thus, female researchers are underrepresented. There is a clear age difference between the two groups. Those who moved abroad for work or research tend to be younger than those who remain in Germany (Figure 3), a finding which is consistent with the findings reported in the literature (e.g. Van Bouwel 201; Cañibano et al. 2011). The increased age of the respondents is a

consequence of the data selection. The first publication usually appears as a PhD student. That means that nobody in the data set can be younger than about 38 years (at the date of the survey), if his/her first publication was issued when he was for example 25 years old in 2000.

Figure 3: Scientific Degree and age of the researcher

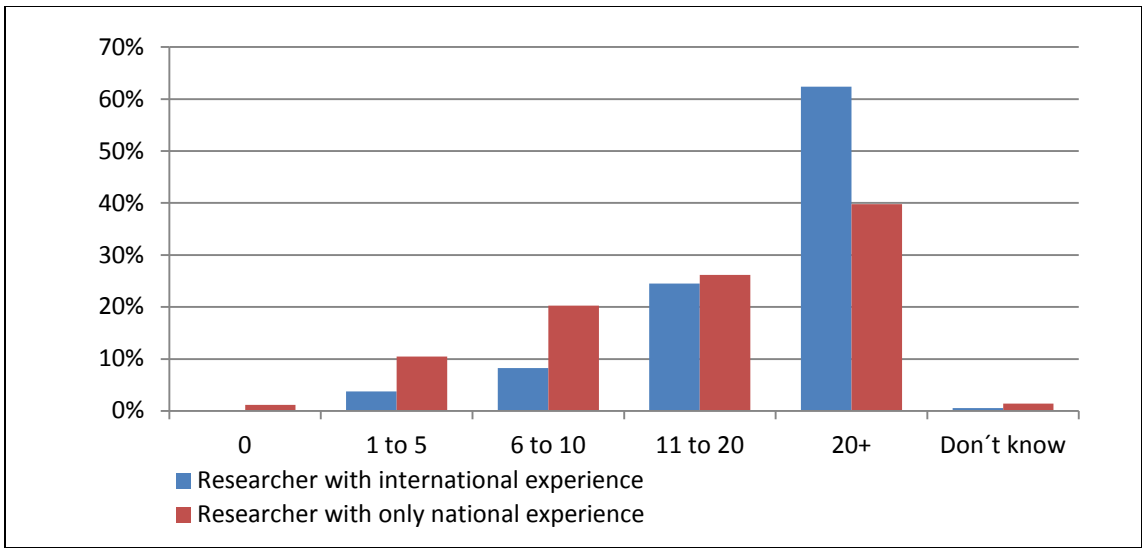


Explanatory note: The sum of percentage of the Degree is higher than 100% because it is possible that one researcher has more than one degree. Source: Calculations of Fraunhofer ISI.

More than 80% of the respondents have a PhD degree (Figure 3). 55% of scientists with international and 44% of scientists with national experience have a professorship. It is not surprising that the bachelor and master graduation are underrepresented because they were introduced in Germany only a few years ago.

Most of the respondents had more than 20 publications in ten years. According to the data the amount of scientists with more than 20 publications is much higher if they have international experience. To make sure that there is a real statistical effect a regression would be necessary (see chapter 4.1.1 and 4.1.3).

Figure 4: Number of publications

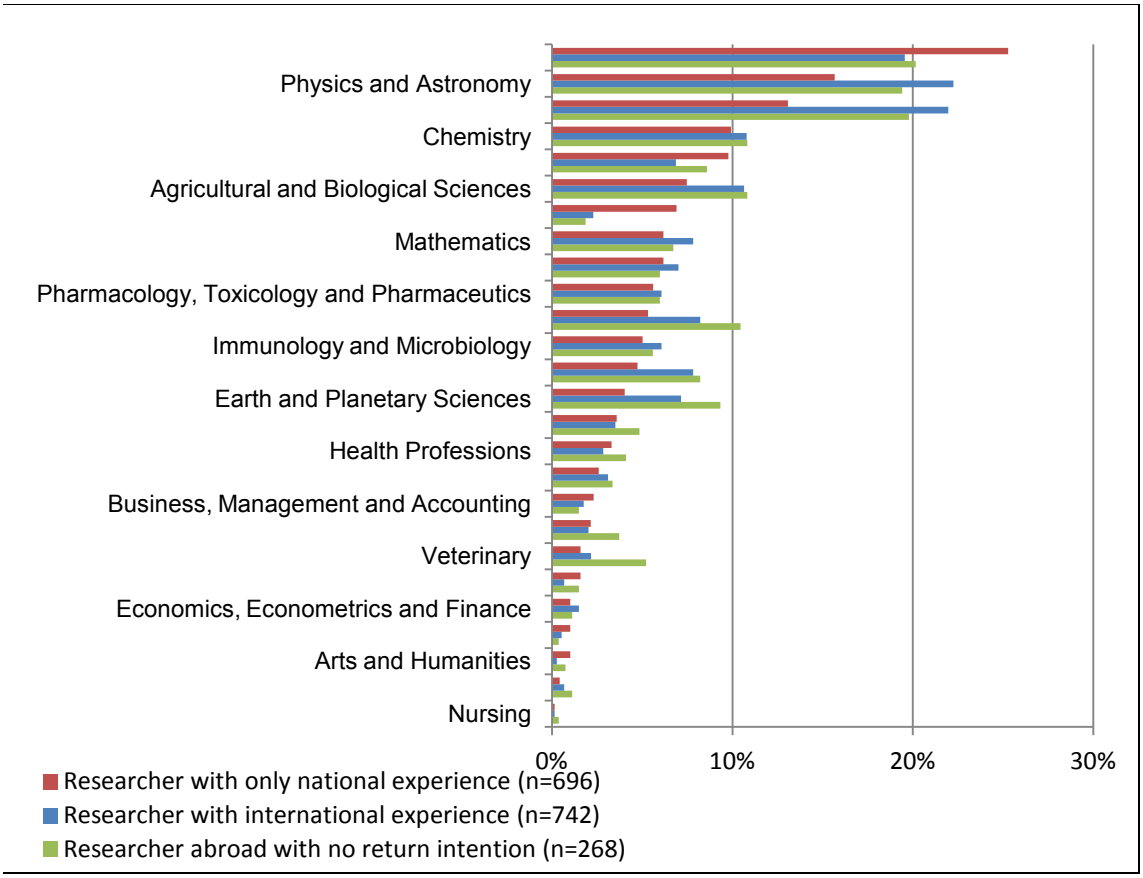


Source: Calculations of Fraunhofer ISI.

There is an age difference between the groups regarding the number of publications. 20 and more publications are mostly published in the international group by the 41-50 year-old scientists (65%) and in the national group by the 51-65 year-old researchers (46%) (Table A-1 in the Appendix), a finding that is consistent with other analyses. For example, elsewhere we showed that researchers participating in the international scholarship program Marie Curie of the European Commission published significantly more papers than a randomly drawn control group with similar characteristics. Both values are higher than the total percentage number (Table A-1 in the Appendix). Gender differences are more distinct in the group of scientists with international experience; here men are more likely to publish more than female scientists.

Almost all research fields are represented. Most respondents belong to the fields "Medicine", "Physics and Astronomy" and "Biochemistry, Genetics and Molecular Biology". The large share of medical researchers is not surprising since the proportion of medical publications (46% of all German publications 2000-2010) is twice as high as the proportion of each of the other two fields. By comparing the groups, (national vs. international experience), there are huge differences in the research fields. The proportion of international researchers is clearly higher than those of national researchers in "Physics and Astronomy", "Biochemistry, Genetics and Molecular Biology", "Agricultural and Biological Sciences", "Environmental Science", "Earth and Planetary Sciences" and "Neuroscience" (Figure 5).

Figure 5: Research field of the respondents



Explanatory note: The sum of percentage is more than 163% because one researcher can belong to more than one research field. Source: Calculations of Fraunhofer ISI.

The top scientists (20+ publications) with international experience are noticeable in the research fields "Agricultural and Biological Sciences" (76%) and "Physics and Astronomy" (70%), which are higher than the total percentages (Figure 4). Scientists with only national experience are mostly as productive as the average (40%, Figure 4) of each field, except for "Biochemistry, Genetics and Molecular Biology" (44%) and "Pharmacology, Toxicology and Pharmaceutics" (51%, Table A-1 in the Appendix).

Approximately half of the respondents with international experience are currently abroad and have no intention of returning to Germany. It is interesting that the amount of these scientists, compared with the group of scientists with international experience, is especially high in the research fields "Environmental Science", "Earth and Planetary Sciences", "Material science" and "Veterinary".

3.3 Data Validation

In this section, the quality of the data extracted from Scopus is assessed. The data validation helps to detect inconsistencies in the data and to reduce errors in analyses to come.

Here two ways of validation of Scopus data were used. The first approach is about comparing Scopus author data with personal CVs. This approach draws conclusions whether Scopus data - like publication country - are suitable for tracking scientists geographically based on their publications and helps to detect data errors. In the second approach, Scopus author data are compared with the data from the online survey. This approach enables a more detailed validation.

3.3.1 Data Validation on CV Matching

Moed et al. (2013) have pointed out two important errors in Scopus: "merge authors" and "split authors". The former occurs when multiple authors are aggregated with the same author ID. In most cases, this is a result of two authors bearing the same name. To reduce this error, one could identify author IDs in the data set that have several e-mail addresses, an immense number of publications and have published in one year from more than three different countries or in various scientific fields. In a second step, their CVs could be compared with the bibliometric data to find out which author IDs are affected.

A "split authors" error occurs if one author has multiple author IDs. According to Moed et al. (2013), it is difficult to identify the affected author IDs, in particular when the name of an author has changed.

However, other errors like incomplete or incorrect data also occur that are independent of the author ID. To validate our data set, we compared the data from Scopus with the CVs of the authors in a sample set. The aim of this validation step is to find out whether and how precisely Scopus data can track the movement of scientists from one country to another.

We randomly selected 50 authors from our main data set of 37,293 German authors, who published at least one paper each year between 2000 and 2010.

A high proportion of these - namely 41 of 50 authors - could be identified by a Google search. We deduced information about stays abroad in the period 2000 to 2010 from their CVs. To compare the Scopus data and the CV data in detail, six possible codes were assigned that depicted the level of agreement between the Scopus and the CV data for each author in each year (Table 6). If a CV was found, the level of agreement

for one author could change over time, as each year was checked separately. This is especially the case if the above-mentioned merge or split errors occur and information is lost (codes 3 and 4) or wrongly attributed to an author (codes 2 and 4). In fact, there were only 11 of 41 authors for which the CV and the Scopus data were in complete accordance over the whole observation period (code 1).

Table 6 shows the results of the distribution of the codes for each year and the average of the matches. The average is calculated to show the agreement per year between both data sources in the whole period. On average, the CV data and the Scopus data differed completely in 2% of all cases. However, this occurred only for single years of authors and never over the whole observation period. There was 60% full correspondence of data for countries according to the Scopus data and the CVs (code 1). For an average of 18%, there was a match but with additional information in Scopus (14%) or the CV (3%) or both (1%). This suggests a merge error, because there is a documentation of the stay abroad in the publications but not in the CV - a fact that would usually not occur. To identify the number of merge authors, we searched for different criteria like publication rate, institution etc. We did this with all (27) authors that had a code 2 (Scopus and CV country information match with additional countries in Scopus) mismatch in at least one year. These authors show a relatively high number of affiliations, 17.56 on average with values ranging from 7 to 49. The number of publications ranged from 30 to 408, where the maximum value was able to be confirmed by the CV of that specific author.

Table 6: Percentage of matches of country information in Scopus and the CV (n=50)

Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
0	4%	4%	4%	2%	4%	4%	0%	0%	0%	0%	2%
1	46%	42%	60%	68%	62%	62%	66%	58%	70%	64%	60%
2	28%	26%	8%	4%	10%	10%	10%	20%	8%	12%	14%
3	2%	2%	6%	4%	4%	4%	4%	2%	2%	4%	3%
4	0%	4%	2%	2%	0%	0%	0%	2%	2%	0%	1%
5	20%	22%	20%	20%	20%	20%	20%	18%	18%	20%	20%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Codes: 0 = no match of Scopus data and CV; 1 = Full match of Scopus data and CV; 2 = match with additional countries in Scopus; 3 = match with additional countries in CV; 4 = match with additional countries in Scopus and in CV; 5 = CV could not be found on the internet or country was not specified in the CV. Source: Calculations of Fraunhofer ISI.

It is interesting that there were cases in which one author was assigned codes 2 (Scopus and CV country information match with additional countries in Scopus), 3 (Scopus

and CV country information match with additional countries in CV) and 4 (Scopus and CV country information match with additional countries in Scopus and in CV) in different years. Only 22% of the cases received code 1 throughout 2001-2010.

Here, it must be noted that we considered only a very small random sample and random effects are not excluded. Nevertheless, the results show that a scientist to whom a foreign country is assigned in Scopus also had an approximately 63% chance of actually having visited that country in the corresponding year and thus deductions for the mobility of researchers are possible. Another difficulty of the data is that we can not be sure that the country of publication is the same as the country to which they actually moved.

3.3.2 Data Validation of Scopus on Online-Survey Matching

In a matching of the results of the online survey with the Scopus data, the possibility of conducting a migration analysis with the help of bibliometric data was assessed. The group of respondents which said that they had stayed abroad was used to compare the survey and the database data. In particular, the countries of residence, the number of foreign stays, the duration of the longest stay and the publication number were compared. For the latter, we also used the information from the survey whether the person had changed his name or institution during his/her career.

In this section, we compared for the respondents who affirmed to have had indeed stayed abroad during the observed time period and their statements from the survey with the Scopus data. A first indicator of the data quality of Scopus is the fact that 696 out of the 1,531 respondents had not stayed abroad[7]. This means that according to the publication data, they had published with a foreign, non-German address, but essentially claimed that they did not move. The question remains why for the remainder of scientists who were selected based on the Scopus data, a foreign address was stored in Scopus.

One problem might be the time lag that could have distorted the comparison of Scopus and survey data. If a researcher conducted a stay abroad and submitted a paper in that time period, the paper will not necessarily be published before he returns to his/her home country. Usually, the paper is published with a time lag, which might lead to delayed residence country information. It is also possible that some authors have multiple affiliations, without completely giving up their German address.

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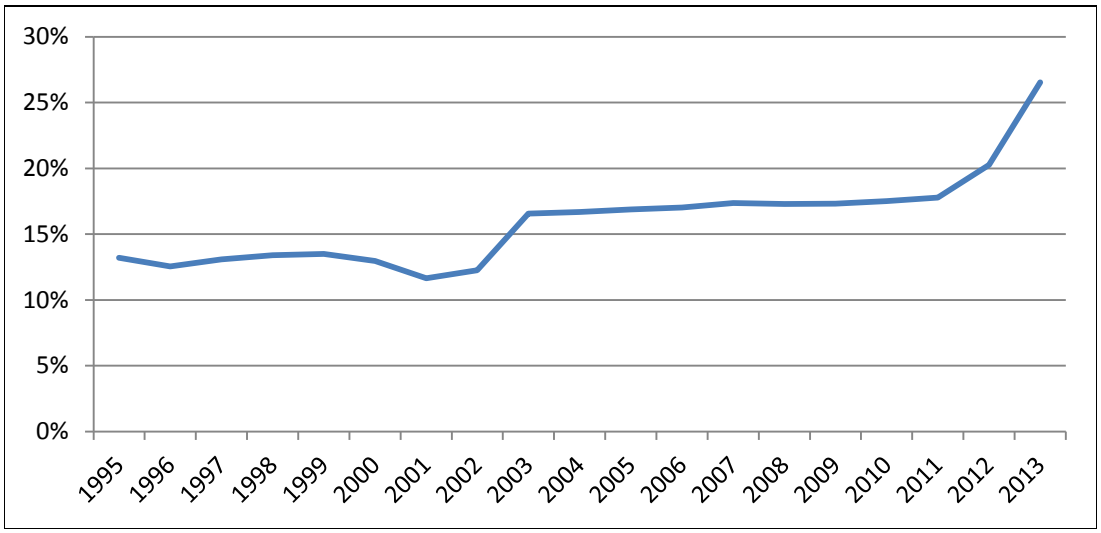
7 Abroad in this context refers to all countries outside Germany. Thus, even respondents who stated that they were not German residents were included.

Another possible explanation is that Scopus mixed the author address information for publications with multiple authors. Figure 6 shows the share of publications in Scopus for which author addresses with at least 2 different countries were recorded. The sudden rise in this share after 2002 cannot be caused by a mere behavior change of researchers, so that a database error can be suspected.

If indeed a database error occurred, in which country information was lost or mixed (i.e. co-authors shared the country information of the first author), the set of German researchers we defined and their movements in the first years might have been reported wrongly in the database. However, we were not aware of this problem (if indeed it is one) at the beginning of this project and could not react in time. Nonetheless, it might have an impact on the results presented in this section.

Figure 6: Percentage of publications with two or more countries in the author addresses in Scopus.



Source: Calculations of Fraunhofer ISI.

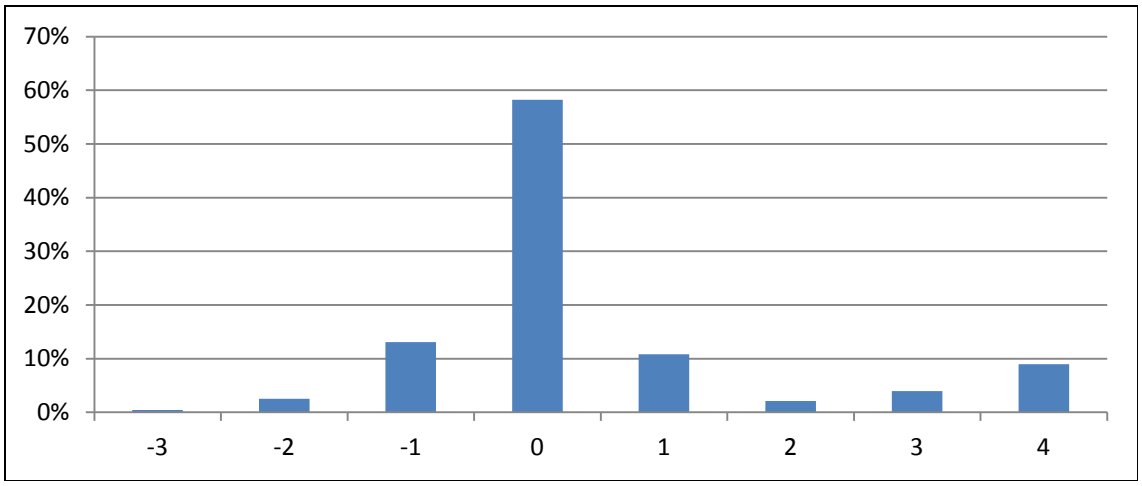
We still compared the most important characteristics of the researchers given in Scopus and in the survey. One of the most fundamental ones for this study was the number of stays abroad a researcher had. Figure 7 shows the discrepancies or accordance between the absolute numbers of foreign stays. The x-axis represents the difference between the number of stays given in the survey by a researcher and the respective data in Scopus for the same researcher. The bars show the percentage of researchers who have the respective difference in the number of stays. Positive values indicate that the researcher stated more stays in the questionnaire than we found in the Scopus data base, negative values show a higher number of stays abroad in the Scopus data base. No difference (a value of 0) represents an exact match for the absolute number

of stays regardless of their actual conduction. We excluded statements in the survey that covered stays outside the time window, i.e. before 2000 and after 2010.[8]

For 58%, i.e. 280 out of 481 of the German researchers who had stayed abroad and answered the questionnaire, we found a matching number of stays abroad in both data sources. For discrepancies, the majority of them only differed in a value of +/-1.

Some (43 in total) of the researchers stated in the survey that they had been abroad 4 times more than we found in the Scopus data. However, the trend for a diversion in higher numbers might be also caused by research stays which are not identifiable in Scopus (for example because these were only short-term visits of less than 6 months) because no publication was emitted in the respective time period.

Figure 7: Percentage of respondents with the respective difference in number of stays abroad in Scopus and survey.



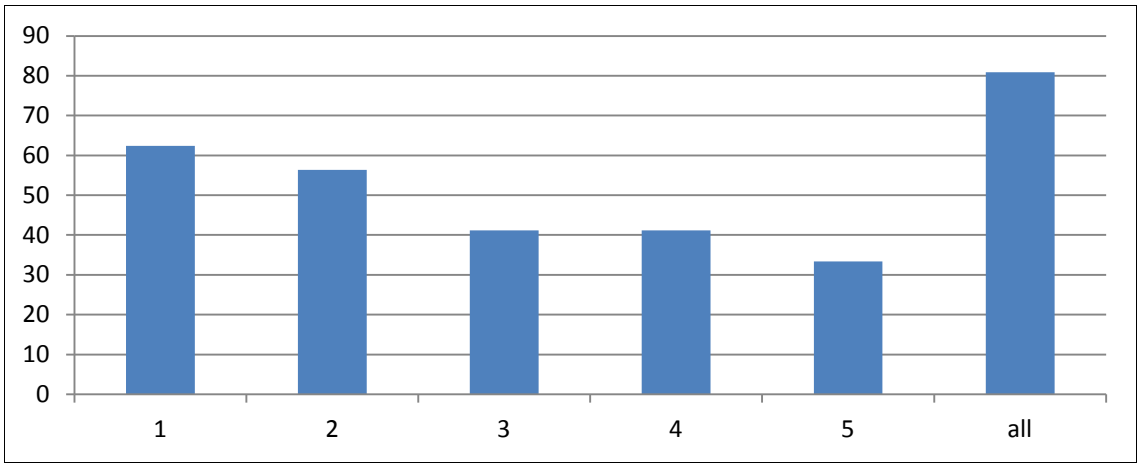
Source: Calculations of Fraunhofer ISI.

In the survey, we asked for the first 5 countries of stays abroad. In the Scopus data of course, no such distinction could be made because all countries were considered, in which the authors have published in 10 years. Thus, we compared the country name given by the respondents to a match in the Scopus data. Figure 8 gives the percentage of respondents, for which we found a corresponding country in the Scopus data. This was done for the single countries separately, i.e. countries 1 to 5 and the set of all countries a respondent provided. However, a time window for the name match was too delicate to apply in this context.

8 The time window was explicitly stated in the survey, but respondents still tended to give complete lists of their experiences abroad.

We found that for approximately 80% of the respondents, a matching country could be found. However, this is any country the respondent gave while the other countries might not have been found. If we specifically take a look at the countries given, the numbers are much smaller. For approx. 62% the country of their first stay could be identified in the database. The numbers are diminishing for later stays. The minimum value is 33% for the country 5, however, the absolute values for this question are also very low.

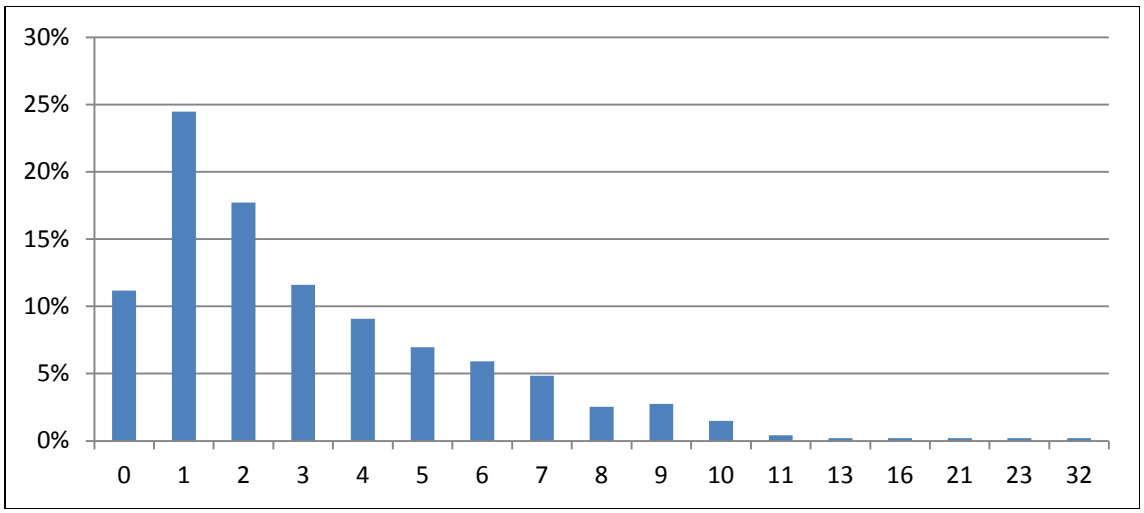
Figure 8: Matches in % for the country name.



Source: Calculations of Fraunhofer ISI.

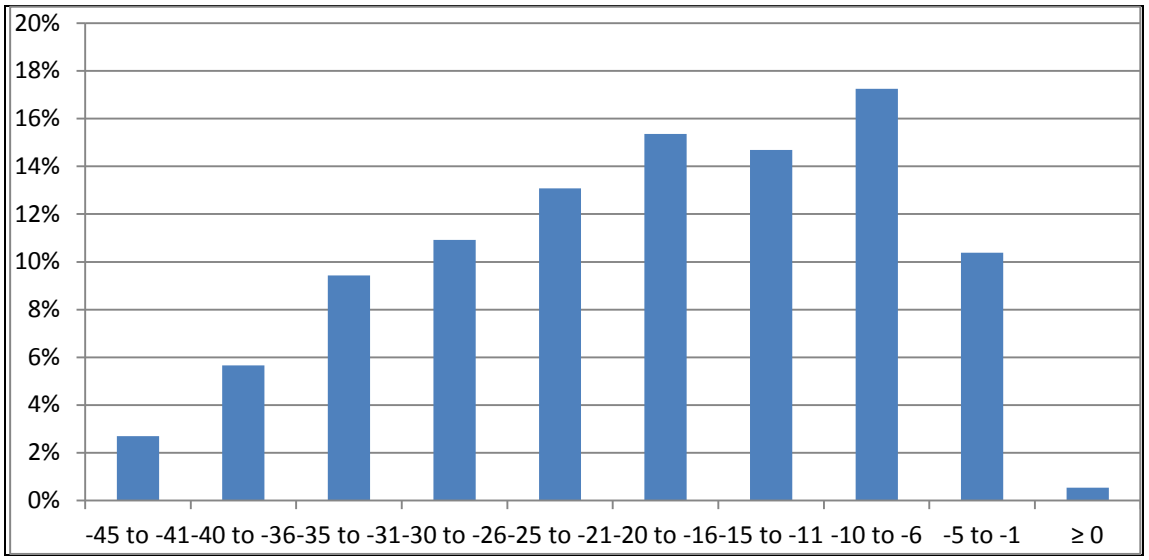
In the survey we asked for the duration of the stay abroad, which we also were able to calculate in the Scopus data. Figure 9 shows the difference between these two values for the respondents who stated in the survey that they were either currently staying in Germany or had the intention of returning to Germany any time in the future. 35% of the respondents had a difference in duration of 1 year or less. A discrepancy of 1 or 2 years might have occurred due to rounding errors: Publications were only assigned to complete years so that a publication in one year could represent anything between a stay of 1 and a stay of 12 months. The duration given by the respondents had to be converted from months to years and was then rounded up, which is another possible error source on the other side of the comparison. In addition, it may be an effect that arises due to the filling of gaps. If an author has not published in one year, there is no information about his actual location. In this case we fill the gaps with the information of the previous year. All facts taken into account, the comparison of survey and Scopus data seems promising as with a possible error of up to two years, the duration of a stay can be determined in more than 50% of cases.

Figure 9: Differences in years for longest stay



Source: Calculations of Fraunhofer ISI.

Figure 10: Difference in number of publications for the authors in percent.

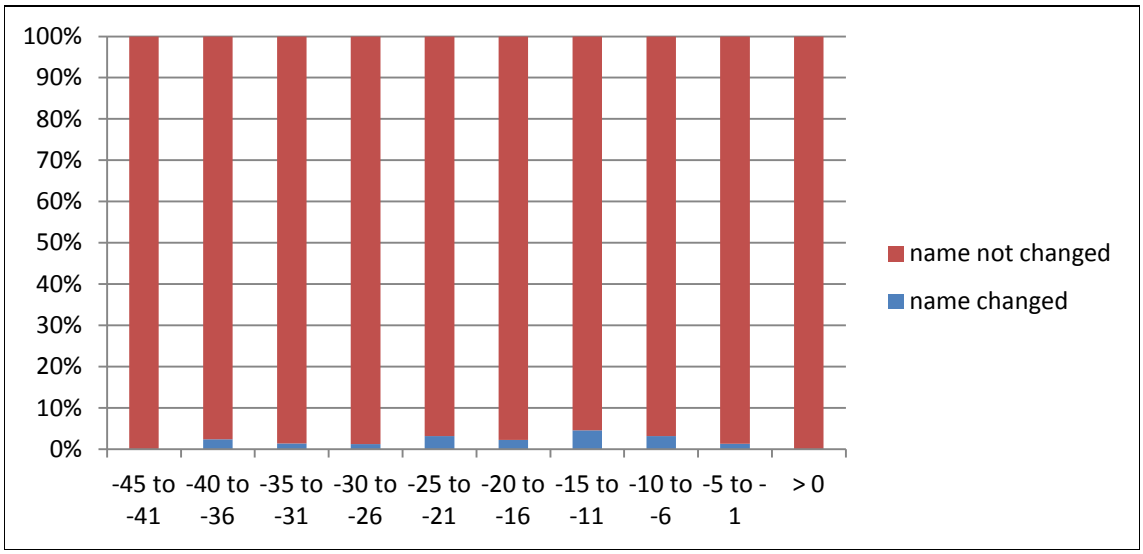


Source: Calculations of Fraunhofer ISI.

Comparing the number of publications according to Scopus and the survey responses, the difference between the two resulted in mostly negative outcomes. This means, that according to Scopus, the number of publications was in 99% of cases higher than what people stated in the questionnaire. This was still the case when we restricted the search in Scopus to only articles and conference proceedings between 2000 and 2010. The question is whether this difference was based on human errors or errors in the database and could be only answered by manual verification. We checked if higher

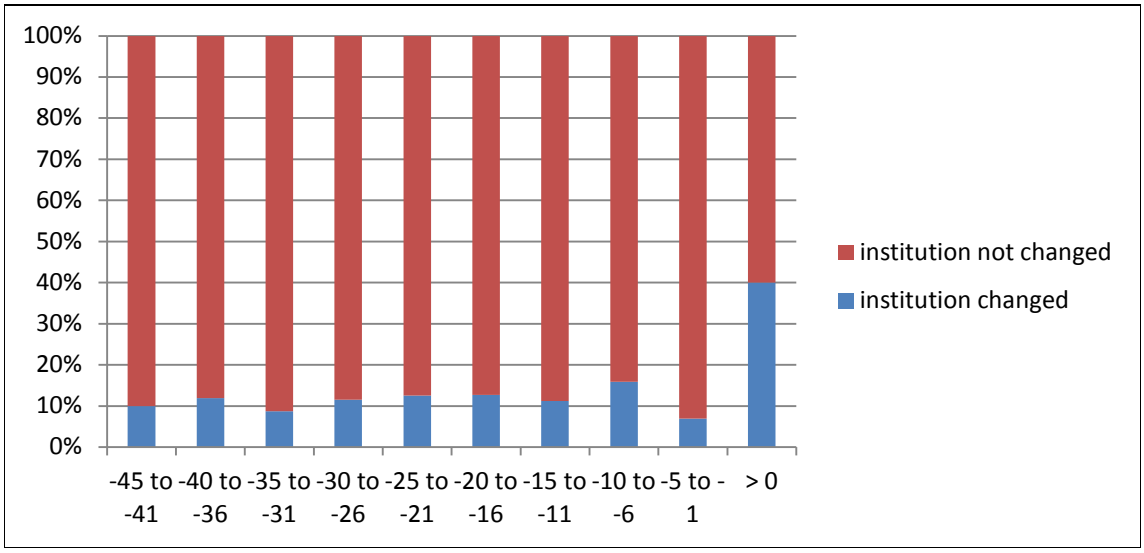
differences were caused by a change of the surname (Figure 11) or the institution (Figure 12) but could not find a pattern.

Figure 11: Difference in number of publications for respondents who changed their name.



Source: Calculations of Fraunhofer ISI.

Figure 12: Difference in number of publications for respondents who changed their institution.



Source: Calculations of Fraunhofer ISI.

Summary

The two approaches of data validation can be summarized as follows: The comparison of a random sample of 50 CVs with the respective Scopus data showed a full match for

60% of CVs. In another 18%, there was a match with additional information in the CV or in Scopus.

Comparing Scopus data with data from the online survey, 58% of the stays abroad were matched. The majority of the remainder set differs in a value of 1, which means there was one additional stay abroad according to Scopus (11%) or the online survey (13%). The duration of a stay could be determined correctly in more than 50% of stays. According to Scopus, the number of publications was higher for 99% of all authors than they stated in the questionnaire, even if publications were restricted to articles and conference proceedings between 2000 and 2010.

4 Research Results

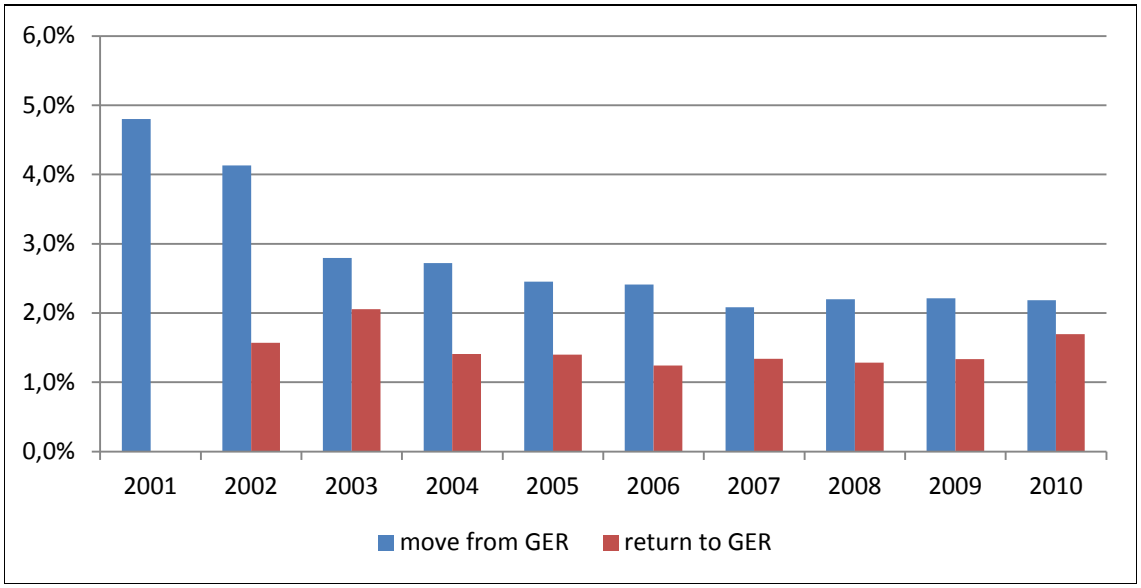
In the following, the results for the question, whether German scientists leave the country for good are presented. Furthermore, the countries the scientists move to, the duration of their stay abroad and their motivations of moving are presented step by step. This chapter contains two parts. The first part presents the bibliometric results and the second part the results of the online survey.

4.1 Research results based on Scopus data

4.1.1 Brain circulation in Germany and their impact

Brain circulation is measured by the change of affiliations of the authors' publications. Figure 13 shows the percentage of German authors who changed their affiliation to a foreign one (move abroad) and back to the German affiliation (return to GER). In the first two years of the examined period, most scientists went abroad. However, this proportion could also include foreign scientists who move back home or to other countries. On the one hand, the proportion of those who go abroad decreases slightly over time, on the other hand, the proportion of those who come back increases. Nevertheless, a rather constant exchange is visible, which suggests brain circulation.

Figure 13: Circulation of German scientists (% of all German authors in the dataset)



Source: Calculations of Fraunhofer ISI.

Research results have shown that German scientists often visit foreign countries. In order to investigate if there is a gain by brain circulation the question follows: Does a stay abroad increase the quality of research?

It is assumed that the productivity of a scientist can be measured in the number of publications and the visibility of authors in the number of citations per publication (citation rate). Therefore, the number of publications in Scopus was counted for each German author in the time period between 2007 and 2009[9]. The citation rate is based on the number of citations in the three years after the years of publications. We analyzed the productivity with regression estimation models (negative binomial) with the number of publications and the number of citations as dependent variable.

The explanatory variable in the models is a dummy variable which is a binary codification of international experience of the German scientists. National experience means that they have published only with a German affiliation while international indicates that they have published at least once with an affiliation from another country. The models contain 44,876 authors[10], of which 81 % have national and 20 % international experience. Both models compare these two groups of authors, one in their number of publi-

9 A period of three years was chosen because there are some authors who had no publications in some years and it was intended to reflect the end of the observation period.

10 The data used for this model are slightly different from those of the other bibliometric analyses, as they are based on a first – less restrictive - data-selection.

cations and one of their citation rates under control of the research field of the authors. The results (Table 7) show, that there is no significant difference between the two groups in the number of publications, which means that there is no productivity difference in the two groups. On the other hand, the effect of the visibility is significant. That means that publications of German scientists with international experience are more often cited (0.331 citations per publication) than publications of German scientists with national experience of the same research field, after controlling for field specific effects.

Table 7: Productivity and visibility of scientists with national vs. international experience

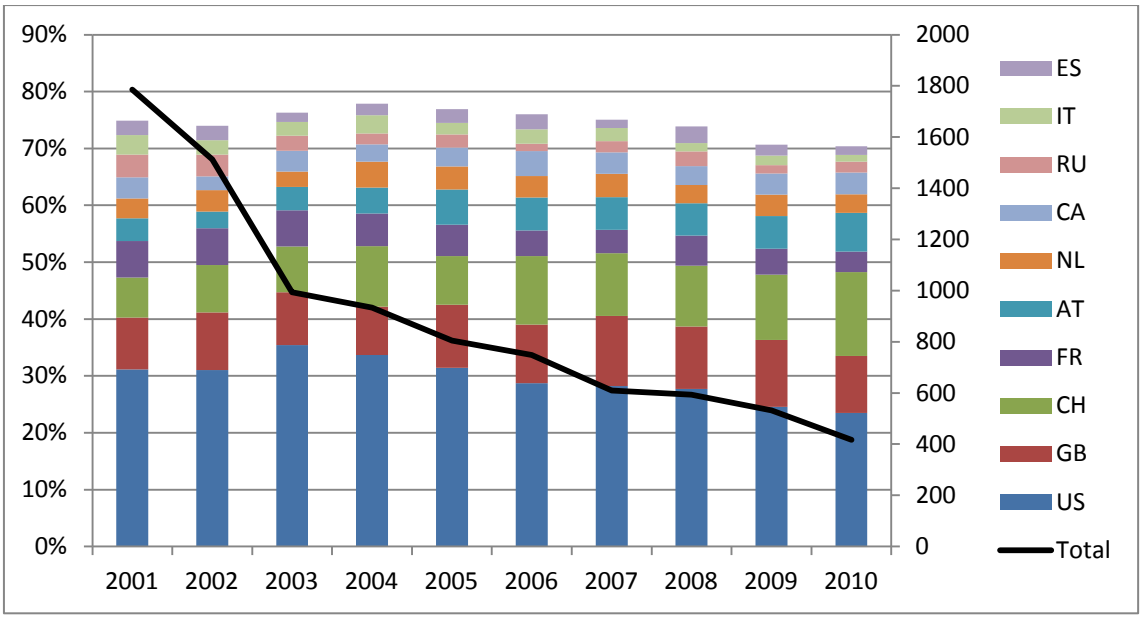
	Productivity: Number of publications (2007-09)	**Visibility :** Citation-rate of publications (2007-09)
Experience (national vs. international)	0.020	0.331***
Research fields as control variable:		
- Multidisciplinary	-1.638	-17.679
- Agricultural and Biological Sciences	-0.862***	-0.375***
- Arts and Humanities	-1.229***	-0.765***
- Biochemistry, Genetics and Molecular Biology	-0.917***	0.450***
- Business, Management and Accounting	-1.384***	-1.030***
- Chemical Engineering	-1.020***	-0.665***
- Chemistry	-0.646***	-0.183***
- Computer Science	-0.323***	-0.986***
- Decision Sciences	-1.100***	-0.135
- Earth and Planetary Sciences	-0.783***	-0.208***
- Economics/ Econometrics/ Finance	-1.253***	-1.049***
- Energy	-0.951***	-1.357***
- Engineering	-0.804***	-1.191***
- Environmental Science	-0.911***	-0.208***
- Immunology and Microbiology	-0.886***	0.207***
- Materials Science	-0.767***	-0.584***
- Mathematics	-1.097***	-1.303***
- Medicine	-0.669***	0.111***
- Neuroscience	-0.749***	0.276***
- Nursing	-1.198*	-0.860
- Pharmacology/ Toxicology/ Pharmaceutics	-0.978***	-0.196***
- Physics and Astronomy	-0.558***	-0.130***
- Psychology	-0.843***	-0.380***
- Social Sciences	-1.283***	-0.994***
- Veterinary	-0.778***	-1.001***
- Dentistry	-0.745***	-0.459***
- Health Professions	-1.377***	-1.635***
Number of Observations	44,876	44,876
Pseudo R2	0.45%	2.56%

* p< 0.1, ** p< 0.05, *** p< 0.01. Source: Calculations of Fraunhofer ISI.

4.1.2 Destinations of German scientists

The question arises which countries are particularly attractive for German migratory scientists. Figure 14 shows the top 10 most popular migration countries for German scientists in the period between 2000 and 2010. The United States are clearly the most popular country, because they are the destination of 31% of movements. The values for Great Britain and Switzerland are similar (around 10 %), but with a large gap to the US. France, Austria, the Netherlands, Canada, Italy, Russia and Spain are on approximately the same level (between 2% and 6% of the movements) with the ranks 4 to 10. The percentage amount of scientists who moved to these countries is relatively stable over time. The total number of movements decreased, probably also due to the fixed dataset of authors.

Figure 14: Top 10 migration countries for separate years.



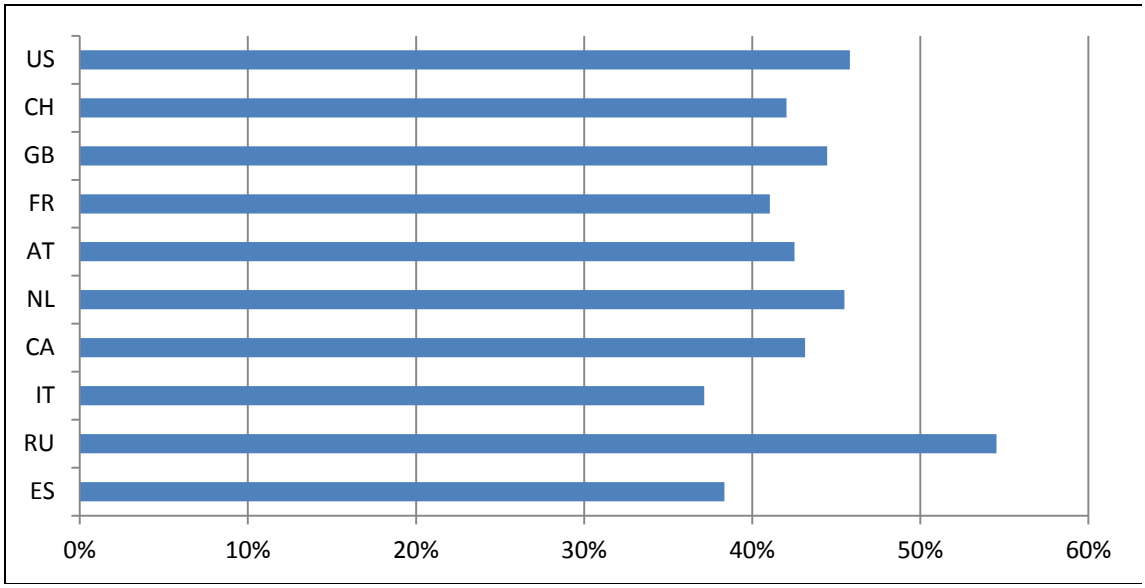
Source: Calculations of Fraunhofer ISI.

Of the emigrating scientists, more remain abroad than return to Germany (see Figure 13). This could be an effect of the methodical problem that was just shown. 50% stated that they have never been abroad, which suggests homonyms where German and foreigners without movement were mixed together in one ID. Those foreigners of course do not come back, because they have no relation to Germany.

When analyzing the countries from which they return, we take into account that scientists may visit various countries before returning to Germany. In 2001, the first migration was observed and thus the first returnees were due in 2002.

Figure 15 shows the proportion of returnees in relation to the total number of migrants to the top 10 migration countries. The share of migrants returning from Italy is relatively small at 39%, closely followed by Spain (41%). In contrast, most scientists come back from Russia (58%). The other countries share the middle field.

Figure 15: Rate of return of migratory scientists (top 10 countries of migration)



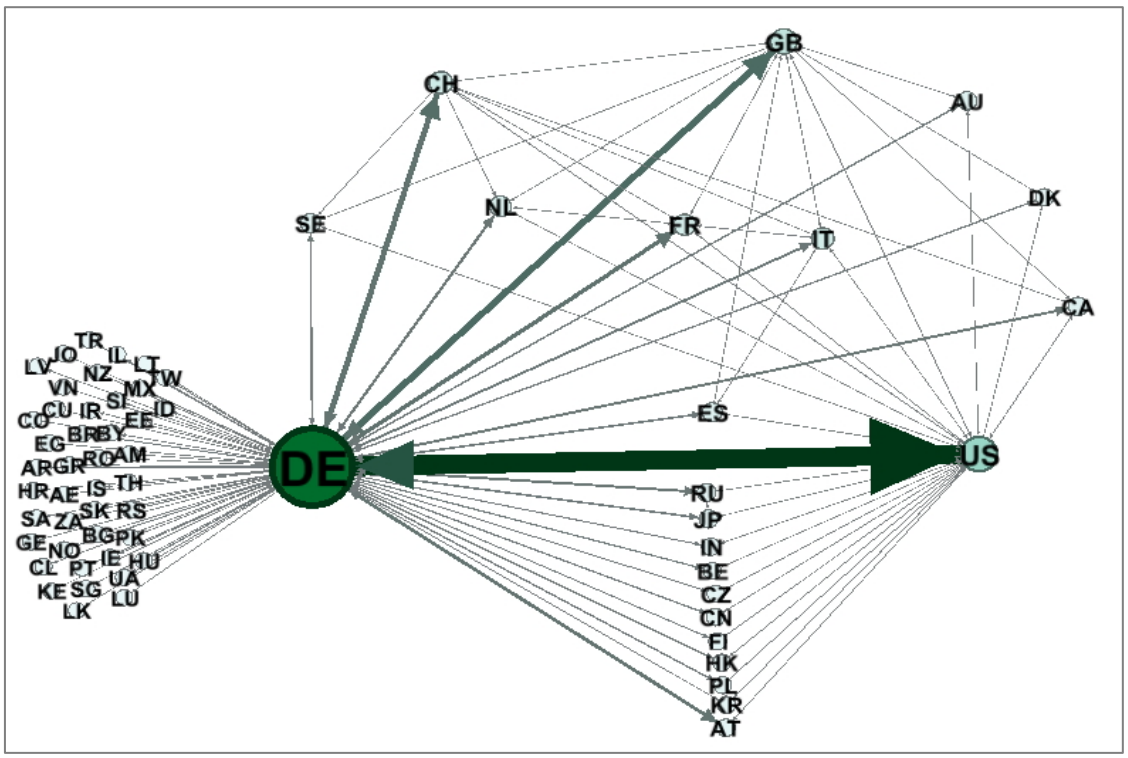
Source: Calculations of Fraunhofer ISI.

At the current stage of research, it is difficult to say whether the migrants to those countries with exceptionally high return rates – i.e. the US, Switzerland, UK, Russia - have more incentives to return or had planned shorter stays abroad from the start. This matter was investigated in the online survey (see Chapter 4.2).

To get an impression of how scientists move from one country to another, we analyzed the country exchange of scientists in 10 years. We visualize these results in a network analysis via Gephi[11]. Therefore, we analyzed the moves from 6,552 authors from one country to another (Figure 16). The arrows indicate the direction of migration. The thicker the arrow, the more moves to the corresponding country were observed. In most cases the U.S. is involved, but also Great Britain, France and Switzerland are popular hubs. It can be seen that many scientists move to the popular countries, especially to the US, UK, France or Switzerland via detours. These detour countries are often Canada, Italy, Spain and Netherlands.

11 Gephi is an open-source software for visualizing and analyzing large networks graphs. https://gephi.org/, last checked in November 2013.

Figure 16: Exchange of German scientists between countries[12] within 10 years



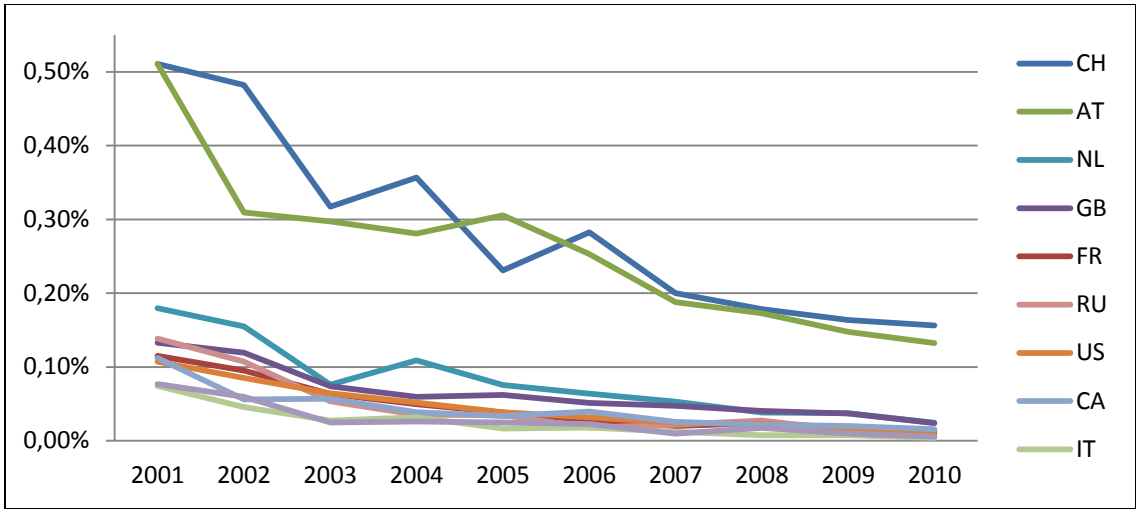
Source: Calculations of Fraunhofer ISI.

For the mapping of the network, authors were selected who moved from one country to another in the time period 2000-2010.

The US are the largest country and also have more research organizations and researchers than the other countries. Thus, size effects might occur. To account for this, we have normalized the number of migratory scientists to the number of all the scientists of the Top10 countries in Scopus (per year). By this normalization, the US loose their first place and are ranked considerably lower. Now the top two places are occupied by Switzerland and Austria (Figure 17). These results confirm that the proximity and the language of a country have a great influence on which country scientists choose as a destination. This is in concordance with the empirical literature, both on the migration of scientists (e.g.Franzoni et al. (2012) and Moed et al (2013)) as well as on international co-publications (e.g. Michels et al. 2013; Fraunhofer ISI et al. 2009).

12 Only the destinations with more than five scientists are included in the graph.

Figure 17: Top 10 migration countries (number of moving scientists normalized to the number of authors per country in Scopus)

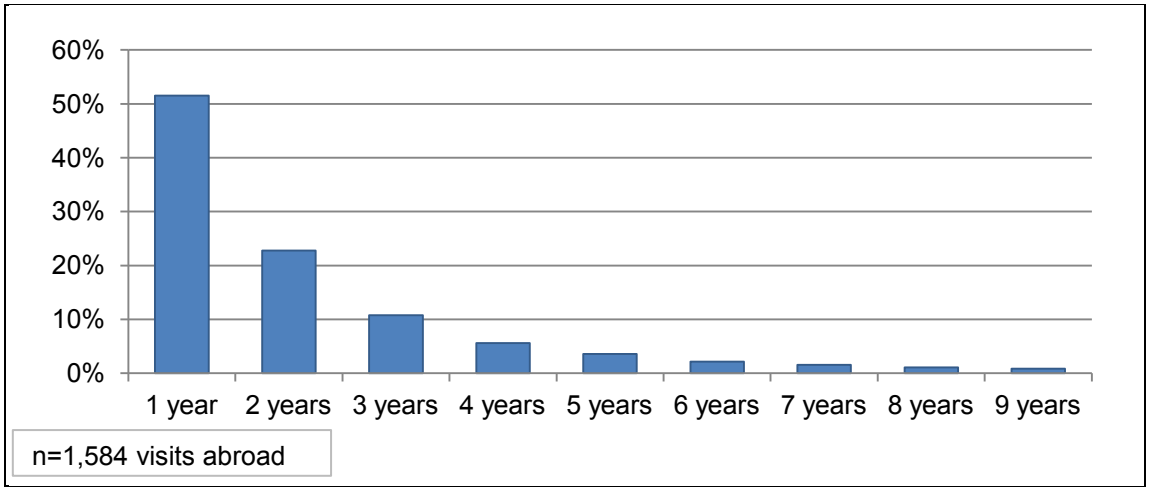


Source: Calculations of Fraunhofer ISI.

4.1.3 Duration of stay

To analyze the duration of the stay abroad we concentrate on authors with complete information about their residence (in their publications) until 2010. This corresponds to a number of 1,584 authors. Figure 18 shows the percentage (longest stay abroad) of the authors returning after a time period between 1 and 9 years. It shows, that half of the authors returned to Germany after one year abroad. The longer stays (4-9 years) account for 15% of returnees.

Figure 18: Duration of stay abroad within 10 years



Source: Calculations of Fraunhofer ISI.

The question arises, if a longer stay abroad increases a scientist´s productivity and visibility in the community. To answer this question we conducted an analysis of productivity and visibility with regression estimation models (negative binomial) with the number of publications and the number of citations as dependent variable, similar to the analysis in Section 4.1.1. The target group is now German scientists with international experience, 9,225 authors[13]. The explanatory variable in these models is the number of years of the longest stay abroad of one author in the time period between 2000 and 2010 and the destination is a control variable. The minimum number is one year and the maximum number 9 years. The results of the models (Table 8) show again: there is no significant effect regarding the number of publications. The duration of the stay abroad has no effect on the number of publications between 2007 and 2009, but a negative effect on the citation rate. The longer scientist stay abroad the lower their citation rate (-0.345 citations per publication). It suggests that short stays abroad are a milestone in the career and prepare scientists for a scientific career, while longer stays abroad turn into a very normal everyday life abroad.

Table 8: Productivity and visibility by duration of stay abroad

	Productivity: Number of publications (2007-09)	**Visibility :** Citation-rate of publications (2007-09)
Duration of stay abroad in years	0.011	-0.345**
Destination country as control variable:		
US	0.181***	2.493***
CH	0.193***	1.815***
GB	0.203***	1.768***
FR	0.206***	0.617***
AT	0.258***	0.060***
NL	0.250***	0.551***
CA	0.294***	1.707***
IT	0.318***	1.883***
RU	0.196***	-1.705***
ES	0.268***	0.918***
Number of Observations	9,225	9,225
Pseudo R2	0.39%	1.75%

* p< 0.1, ** p< 0.05, *** p< 0.01. Source: Calculations of Fraunhofer ISI.

13 The data again might differ from other data as described in Section 4.1.1..

4.1.4 Scientific Mobility in other Countries

To compare the scientific mobility in other countries with that of Germany, the same analyses were conducted for Austria, France and Great Britain. In total, 4,185 Austrian, 35.261 French and 39.522 British scientists were identified in Scopus in 2000, with an address in the same country in 1998 and 1999. The target group of the actual evaluation was again the authors who had a foreign address in the time period between 2000 and 2010.

Austria

18% of Austrian scientists have international experience according to their publications, 10% published only with a foreign address and 8% with foreign and Austrian addresses. These scientists mostly belong to the research field of Medicine (26%) or Biochemistry, Genetics and Molecular Biology (19%) and most of them published one paper per year (Table 9).

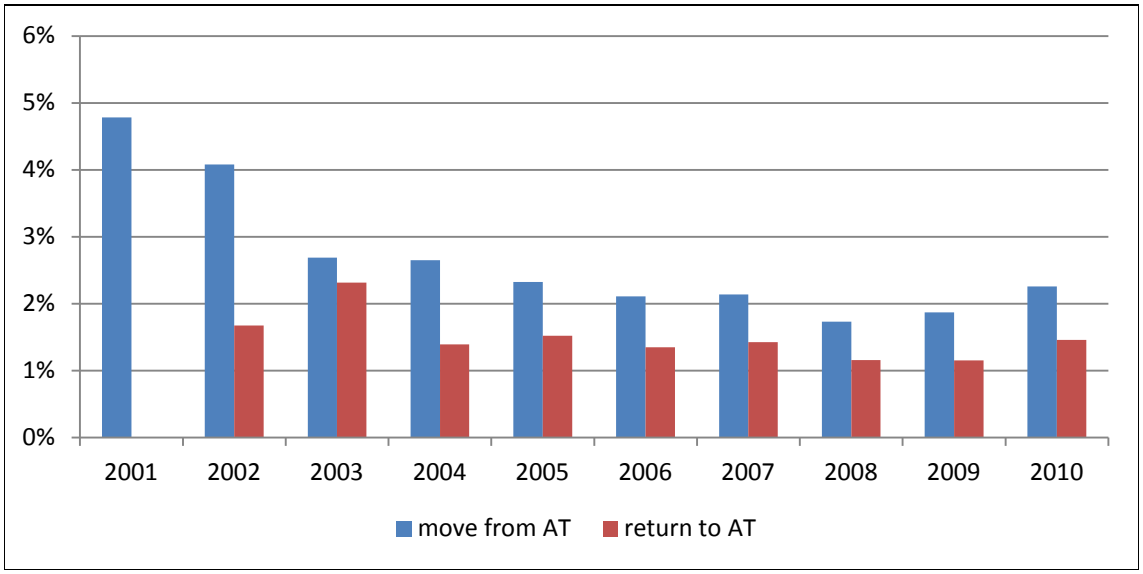
Table 9: Percentage of Austrian authors by publication addresses and research field

	Total data set	AT address	AT and foreign address	Foreign address
authors per year (2001-2010)	100% (4,185)	82%	8%	10%
Main research fields:				
➢Agricultural and Biological Sciences	5%	5%	4%	6%
➢Biochemistry, Genetics and Molecular Biology	11%	11%	14%	19%
➢Chemistry	5%	4%	5%	7%
➢Earth and Planetary Sciences	3%	4%	3%	4%
➢Engineering	4%	4%	4%	5%
➢Materials Science	3%	3%	3%	3%
➢Medicine	47%	49%	42%	26%
➢Physics and Astronomy	7%	5%	9%	14%

Source: Calculations of Fraunhofer ISI.

Figure 19 shows the moves of Austrian scientists measured via their publications. The amount of those who move from and return to Austria is relatively constant, about 2% of the scientists move and about 1.5% come back.

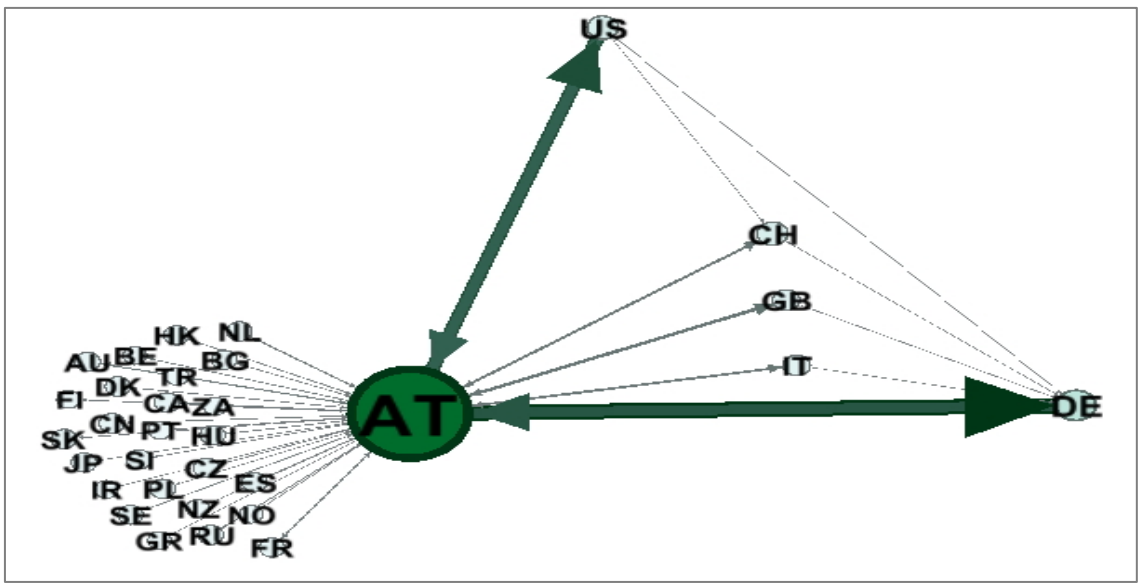
Figure 19: Circulation of Austrian scientists (% on all Austrian authors in the dataset)



Source: Calculations of Fraunhofer ISI.

To detect possible brain circulation, the moving paths of the Austrian scientists are reflected in Figure 20. The results show, that Austrian scientists mostly prefer Germany and the US as research destinations and they rarely switch from one foreign country to another. Some scientists move via Great Britain, Italy or Switzerland to Germany.

Figure 20: Exchange of Austrian scientists between countries[14] within 10 years



14 Only the destinations with more than five scientists are included in the graph.

Source: Calculations of Fraunhofer ISI.

France

French scientists have mostly national experience (87%) and belong to the research field of Medicine (28%). 7% published with only a foreign address, they mostly belong to the research field Biochemistry, Genetics and Molecular Biology (21%) (Table 10).

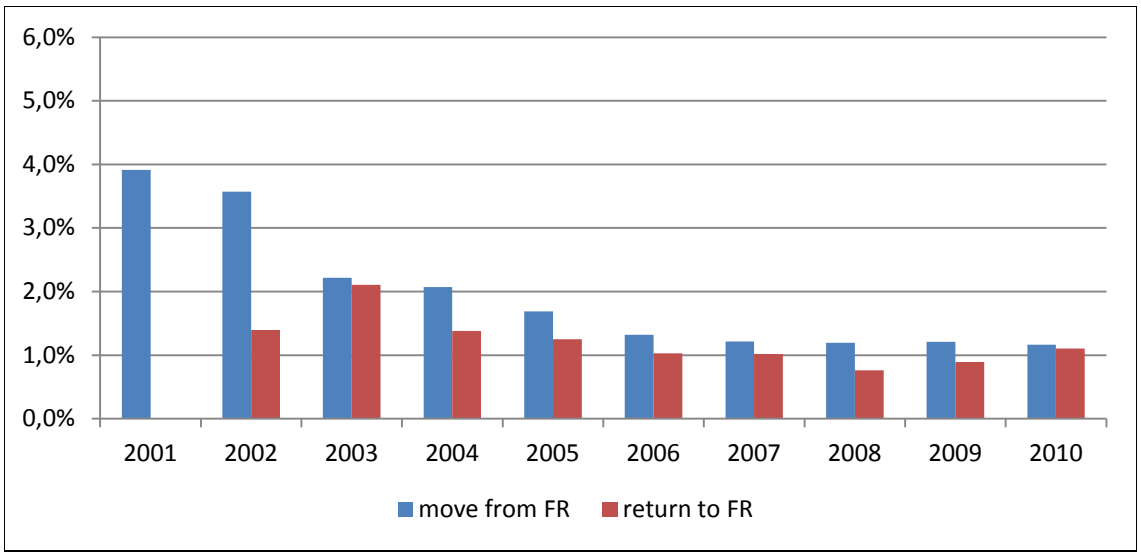
Table 10: Percentage of French authors by publication addresses and research field

	Total data set	FR address	FR and foreign address	Foreign address
authors per year (2001-2010)	100% (35,261)	87%	6%	7%
Main research fields:				
➢Agricultural and Biological Sciences	6%	6%	7%	5%
➢Biochemistry, Genetics and Molecular Biology	16%	15%	19%	21%
➢Chemistry	6%	6%	6%	8%
➢Earth and Planetary Sciences	5%	5%	7%	5%
➢Engineering	6%	6%	5%	6%
➢Immunology and Microbiology	4%	4%	5%	6%
➢Materials Science	4%	4%	3%	4%
➢Medicine	27%	28%	18%	17%
➢Physics and Astronomy	12%	11%	16%	15%

Source: Calculations of Fraunhofer ISI.

The trend for moving abroad decreased over time. Noticeable here is that the rate of returning scientists is relatively high and in 2010 even almost equal to the proportion of those who move. The French government also runs specific returnee programs and makes it attractive for them to return, obviously with great success.

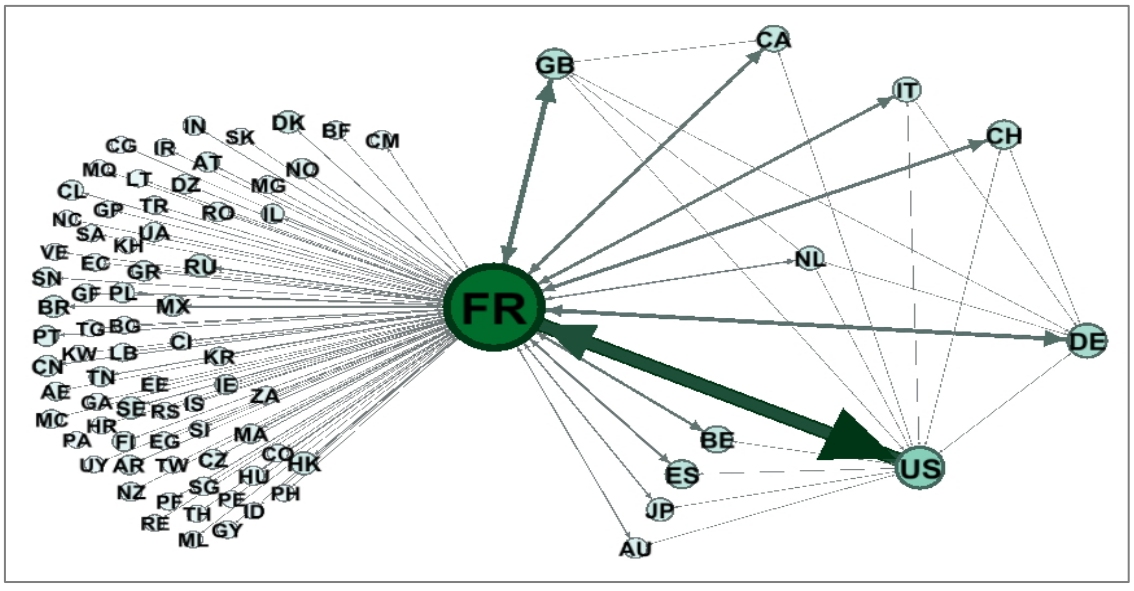
Figure 21: Circulation of French scientists (% of all French authors in the data set)



Source: Calculations of Fraunhofer ISI.

Most of the French scientists moved to the US but also Germany, Great Britain, Canada, Switzerland and Italy are popular destinations. The Netherlands turn out to be a stop over on the way to other countries like the US, Germany and Great Britain and there are some scientists who move via Belgium, Spain, Japan or Australia to the US (Figure 22).

Figure 22: Exchange of French scientists between countries[15] within 10 years



Source: Calculations of Fraunhofer ISI.

15 Only the destinations with more than five scientists are included in the graph.

Great Britain

The same analyses were conducted for British scientists. 19% of British scientists (39,522) in the selected data have international experience, mostly in the research field of Medicine (24%), even if the share is below of those who published only nationally. The share of researchers of Biochemistry, Genetics and Molecular Biology is higher for scientists with international experience than for those with just national experience, which means that those are more likely to move abroad compared to the other fields (Table 11).

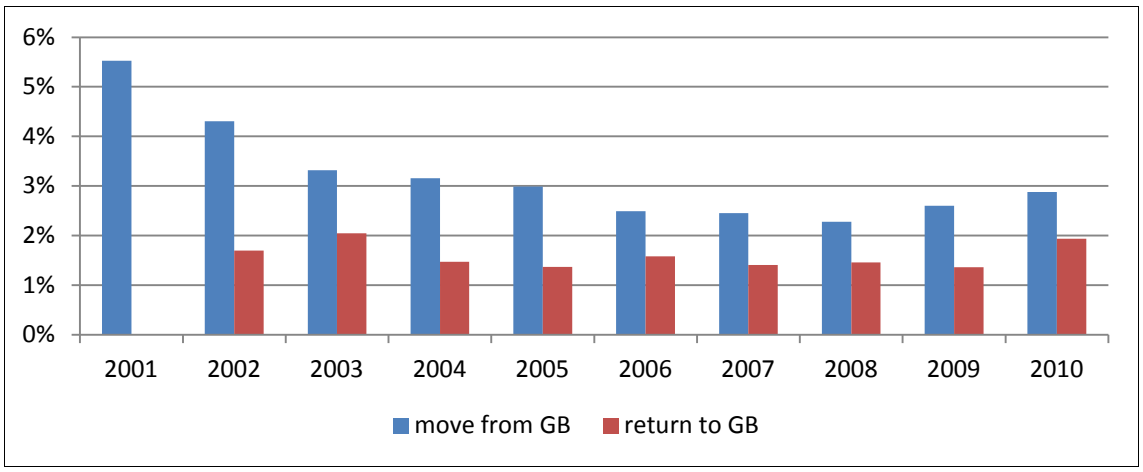
Table 11: Percentage of British authors by publication addresses and research field

	Total data set	GB address	GB and foreign address	Foreign address
authors per year (2001-2010)	100% (39,522)	81%	7%	12%
Main research fields:				
➢Agricultural and Biological Sciences	6%	6%	8%	7%
➢Biochemistry, Genetics and Molecular Biology	12%	12%	15%	17%
➢Chemistry	4%	4%	5%	6%
➢Earth and Planetary Sciences	5%	4%	6%	6%
➢Engineering	6%	6%	6%	7%
➢Medicine	34%	36%	29%	24%
➢Physics and Astronomy	7%	5%	8%	10%

Source: Calculations of Fraunhofer ISI.

The migration rate of British scientists decreased from 2000 until 2008 and then increased until 2010. The return rate is up to 2% in 2003 and 2010, but fluctuates in the period (Figure 23). It seems that only half of those who move abroad come back. It could be that they tend to stay abroad longer. British scientists tend to skip many countries before they return to their home country.

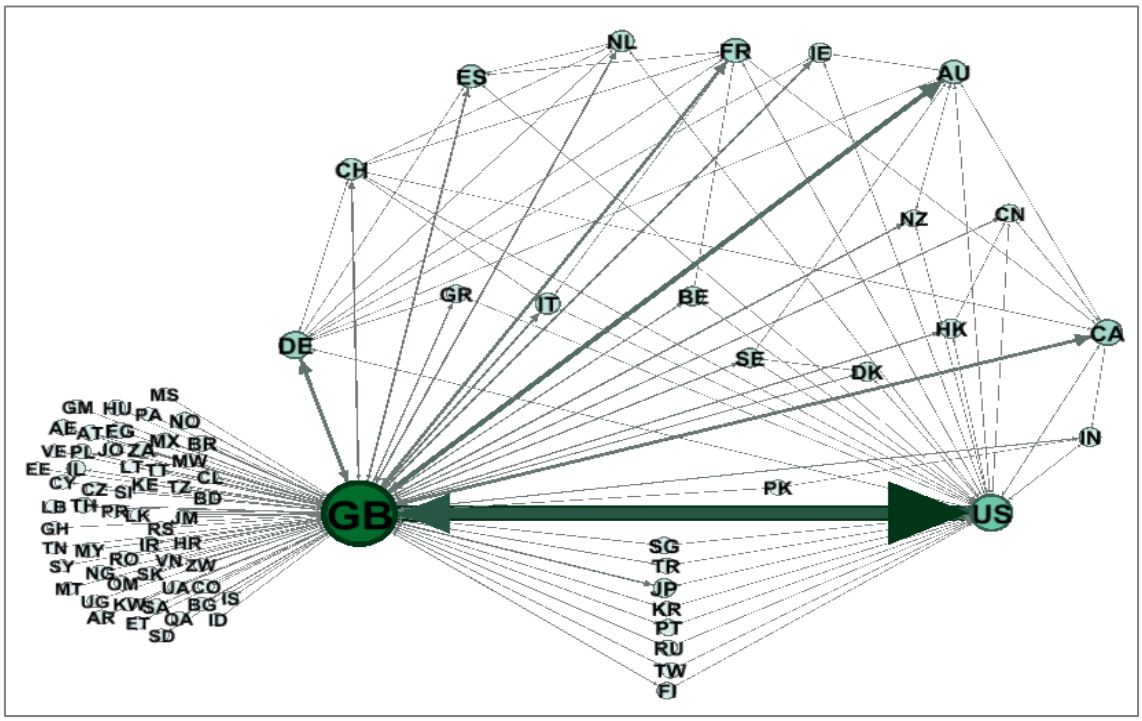
Figure 23: Circulation of British scientists (% of all British authors in the data set)



Source: Calculations of Fraunhofer ISI.

Figure 24 shows the moves of British scientists in 10 years. Their favorite destinations are the US, but also Canada, Australia, Germany and France.

Figure 24: Exchange of British scientists between countries[16] within 10 years



Source: Calculations of Fraunhofer ISI.

16 Only the destinations with more than five scientists are included in the graph.

Comparing Brain circulation of German, Austrian, French and British scientists

To compare the four countries it is necessary to summarize the unique features of the countries first. Austria has the smallest data set, because it has a relatively low number of authors in Scopus. The other three data sets have approximately the same size. In all four countries the migration rate is between 1 and 3% of the selected scientists, the lowest rate was in France and the highest in Great Britain. French scientists are less likely to have international experience than scientists from other countries. British and German scientists are more likely to jump from one country to another than French or Austrian scientists. For Germany, France and Great Britain the most popular destination is the US, whereas Austrian scientists prefer Germany (Table 12).

Great Britain has the lowest return rate of all, but as they travel through many countries it is possible that they stay abroad longer. France has the highest return rate - between 50% and 60%; this seems plausible as French scientists are also less likely to move in the first place. The return rates of Austrian scientists are slightly higher than those of German scientists, whereas 49% returned from Germany.

Countries with many research organizations (like the US) have the chance to attract more foreign scientists than others. To account for this, we have normalized the number of migratory scientists to the number of all scientists covered by Scopus for the respective destination country. By doing so, the US loose the first place and are ranked considerably lower. Now the top five most visited countries by German scientists are Switzerland, Austria, the Netherlands, Great Britain and the USA/ France. For Austria there are two changes; instead of the US and Italy, Slovakia and Switzerland are among the top 5 most visited countries; Germany remains in first place. For France, Switzerland takes the first place and the Netherlands enter the top five. Ireland, New Zealand and Australia turn out to be more popular for British scientists when controlling for the size of the researcher community (Table 12). There seems to be a link between the chosen destination and the similarity to the home language as well as to the regional proximity of the home country to the countries the scientists visited.

Table 12: Comparing Destinations of German, Austrian, French and British scientists[17]

	Germany	Austria	France	Great Britain
Total number of authors	37,293	4,185	35,261	39,522
Share of authors who give up their home address (target group)	10%	10%	7%	12%
Top 5 of visited counties (% return rates)	USA (47%) Great Britain (45%) Switzerland (42%) France (41%) Austria (44%)	Germany (49%) USA (49%) Great Britain (52%) Australia (56%) Italy (39%)	USA (56%) Great Britain (60%) Germany (52%) Switzerland (51%) Canada (50%)	USA (26%) Australia (17%) Canada (11%) Germany (18%) France (14%)
Top 5 of visited counties (normalized by Scopus number of authors)	Switzerland Austria Netherlands Great Britain USA/ France	Germany Slovakia Switzerland Australia Great Britain	Switzerland Belgium Canada Great Britain Netherlands	Ireland New Zealand Australia Canada USA

Source: Calculations of Fraunhofer ISI.

4.2 Research results based on the Online-Survey

In this section the data from the online survey are analyzed. First of all, the respondents of the survey are described in terms of age, gender, qualification level, research field and number of publications. In each case, migratory and non-migratory German scientists are compared.

In the second part, the migratory behavior and motivation of German scientists to study or work abroad is examined.

The last part of this chapter is about the consequences of migration. Therefore, the analysis concentrates on networks and cooperation structures.

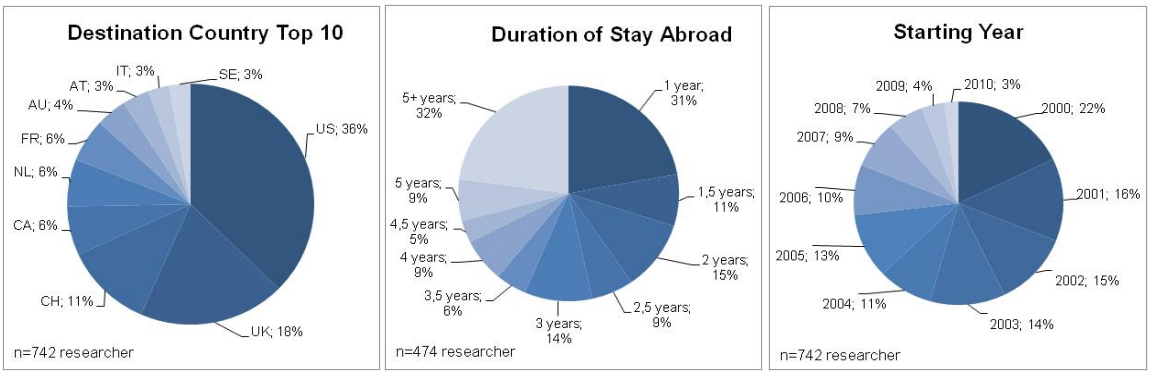
17 Detailed information in the Appendix.

4.2.1 Motivation analysis

The motivation analysis is based on the questionnaire responses of German scientists (n=742) who worked more than six months abroad in the time period from 2000 to 2010. These were previously defined as scientists with international experience.

The most popular destinations for scientists are the USA (36%), the UK (18%) and Switzerland (11%). Other countries like Canada, the Netherlands and France are also well visited, by 6% each. The duration of their visit abroad is in most cases one year (31%) or more than 5 years (32%) excluding those who plan to emigrate forever. The starting year of a visit abroad includes every year between 2000 and 2010 (see Figure 25).

Figure 25: International destination, duration of the stay abroad (excl. scientists with no intention to return) and starting year

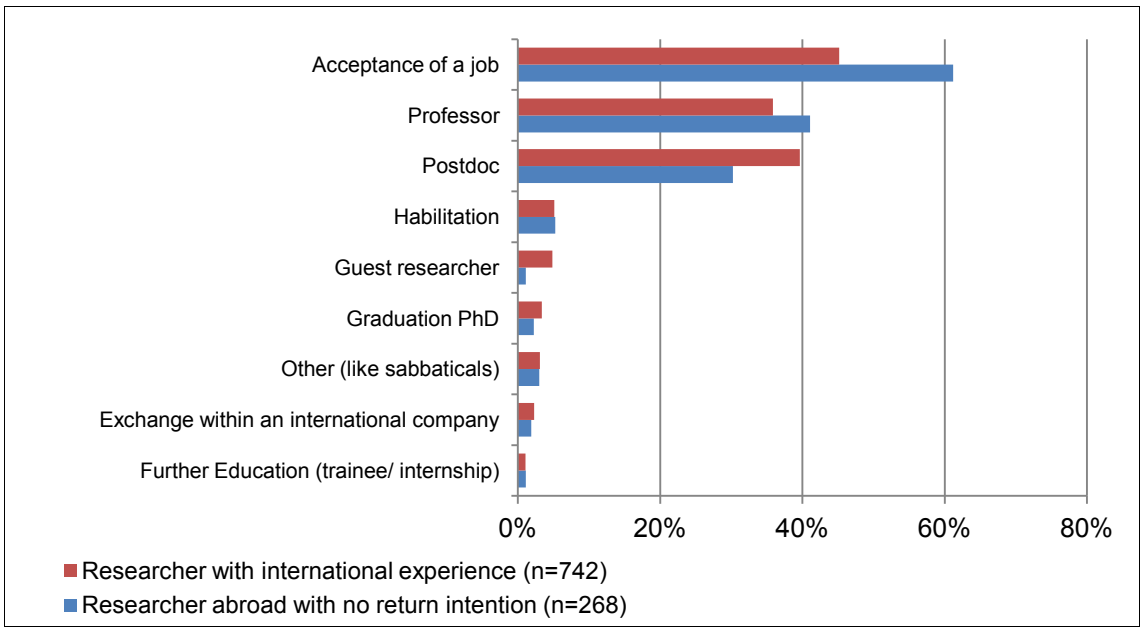


Source: Calculations of Fraunhofer ISI.

Most scientists visited universities abroad (65%), non-university research institutes (23%) or companies (9%).

Figure 26 shows the reasons for scientists to stay abroad for all scientists and those who stayed abroad and had no intention of returning. The main incentive is the acceptance of a job, especially for those who have no intention of coming back to Germany. The same trend is visible for professors. However, a postdoctoral position is less often a reason for leaving Germany for good.

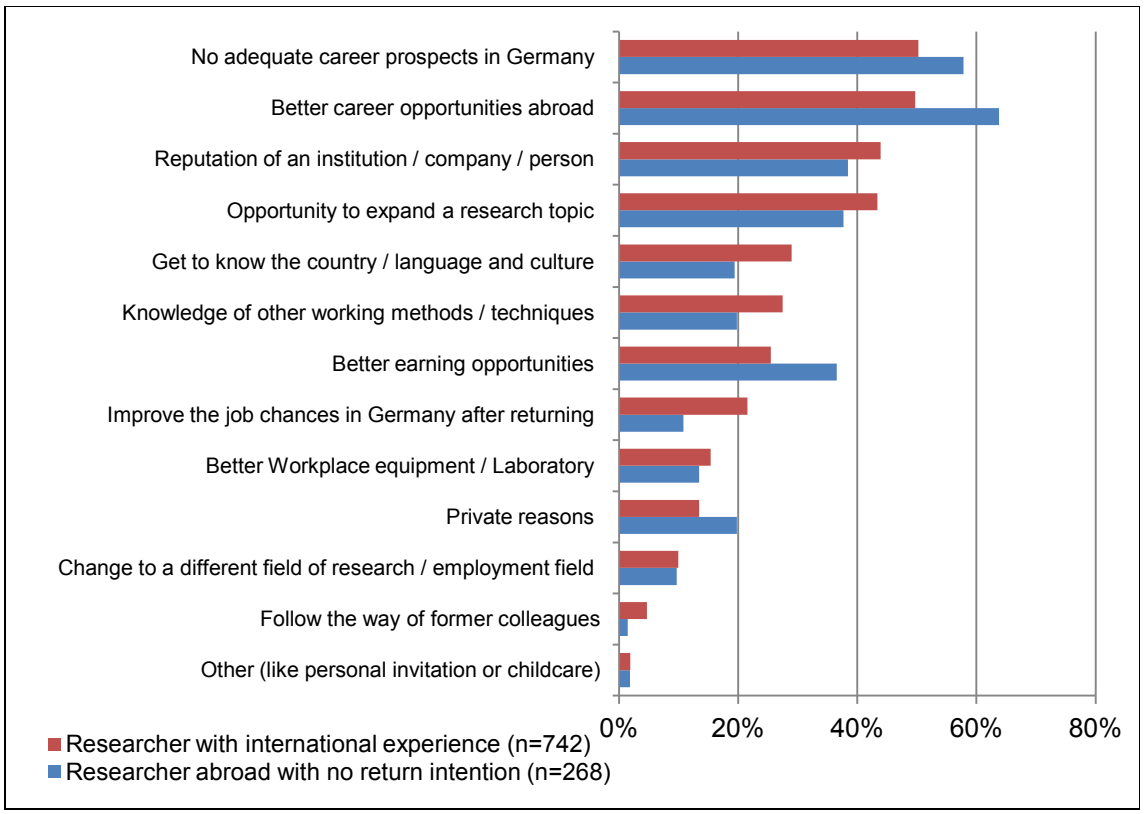
Figure 26: Reasons for staying abroad



Source: Calculations of Fraunhofer ISI.

The main motivation for German scientists to move abroad is to find better career prospects. Some respondents declared there were fewer career opportunities in Germany due to the "Hochschulrahmengesetz", a law for universities which determines the maximum duration of contracts. Additionally, lacking job opportunities for older professors were often mentioned in the open responses. Researchers with no intention of returning are more often driven by the motivation of better career opportunities, better earnings abroad and by private reasons than all researchers with international experience. As private reasons respondents stated for example better child care or a job offer for their partner.

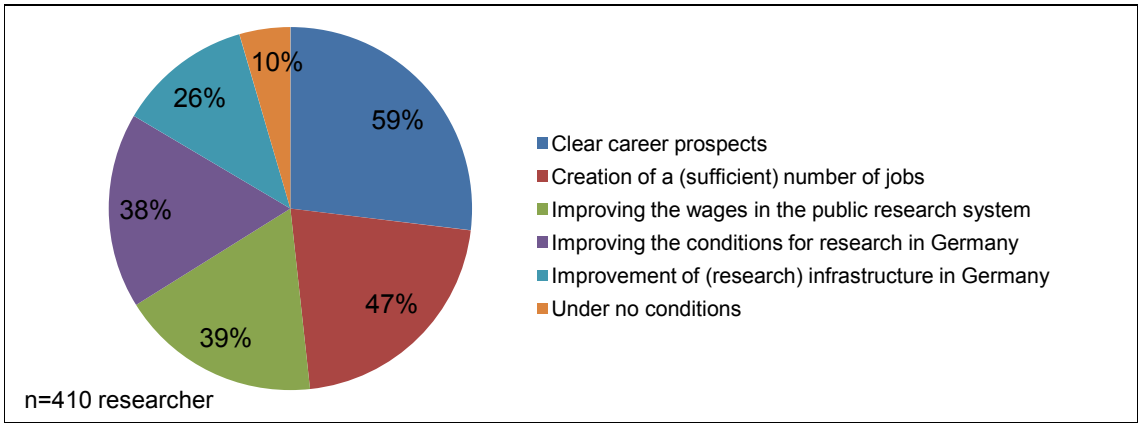
Figure 27: Motivation for staying abroad



Source: Calculations of Fraunhofer ISI.

36% of the researchers with international experience (n= 268) have no intention of returning to Germany. This corresponds to 52% of those living abroad at the time of the survey (n=410). Authors with no intention of returning were asked about the conditions under which they would move back to Germany. About half of those who live abroad would go back if there are clear career prospects and sufficient job alternatives in Germany. Other conditions are improving wages in the public research system, research conditions and the research infrastructure in Germany. Only 10% have settled abroad and would not go back under any circumstances (Figure 28).

Figure 28: Conditions for moving back to Germany

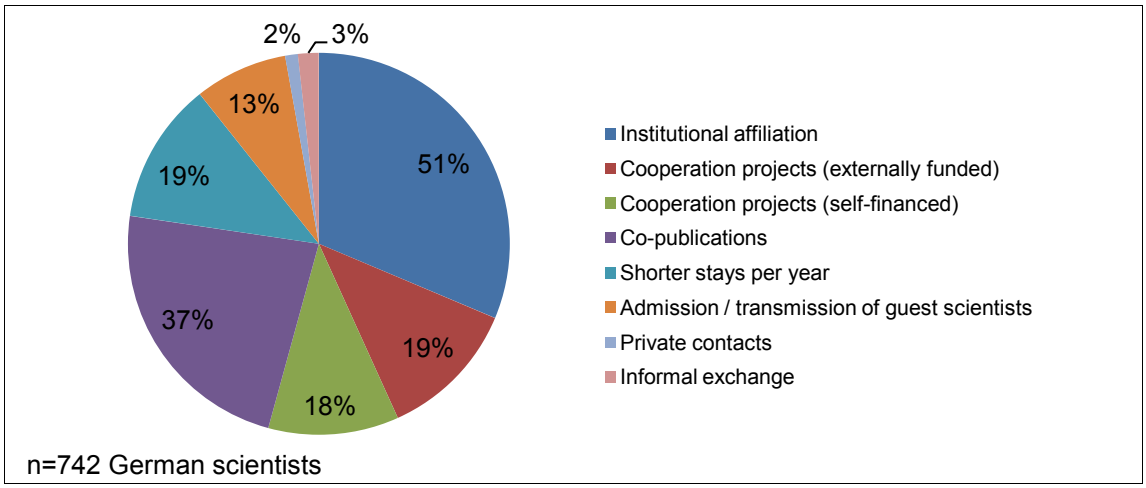


Source: Calculations of Fraunhofer ISI.

4.2.2 Networking through scientific mobility

It is assumed that brain circulation in terms of moving from one country to another helps scientists to build up networks of knowledge. The respondents with experience abroad (742) were asked if they have any contact to their host institution and if so, in which way. 89% of the researchers with international experience stay in contact with the foreign institutions they visited. Half of them still belong to these institutions. Many have contact in cooperation projects (37%), co-publications (37%) or through the exchange of guest scientists. Private contact (2%) or just informal exchange (3%) is less important (Figure 29).

Figure 29: Type of contact to former host institutions abroad



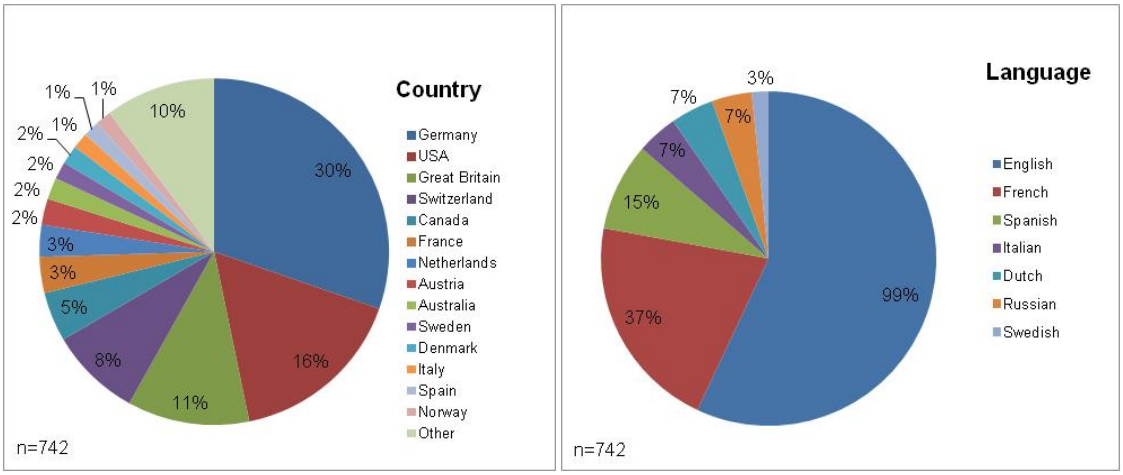
Source: Calculations of Fraunhofer ISI.

70% of the respondents think that their visits abroad are conducive for their careers and 28% that their international publications are more valuable than their national ones.

As main advantages of international publications the respondents named the following (multiple answers were possible): the reputation of the institution and the co-authors (61%), the higher visibility in the research community (52%), more opportunities for interdisciplinary research (46%) or special topics (45%), new working methods (38%) and better working equipment or laboratory (37%).

Some scientists with international experience lived at the moment of the survey in different countries. Only 30% of them were in Germany, 16% in the USA, 11% in Great Britain and 8% in Switzerland (Figure 30). All researchers speak German and as a consequence of the many visits abroad additional languages, in any case English (99%) and further languages like French (37%) and Spanish (15%).

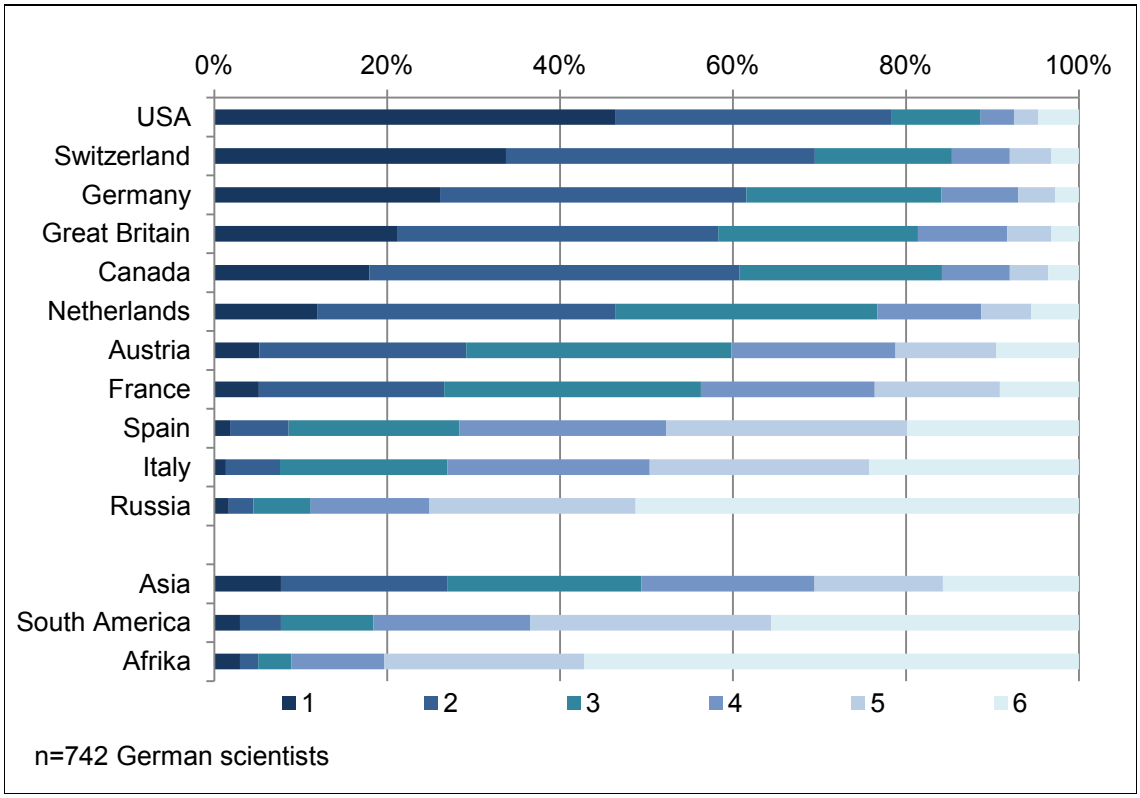
Figure 30: Current residence country and language knowledge



Explanatory note: The sum of percentage is higher than 100%. Source: Calculations of Fraunhofer ISI.

The scientists have evaluated the attractiveness of the country on a scale from 1 (very attractive) to 6 (not attractive, Figure 31). The most attractive country (grades 1 and 2) are the USA (78%), which is followed by Switzerland (69%), Germany (62%), Canada (58%) and Great Britain (61%). It seems that the language is an important aspect, as German-speaking and English-speaking countries are assessed as particularly attractive by German scientists.

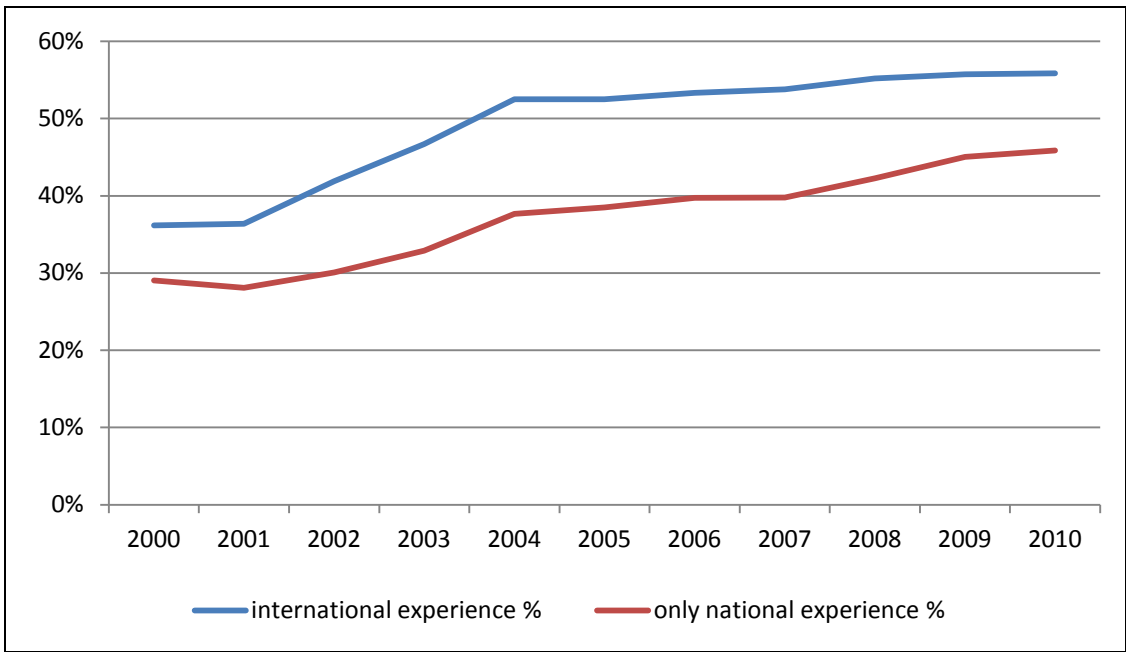
Figure 31: Attractiveness of Countries/Continents (1=very attractive to 6=not attractive)



Source: Calculations of Fraunhofer ISI.

The international networking of scientists can be investigated by considering co-publications. In the following, a simple comparison of the two groups is shown regarding international publications. International publications are defined here as publications with authors from different countries. Scopus data are used to count the number of publications of the two groups of respondents in the time period between 2000 and 2010 (Figure 32). It is a consequence of the international experience, that the share of international co-publications of all publications is higher for scientists with international experience than for those which have only national experience. The difference between the two groups decreased slightly from 2007 onwards as a consequence of an increase of international publications in the group with only national experience.

Figure 32: Share of international publications to the total number of publications of respondents with only national or international experience.



Source: Calculations of Fraunhofer ISI.

5 Discussion

The main research question in this study was: do German scientists migrate abroad for good? The question could be answered by investigating publications by German scientists and their answers in the online survey. The results show that most German scientists, about 80%, have only national experience (publish only with German addresses). This does not mean that they do not travel at all, but they do not have longer visits abroad.

Scientists with international experience (published with German and /or other countries addresses) are according to their publications very mobile and circulate from one country to another. For more or less half of the analyzed scientists a German address could be found in the single years, but this status changed often. The stays abroad lasted one year for half of them and for nearly a quarter two years. Thus, according to their publications a relatively constant exchange of German scientists is visible, which suggests brain circulation. The most popular countries are the United States, Great Britain, Switzerland, France and Austria but if these results are normalized by the number of authors in Scopus, Switzerland and Austria turn out to be the most popular destinations. Although the US are ranked at the top in the absolute counts, when normalizing for size effects they loose that position to Switzerland. These results are not surprising

as the language similarities and proximity to Germany are important factors for the selection of the destination. So an (unsurprising) pattern is visible: neighboring countries and countries with no linguistic barrier are clearly preferred.

The regression analysis of productivity and visibility has shown that scientists with international experience do not publish more than scientists with national experience, but are significantly more cited which suggests a higher visibility in the community. However, this visibility effects decreases the longer the international experience abroad lasts. This implies that stays abroad are rewarded with citations but only if the stays are rather shorter. Therefore, it can be concluded that brain circulation fosters scientists' visibility.

Comparing brain circulation in Germany with other countries – such as Austria, France and Great Britain - is seems that German scientists occupy a middle position. They travel more and are better connected to other countries than Austrian and French scientists, but less than their British counterparts. On the other hand, they are more likely to return to their home country than British scientists. It is interesting that many British scientists move to many other countries via the US.

It was not really possible to detect brain drain solely on the basis of the publication data, because publications tell us nothing about motivations of moving to other countries or intentions to come back. It is also not clear how long scientists will stay abroad if they do not return during the observation period. We got this information via the online survey. The results show that there is as a group of authors who leave Germany for good due to lack of prospects. They account for 36% of German respondents with international experience. However, it is unclear whether this number is representative of all defined German scientists with international experience, as the participation rate in the online survey was 25%. Nevertheless, the results give a first impression for this group's motivations to stay permanently abroad. They are mostly motivated by better career and earning opportunities abroad. Also private reasons play an important role for the decision to leave Germany for good.

The second research topic of this study was the data quality of the bibliometric database Scopus and if scientific mobility in Germany can be measured by applying this data. To evaluate the quality of Scopus the data were compared with CV data of the authors found by Google and their respondents of the online-survey. The CV approach confirmed accordance between both data sources of 78% and the online-survey approach of 80% by comparing the countries of publications and countries where scientists have been. This matching rate is – in this context – relatively high, as we can not assume that scientists published in each visited country or not include each residency

in their CV. Moreover, in the online-survey the authors were asked only about the last 5 stays abroad with a duration of more than half a year. This means that all other or all shorter stays abroad were not recorded. Additionally, not every publication of each author of our data set is covered in Scopus because of journal limitations in the database.

The duration of a stay abroad determined by the publication country was confirmed in more than half of the stays abroad by the online survey. As we assumed that if authors had no publications in one year, they were in the same country of their last publication, which may have distorted the data.

This means, that according to Scopus, the number of publications was 99% higher than what people stated in the questionnaire, even if publications were restricted to articles and conference proceedings between 2000 and 2010. These findings could have two explanations. It could be due to the merge error in the database so that several authors share an ID and thus the alleged author seems to have published more. The other explanation is that authors often count only those publications as their own in which they appeared as the first author.

Even if the database has to deal with some problems, bibliometric data still can be used to identify and analyze scientific mobility. Of course, the quality of the data should be continuously improved to reduce the extent of the merge and split error.

It can be concluded, that there is brain drain in Germany, but the share of brain circulation is even greater. In addition, it was shown how scientists can be traced from their publications and what effect data quality may have.

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7 Appendix

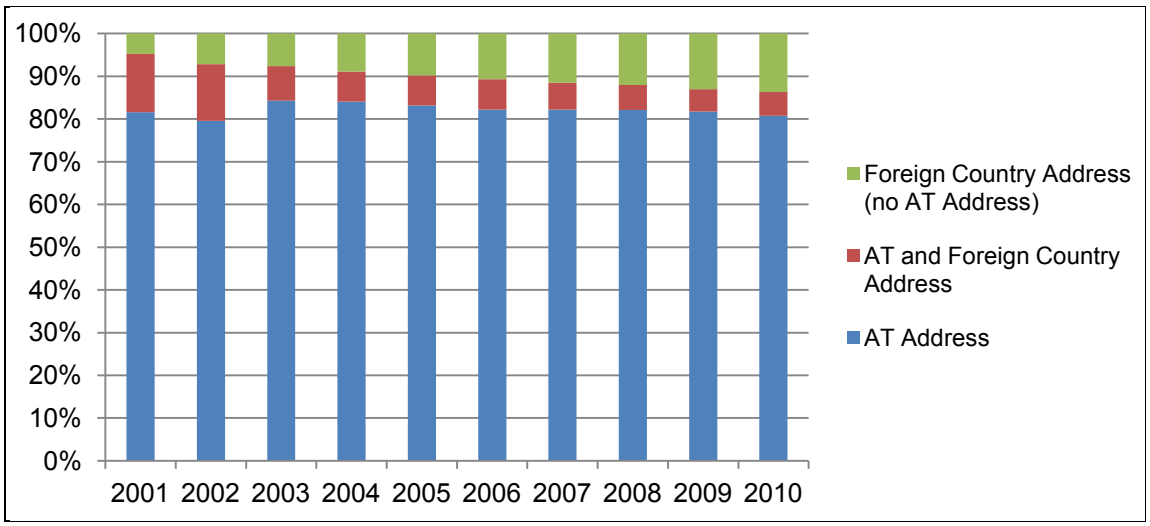
Table A-1: Number of publications by age, gender and research field of researcher with only national vs. international experience

	international experience						national experience					
	0	1-5	6-10	11-20	20+	Total	0	1-5	6-10	11-20	20+	Total
Age												
bis 40 years	2%	7%	11%	27%	52%	44	35%	41%	6%	6%	12%	17
41- 50 years	0%	3%	7%	24%	65%	491	1%	12%	21%	28%	36%	220
51 - 65 years	0%	5%	11%	23%	61%	188	0%	6%	19%	28%	46%	325
65+ years	0%	0%	6%	47%	47%	17	0%	16%	24%	23%	35%	132
Gender												
male	0%	4%	8%	23%	64%	593	1%	11%	20%	26%	40%	567
female	0%	1%	11%	32%	56%	122	2%	9%	24%	26%	36%	107
Main research field												
Engineering	0%	18%	18%	29%	35%	17	1%	9%	27%	23%	40%	176
Physics and Astronomy	0%	5%	6%	18%	70%	165	0%	13%	17%	27%	39%	109
Biochemistry, Genetics and Molecular Biology	0%	0%	10%	29%	60%	163	0%	5%	19%	30%	44%	91
Chemistry	0%	3%	11%	20%	66%	80	0%	9%	14%	32%	39%	69
Materials Science	0%	4%	8%	20%	69%	51	3%	15%	7%	33%	39%	67
Agricultural and Biological Sciences	0%	0%	6%	18%	76%	79	0%	12%	23%	25%	38%	52
Mathematics	0%	2%	17%	22%	59%	58	4%	17%	23%	25%	31%	48
Medicine	0%	2%	7%	28%	62%	145	0%	5%	12%	44%	40%	43
Computer Science	0%	4%	13%	37%	46%	52	2%	16%	21%	21%	40%	43
Pharmacology, Toxicology and Pharmaceutics	0%	4%	11%	16%	62%	45	0%	3%	23%	23%	51%	39
Environmental Science	0%	2%	5%	25%	67%	61	0%	8%	19%	27%	32%	37
Immunology and Microbiology	0%	0%	11%	24%	64%	45	0%	3%	31%	23%	43%	35
Neuroscience	0%	3%	3%	26%	67%	58	0%	12%	21%	30%	36%	33
Earth and Planetary Sciences	0%	2%	8%	19%	70%	53	0%	7%	14%	25%	50%	28
Energy	4%	12%	8%	15%	62%	26	8%	32%	12%	12%	32%	25
Health Professions	0%	0%	0%	29%	71%	21	0%	17%	35%	9%	39%	23
Psychology	0%	0%	4%	22%	74%	23	0%	0%	28%	22%	50%	18
all (Average)	0%	4%	8%	25%	62%	742	1%	10%	20%	26%	40%	696

Source: Calculations of Fraunhofer ISI.

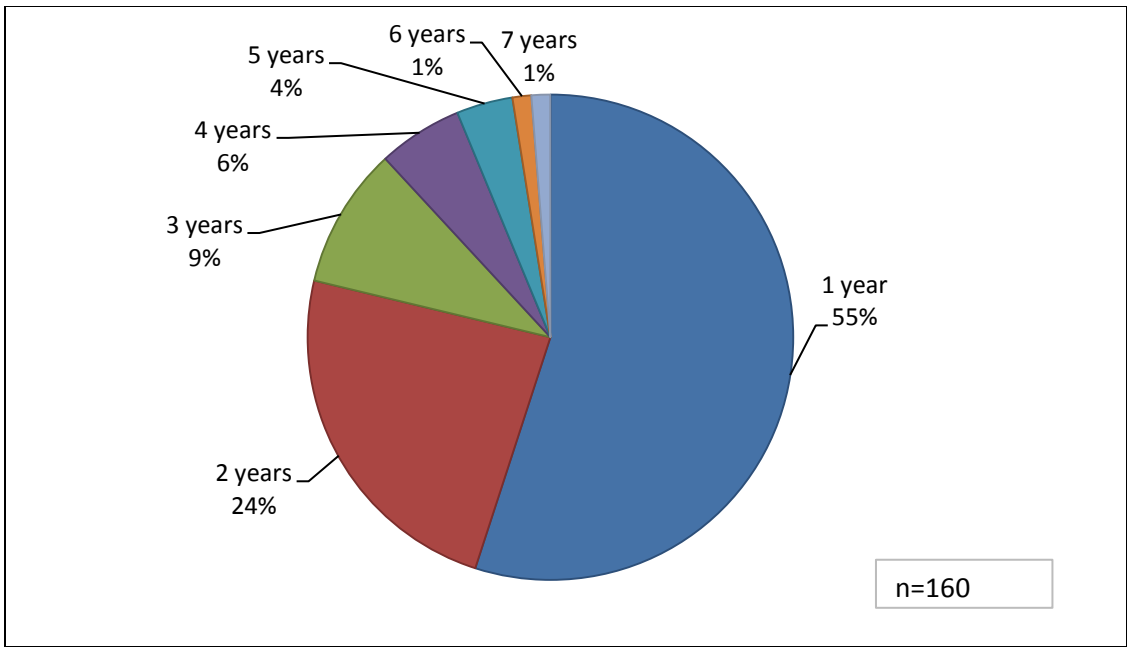
Austria

Figure A-1: Author addresses 2000-2010.



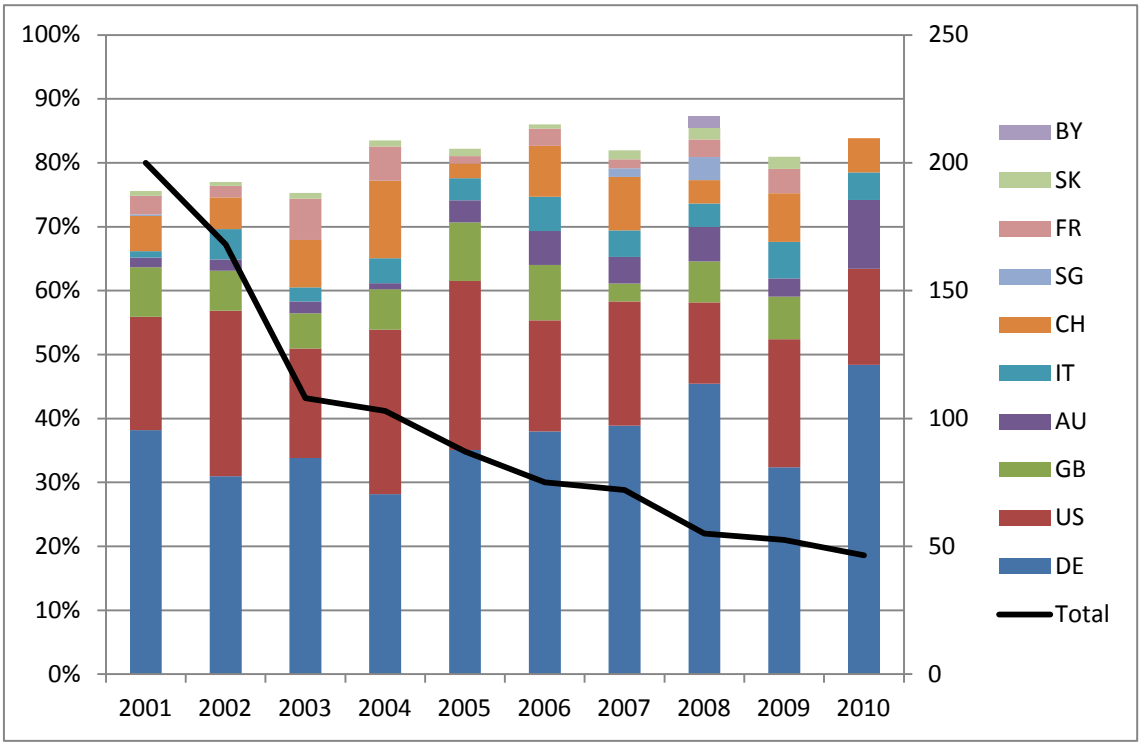
Source: Calculations of Fraunhofer ISI.

Figure A-2: Duration of period spent abroad in years (residencies of less than 10 years which were not finished in 2010 were excluded).



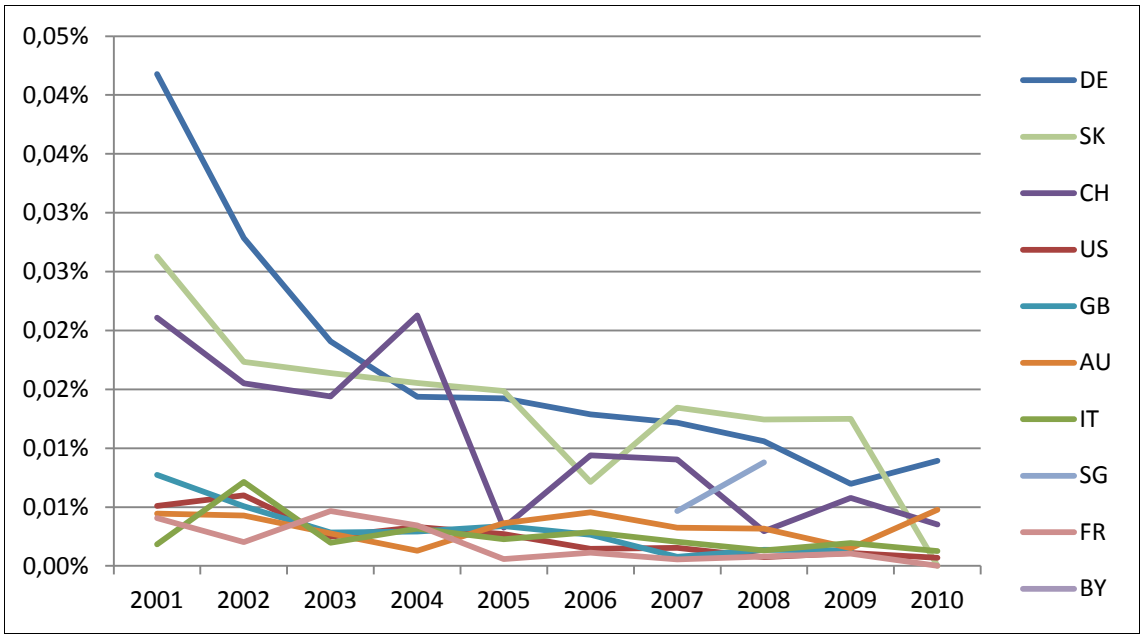
Source: Calculations of Fraunhofer ISI.

Figure A-3: Top 10 countries to which Austrian scientists move.



Source: Calculations of Fraunhofer ISI.

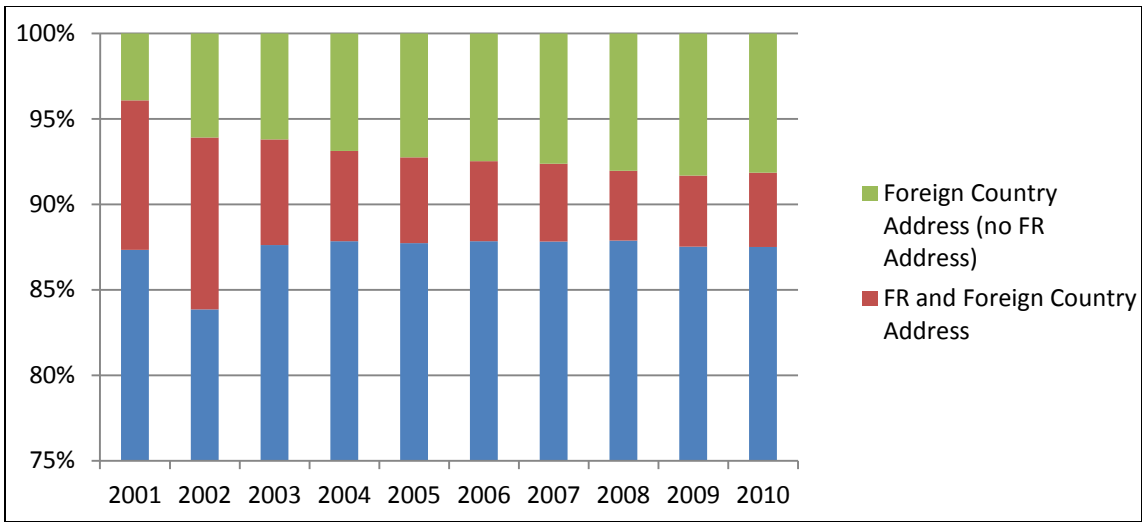
Figure A-4: Top 10 countries – Number of moving scientists normalized to the number of authors per country in Scopus



Source: Calculations of Fraunhofer ISI.

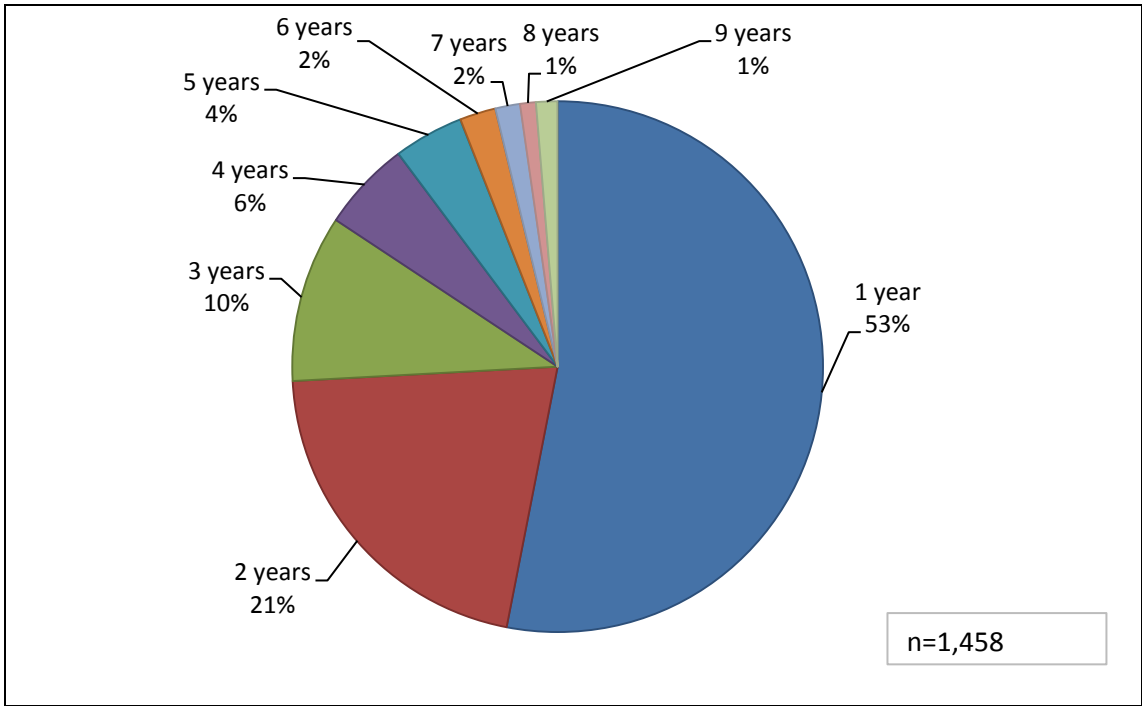
France

Figure A-5: Author addresses 2000-2010.



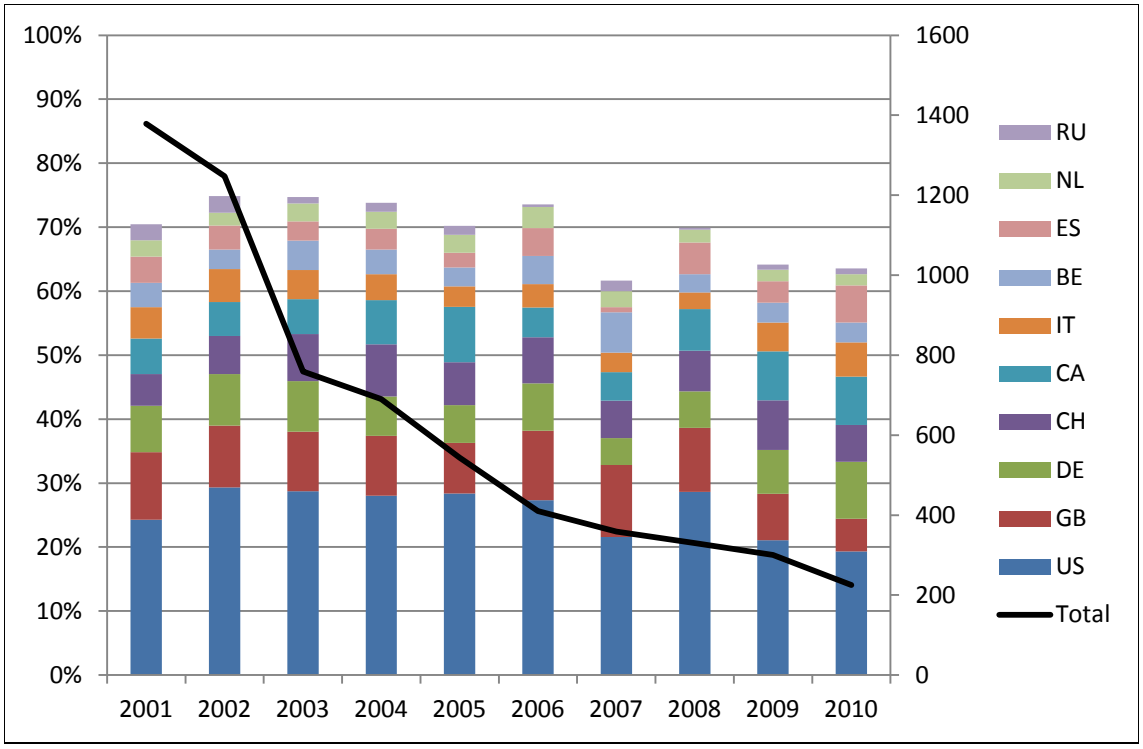
Source: Calculations of Fraunhofer ISI.

Figure A-6: Duration of period spent abroad in years (residencies of less than 10 years which were not finished in 2010 were excluded).



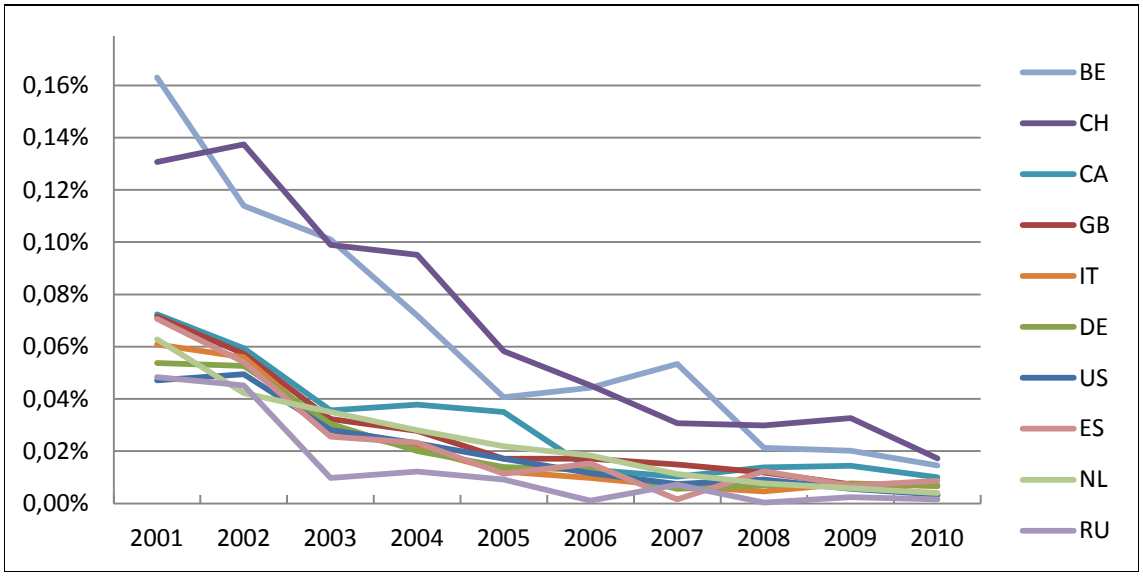
Source: Calculations of Fraunhofer ISI.

Figure A-7: Top 10 countries to which French scientists move.



Source: Calculations of Fraunhofer ISI.

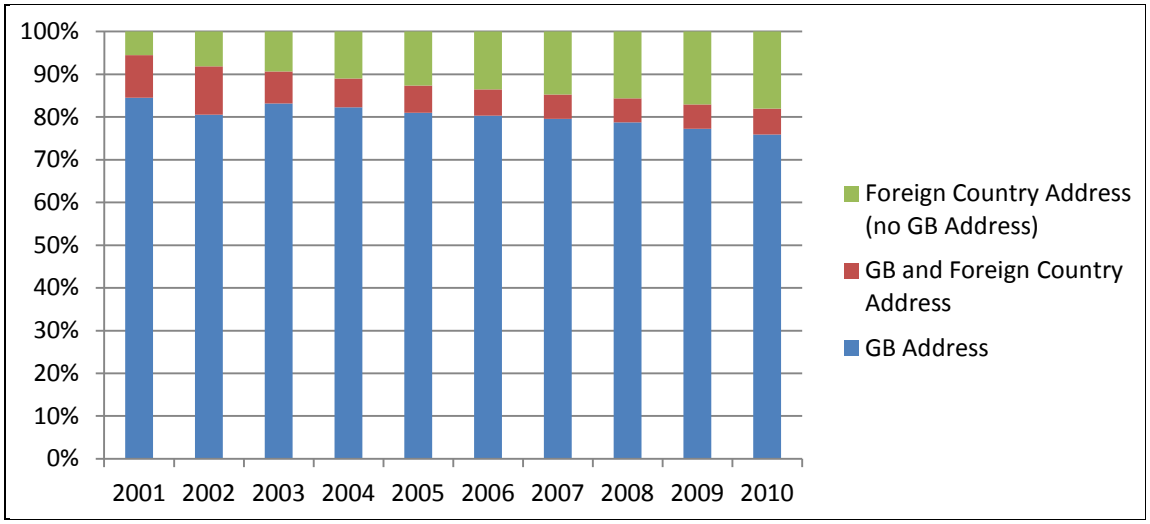
Figure A-8: Top 10 countries – Number of moving scientists normalized to the number of authors per country in Scopus



Source: Calculations of Fraunhofer ISI.

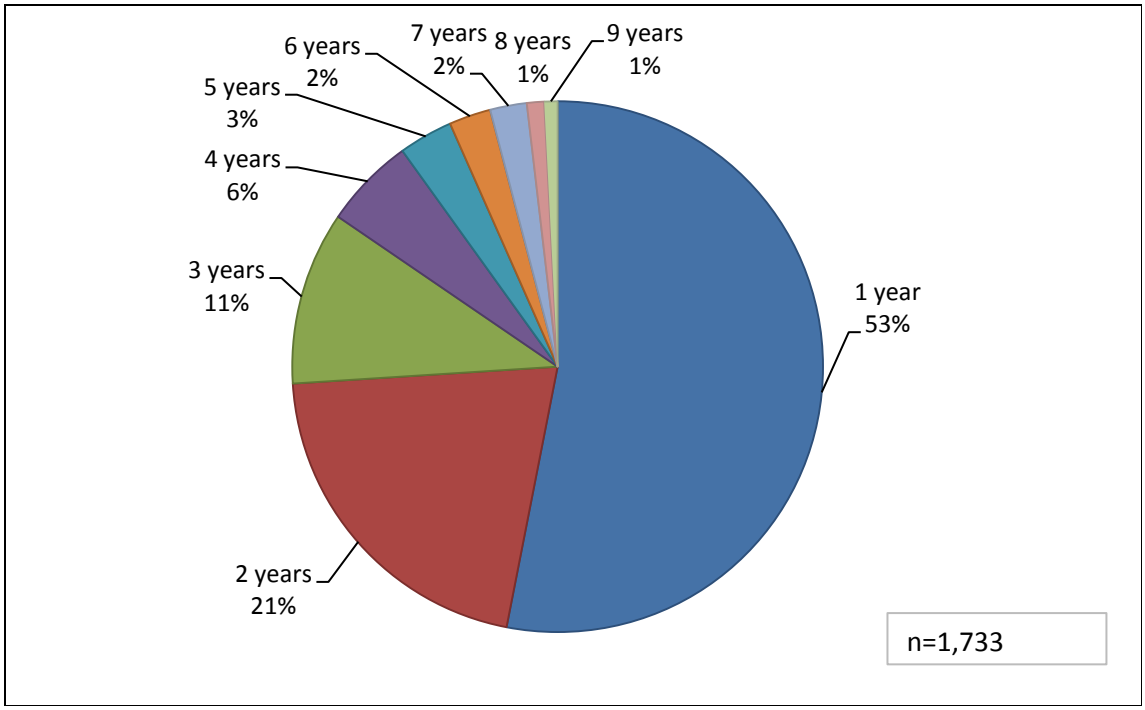
Great Britain

Figure A-9: Author addresses 2000-2010.



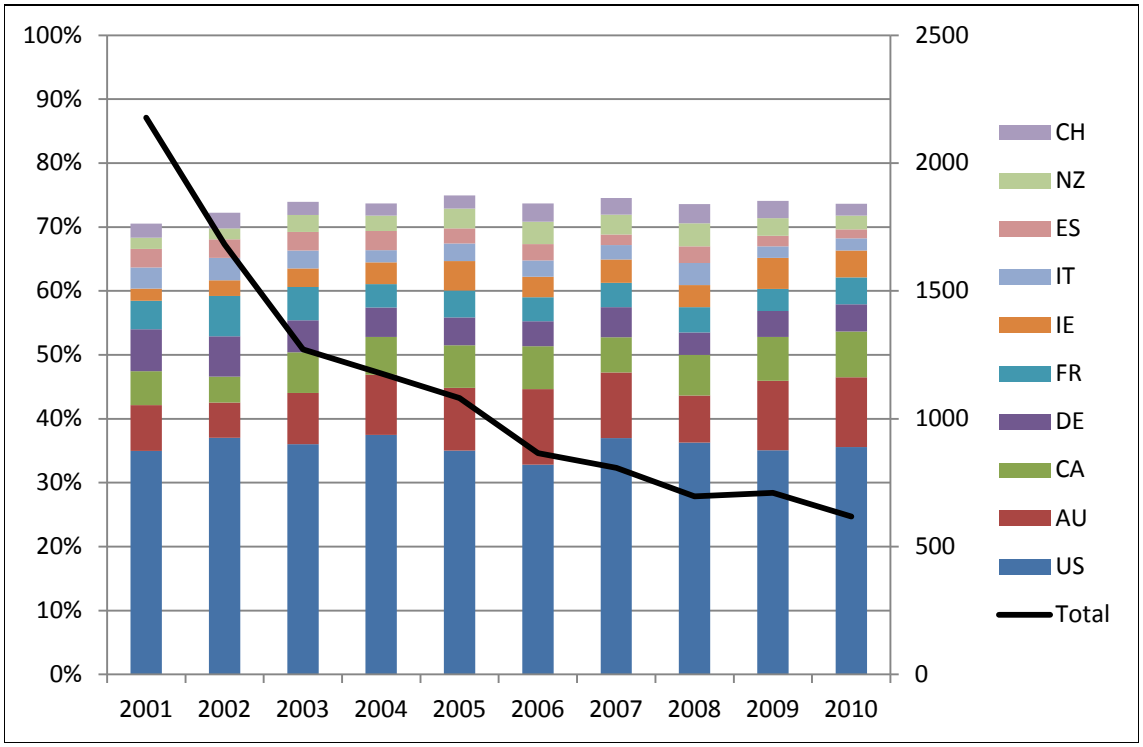
Source: Calculations of Fraunhofer ISI.

Figure A-10: Duration of period spent abroad in years (residencies of less than 10 years which were not finished in 2010 were excluded).



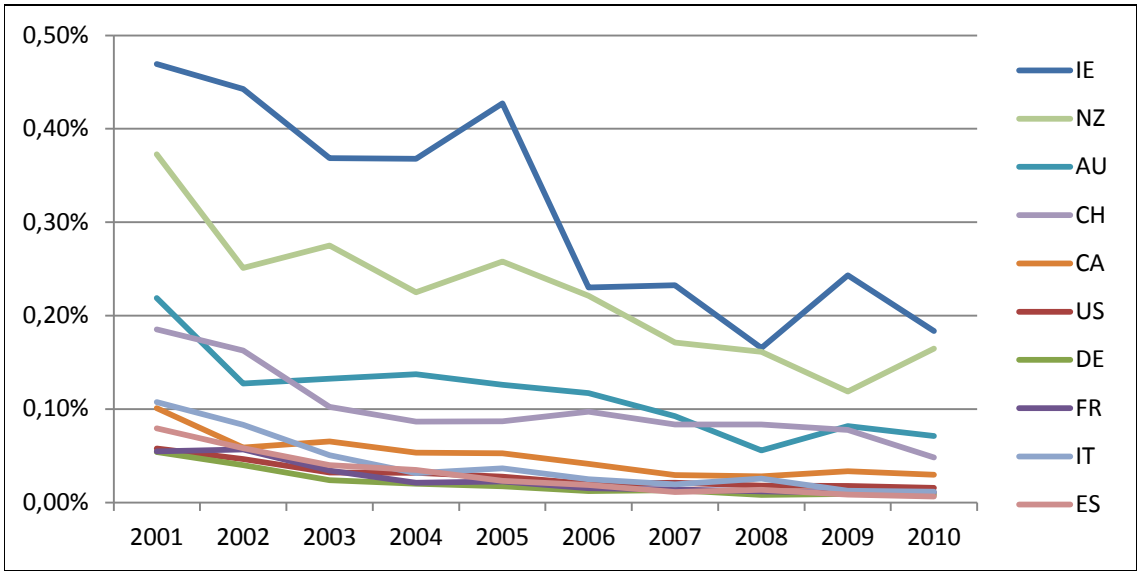
Source: Calculations of Fraunhofer ISI.

Figure A-11: Top 10 countries to which British scientists move.



Source: Calculations of Fraunhofer ISI.

Figure A-12: Top 10 countries – Number of moving scientists normalized to the number of authors per country in Scopus



Source: Calculations of Fraunhofer ISI.

Questionnaire (German Edition)

Befragung zum Thema Wissenschaftlermobilität
im Auftrag des Bundesministeriums für Bildung und Forschung (BMBF)

Sehr geehrte Damen und Herren,
vielen Dank, dass Sie sich die Zeit nehmen, um an der Umfrage zum Thema "Wissenschaftlermobilität" teilzunehmen.
Die Befragung dient der Datenvalidierung und Erforschung von wissenschaftlich motivierten Auslandsaufenthalten.
Ihre Mitwirkung soll dazu beitragen, die Rahmenbedingungen für Wissenschaftler in Deutschland offen zu legen
und die daraus gewonnenen Erkenntnisse in die Gestaltung von künftigen Maßnahmen einfließen zu lassen.
Sie können die Befragung an jeder beliebigen Stelle unterbrechen und später durch erneutes Aufrufen des Links fortsetzen.
Durch Ihre Teilnahme erklären Sie sich bereit, dass Ihre Daten zusammen mit anderen Daten ausgewertet werden.
Ihre Angaben werden streng vertraulich behandelt und anonymisiert ausgewertet.

Bei Rückfragen wenden Sie sich bitte per E-Mail an: ScientificMobility@isi.fraunhofer.de
Herzlichen Dank für Ihre Unterstützung!

Sonia Conchi und Carolin Michels
Fraunhofer Institut für
System- und Innovationsforschung ISI
Breslauer Straße 48
76139 Karlsruhe
www.isi.fraunhofer.de

Wie viele längere (mehr als 6 Monate am Stück) Auslandsaufenthalte (inkl. Berufstätigkeit im Ausland) hatten Sie im Zeitraum von 2000 bis 2010?

O 1 O 2 O 3 O 4 O 5und mehr O keine O weiß nicht/ keine Angabe

Bitte denken Sie an jeden Ihrer längeren Auslandsaufenthalte (6+ Monate) und nennen Sie uns Beginn, Dauer und Zielland. Daneben sind wir auch an der gastgebenden Organisation, dem Anlass, der Motivation zum Aufenthalt und der Finanzierung interessiert.
Für die Beantwortung der folgenden Fragen ist es erforderlich, dass Sie diese auf Ihre berufliche Laufbahn im Zeitraum von 2000 bis 2010 beziehen. Hatten Sie mehr als 5 Aufenthalte, so denken Sie bitte an die für Sie wichtigsten.

	1. Aufenthalt	2. Aufenthalt	3. Aufenthalt	4. Aufenthalt	5. Aufenthalt
Jahr der Anreise	O	O	O	O	O
Dauer in Monaten	O	O	O	O	O
Land des Aufenthalts	O	O	O	O	O
Organisationstyp im Zielland					
Universität/ Hochschule	O	O	O	O	O
Außeruniversitäre Forschungseinrichtung	O	O	O	O	O
Unternehmen	O	O	O	O	O
Politik/Administration/ Intermediäre	O	O	O	O	O
Anderer Organisationstyp, und zwar:	O	O	O	O	O
Anlass des Aufenthalts					

Austausch innerhalb eines internationalen Unternehmens	O	O	O	O	O
Promotion	O	O	O	O	O
Postdoc	O	O	O	O	O
Habilitation	O	O	O	O	O
Professur	O	O	O	O	O
Antritt einer Arbeitsstelle	O	O	O	O	O
Betriebliche Fortbildung im Rahmen eines Trainee-Programms/ Praktikums	O	O	O	O	O
Anderer Anlass, und zwar:	O	O	O	O	O
Motivation für den Auslandsaufenthalt					
Renommee einer Institution/ Unternehmen/ Person	O	O	O	O	O
Möglichkeit, ein Forschungsthema zu vertiefen	O	O	O	O	O
Bessere Karrieremöglichkeiten im Ausland	O	O	O	O	O
Kennenlernen anderer Arbeitsmethoden/ -techniken	O	O	O	O	O
Keine adäquate berufliche Perspektive in Deutschland	O	O	O	O	O
Private Gründe	O	O	O	O	O
Verbesserung der Chancen auf dem deutschen Arbeitsmarkt nach der Rückkehr	O	O	O	O	O
Bessere Ausstattung am Arbeitsplatz/Labor	O	O	O	O	O
Bessere Verdienstmöglichkeiten	O	O	O	O	O
Wechsel in ein anderes Forschungsgebiet/ Beschäftigungsfeld	O	O	O	O	O
Dem Vorbild von Kollegen folgen	O	O	O	O	O
Land/ Sprache und Kultur kennenlernen	O	O	O	O	O
Andere Motivation, und zwar:	O	O	O	O	O
Hatten Sie ein Stipendium für den Aufenthalt?					
Ja, deutsches Programm	O	O	O	O	O
Ja, EU-Programm	O	O	O	O	O
Ja, sonstiges Programm	O	O	O	O	O
Nein	O	O	O	O	O
keine Angabe	O	O	O	O	O

Haben Sie noch Kontakt mit mindestens einer der Institutionen, die Sie aufgenommen hatte?
O Ja O Nein O keine Angabe

Wenn Ja, Auf welche Weise?
O Institutionelle Zugehörigkeit
O Kooperationsprojekte (extern finanziert)
O Kooperationsprojekte (selbstfinanziert)
O Ko-Publikationen
O Kürzere Aufenthalte pro Jahr
O Aufnahme/Entsendung von Gastwissenschaftlerinnen und Gastwissenschaftler
O Sonstiges:_____

Wie sehr hat Ihnen der Auslandsaufenthalt bzw. haben Ihnen die Auslandsaufenthalte (6+ Monate) bei Ihrer Karriere geholfen?

Bitte geben Sie Ihre Meinung auf einer Skala von 1 bis 6 an, wobei 1= hat mir sehr geholfen und 6 =hat mir gar nicht geholfen.
O 1 O 2 O 3 O 4 O 5 O6 Okeine Angabe

Sind Sie der Meinung, dass Ihre im internationalen Austausch erarbeiteten Publikationen wissenschaftlich "wertvoller" sind als Ihre nationalen Publikationen aus dem Heimatland?
O Ja O Nein, gleichwertig O Nein, weniger wertvoll O Weiß nicht/ keine Angabe

Was hat Ihrer Meinung nach dazu beigetragen, dass die im internationalen Austausch erarbeiteten Publikationen wissenschaftlich "wertvoller" sind?
O Renommee der Institution/ Unternehmen/ Co-Autoren
O Möglichkeit, ein Forschungsthema zu vertiefen
O Kennenlernen anderer Arbeitsmethoden / -techniken
O Bessere Ausstattung am Arbeitsplatz/ Labor
O mehr Sichtbarkeit in der Forschungs-Community
O mehr Interdisziplinarität
O Sonstiges:_____

Was hat Ihrer Meinung nach dazu beigetragen, dass die im internationalen Austausch erarbeiteten Publikationen wissenschaftlich "weniger wertvoll" sind?
O Renommee der Institution/ Unternehmen/ Co-Autoren
O Weniger Möglichkeiten, ein Forschungsthema zu vertiefen
O Fehlende Arbeitsmethoden / -techniken
O Schlechtere Ausstattung am Arbeitsplatz/ Labor
O weniger Sichtbarkeit in der Forschungs-Community
O weniger Interdisziplinarität
O Sonstiges:_____

In welchem Land arbeiten Sie momentan überwiegend?
O Deutschland
O Frankreich
O Großbritannien
O Italien
O Kanada
O Niederlande
O Österreich
O Russland
O Schweiz
O Spanien
O USA
O Anderes Land:_____

Welche Nationalität haben Sie? *Mehrfachnennungen möglich!*
O Deutsch
O Amerikanisch (USA)
O Englisch (GB)
O Französisch
O Italienisch
O Kanadisch
O Niederländisch
O Österreichisch
O Russisch
O Schweizer
O Spanisch
O Andere und zwar:_____

Welche Sprache/n sprechen Sie? *Mehrfachnennungen möglich*!
O Deutsch

O Englisch
O Französisch
O Spanisch
O Italienisch
O Holländisch
O Russisch
O Andere und zwar:_____

Planen Sie eine Rückkehr nach Deutschland?
O Ja
O Nein
O keine Angabe

Wenn Nein, Warum nicht?
O Renommee einer Institution/ Unternehmen/ Person
O Möglichkeit, ein Forschungsthema zu vertiefen
O Bessere Karrieremöglichkeiten im Ausland
O Kennenlernen anderer Arbeitsmethoden / -techniken
O Keine adäquate berufliche Perspektive in Deutschland
O Private Gründe
O Schlechte Chancen auf dem deutschen Arbeitsmarkt
O Bessere Ausstattung am Arbeitsplatz/ Labor
O Bessere Verdienstmöglichkeiten
O Wechsel in ein anderes Forschungsgebiet/Beschäftigungsfeld
O Land/ Sprache und Kultur kennenlernen
O Sonstiges:_____

Unter welchen Bedingungen würden Sie nach Deutschland zurückkehren?
O Verbesserung der Entlohnung im öffentlichen Forschungssystem
O Verbesserung der (Forschungs)Infrastruktur in Deutschland
O Verbesserung der Rahmenbedingungen für Forschung in Deutschland (bspw. Regulation, Autonomie/Felxibilität, Arbeitszeit, Kinderbetreuung o.ä.)
O Eröffnung klarer Karriereperspektiven
O Schaffung einer (ausreichenden) Zahl an Stellen
O Andere nämlich:_____
O Unter keinen

Planen Sie in den nächsten 3 Jahren längere (mehr als 6 Monate) Auslandsaufenthalte?
O Ja
O Nein, unter keinen Umständen
O Nein, aber ich könnte es mir vorstellen, wenn es sich ergibt
O keine Angabe

In welchen Ländern planen Sie einen längeren (6+ Monate) Auslandsaufenthalt?
O USA
O Schweiz
O Spanien
O Russland
O Frankreich
O Italien
O Kanada
O Niederlande
O Österreich
O Großbritannien
O Andere:_____

Planen Sie, für immer aus Deutschland auszuwandern?
O Ja
O Nein

O keine Angabe

Wenn Ja, aus welchen Gründen?
O Renommee einer Institution/Unternehmen/Person
O Möglichkeit, ein Forschungsthema zu vertiefen
O Bessere Karrieremöglichkeiten im Ausland
O Kennenlernen anderer Arbeitsmethoden/-techniken
O Keine adäquate berufliche Perspektive in Deutschland
O Private Gründe
O Schlechte Chancen auf dem deutschen Arbeitsmarkt
O Bessere Ausstattung am Arbeitsplatz/Labor
O Bessere Verdienstmöglichkeiten
O Wechsel in ein anderes Forschungsgebiet/Beschäftigungsfeld
O Rückkehr in mein Heimatland
O Land/Sprache und Kultur kennenlernen
O Sonstiges:_____

Wie attraktiv schätzen Sie folgende Länder/ Kontinente für Ihre berufliche Weiterentwicklung ein?
Bitte vergeben Sie Schulnoten von 1 (sehr attraktiv) bis 6 (sehr unattraktiv).

Deutschland	O 1	O 2	O 3	O 4	O 5	O 6
USA	O 1	O 2	O 3	O 4	O 5	O 6
Schweiz	O 1	O 2	O 3	O 4	O 5	O 6
Spanien	O 1	O 2	O 3	O 4	O 5	O 6
Russland	O 1	O 2	O 3	O 4	O 5	O 6
Frankreich	O 1	O 2	O 3	O 4	O 5	O 6
Italien	O 1	O 2	O 3	O 4	O 5	O 6
Kanada	O 1	O 2	O 3	O 4	O 5	O 6
Niederlande	O 1	O 2	O 3	O 4	O 5	O 6
Österreich	O 1	O 2	O 3	O 4	O 5	O 6
Großbritannien	O 1	O 2	O 3	O 4	O 5	O 6
Asien	O 1	O 2	O 3	O 4	O 5	O 6
Afrika	O 1	O 2	O 3	O 4	O 5	O 6
Südamerika	O 1	O 2	O 3	O 4	O 5	O 6

Seit wie vielen Jahren sind Sie beruflich tätig?
O seit weniger als 5 Jahren
O seit 6-10 Jahren
O seit 11-15 Jahren
O seit 16-20 Jahren
O über 20 Jahren

In welchem Bereich sind sie derzeit tätig?
O in der freien Wirtschaft
O in der Forschung
O in beiden Bereichen

Wie oft haben Sie während 2000-2010 die Institution/Organisation gewechselt?
O gar nicht
O 1 Mal
O 2 Mal
O 3 Mal
O 4 Mal und öfters

Welchen akademischen Grad/ Titel haben Sie, und in welchem Jahr haben Sie ihn erlangt?
O Bachelor _____
O Master _____
O Diplom _____
O Dr. (Prüfungsdatum) _____

O Junior-Prof. _____
O Prof. _____
O Sonstiger:_____ _____
O Sonstiger:_____ _____
O Sonstiger:_____ _____

Haben Sie Ihren Namen während Ihrer beruflichen Karriere geändert?
O Ja
O Nein
O keine Angabe

Wie viele Publikationen in Zeitschriften hatten Sie in etwa im Zeitraum 2000-2010?
O keine
O 1-5 Publikationen
O 6-10 Publikationen
O 11-20 Publikationen
O über 20 Publikationen
O weiß nicht
O keine Angabe

Sind Sie derzeit bei mehr als einer Organisation/Institution gleichzeitig beschäftigt?
O Ja
O Nein
O keine Angabe

In welchem/n Forschungsbereich/en arbeiten Sie? *Mehrfachnennungen möglich!*
O Agrar- und Biowissenschaften
O Biochemie, Genetik und Molekularbiologie
O Chemie
O Chemieingenieurwesen
O Energie
O Entscheidungswissenschaften
O Erde und Planetologie
O Gesundheitsberufe
O Immunologie und Mikrobiologie
O Informatik
O Kunst- und Geisteswissenschaften
O Medizin
O Materialwissenschaften
O Maschinenbau
O Mathematik
O Neurowissenschaften
O Pflege
O Pharmakologie, Toxikologie und Pharmazie
O Physik und Astronomie
O Psychologie
O Sozialwissenschaften
O Tiermedizin
O Umweltwissenschaften
O Unternehmen, Management und Buchhaltung
O Volkswirtschaftslehre, Ökonometrie und Finanzen
O Zahnmedizin
O Anderer:_____

Alter:
O bis 40 Jahre O 41- 50 Jahre O 51 - 65 Jahre O 65+ Jahre O keine Angabe

Geschlecht:
O männlich O weiblich

Fragebogen abschicken
Sie sind am Ende der Befragung angelangt.
Bitte klicken Sie "weiter", wenn Sie den Fragebogen abschicken möchten.
Änderungen an Ihren Antworten sind danach nicht mehr möglich.
Falls Sie eine Ihrer Antworten noch ändern möchten, haben Sie mit "zurück" die Möglichkeit, zu der entsprechenden Frage zu gelangen.

Vielen Dank für die Teilnahme!