Brain drain: what we know and what we do not know

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Introduction

In many countries of the world, and probably most markedly in Europe, the mobility of ‘brains’, that is, of tertiary students and of researchers, has in recent years gained currency, and has in fact become an important part of higher education policy. The European Union (EU) expressed the importance it attached to mobility with the creation of programmes such as ERASMUS for students and the Marie Curie scheme for young researchers. Recently, it has started its global ERASMUS Mundus Programme. Important European policy agendas, such as the Bologna and Lisbon processes, also attribute considerable importance to international mobility. The same is true at the national level, where governments have established mobility-related policy objectives and are running bi-lateral schemes for international mobility. For the initiators of these policies and programmes, mobility is a good thing, worthy of every possible support.

At the same time, and parallel to this view of things, there is — and has been for a long time — a darker perception of international mobility, or, to be precise, of some of its (supposed) effects, which are fears linked to the idea of the ‘brain drain’. Although the term has never been very precisely defined, it is generally understood to refer to a sustained and substantial net outflow of persons from one country to another. If it happens on a large scale, ‘brain drain’ can threaten the very foundations of a country’s higher education and science systems, which is (said to be) the case in a number of developing countries. The term ‘brain drain’ has also been applied to migration movements between developed countries. One expression of this is the deep conviction of many, if not most observers that Europe is continuously losing researchers and other highly skilled professionals to the USA. This supposed or real exodus has always raised fears. Such concerns have recently been additionally fuelled by the concept of the ‘knowledge society’. According to this theorem, the wealth and material well-being of a nation depends, today much more than in earlier times, on its capacity to produce new knowledge and innovation. To lose one’s key knowledge producers, the researchers, is therefore deemed as much more damaging in times of knowledge-based economies than, say, in past agrarian societies.

At first glance, the parallel existence of the high regard for internationalization and international mobility, and the fear that it may generate a ‘brain drain’, appears contradictory, but this is not necessarily the case.
First, the mobility programmes of the EU, and of individual countries, are intended to foster temporary mobility. Students and researchers are expected to return ‘home’ after a period of study or research abroad (the precise extent to which they do is another issue, about which we often lack information). ‘Brain drain’, on the other hand, is associated with permanent or at the very least, long-term migration.

Secondly, the mobility schemes in question are, in the majority, intra-European or cater for mobility between countries with a similar extent of development\(^2\). ‘Brain drain’, however, is mostly expected to take place between countries with a very different level of development. In those cases where scholarship programmes organize mobility from developing to developed countries, there is often an obligation on the scholarship holder to return on completion of the period abroad.

Beyond the question of whether or not the international mobility of highly skilled professionals and of researchers is a good thing or an instrument that fosters ‘brain drain’ there is another issue, less rarely addressed but at least as important, that is, is there ‘brain drain’ at all, and, if so, which countries are the winners and which are the losers? Or, to put it in less dramatic words; what do we know about ‘brain drain’ and what do we not know? This is the theme of this article. It does, however, limit the investigation of the ‘brain drain’ phenomenon (or myth) in a number of ways in that it focuses:

1. on researchers, in particular, on post docs and other young researchers in their ‘formative years’, predominantly in the natural and life sciences;
2. on the migration of this sub-group of researchers to the USA, which, according to conventional wisdom, is the chief magnet for and the ‘Promised Land’ of all mobile researchers;
3. on the migration, to the USA, of young scientists from a developed region of the world, Europe, or, to be more precise, from two countries: the UK and Germany;
4. on international ‘brain drain’, as should have become obvious from the above, thus excluding migration movements inside one and the same country or ‘sectoral’ migration (for example, from the research system into other employment sectors).

The next section introduces briefly the concept of ‘brain drain’ and the history of the term. Subsequent sections deal with some key problems with regard to the available data on the migration of researchers (that stand in the way of easy answers to the ‘brain drain’ question), statistical information on foreign ‘formative-years researchers’ in the USA, and the mobility of young researchers to the USA from the UK and Germany (trying to answer the question whether or not there is a ‘brain drain’ of young researchers from these two countries to the USA).

\(^2\)The recently launched ERASMUS Mundus Programme is an exception to this rule. It is open to all countries of the world and it does aim at a brain gain for Europe, even if not explicitly stating this.
Human capital, ‘brain gain’ and ‘brain drain’

For most people, ‘capital’ means cash, a bank account, company shares or real estate. Indeed, all of these are forms of capital, they are assets that yield income over time; however, there are more forms of capital than these tangible ones. Knowledge and skills can be considered as forms of capital. Like other assets, they are commonly viewed to yield dividends over time. Education and training (as well as expenditure on health) are seen as key investments with regard to human capital formation. They create private returns, i.e. they will at a later stage result in better employment, which translates into higher incomes for the individuals concerned. In addition, they are also seen as crucial components for the performance levels of national economies: a higher education-level of the workforce will, according to this view, produce higher economic growth and employment. Since growth in today’s societies and economies is thought to be at a much higher level than in earlier ones driven by innovation and thus knowledge (‘knowledge economies’), such investment is seen as more important today than ever before.

Since the knowledge and skills of people constitute capital, when they emigrate from the country where they were educated and trained, that capital also leaves, that is, it is lost by the country of origin and gained by the destination country. From the point of view of the country of origin, its earlier investment into the education and training of the emigrant has been useless spending. What was intended to be an investment turned out to be simple ‘consumption’. This loss is obviously greatest where the investment has been substantial, which is generally considered to the case be for the ‘highly skilled’ and particularly with researchers. The destination country receives the human capital as a gift. It has made a ‘brain gain’, whereas the country of origin has suffered a ‘brain drain’. It should be noted that one usually speaks of ‘brain gain’ and ‘brain drain’ only if there is a sizeable number of migrants, and if the balance of immigrants and emigrants is heavily disproportionate over a longer period of time. Situations that are characterized by the movement of people in sizeable numbers but in a relative equilibrium, are often referred to as ‘brain exchange’ or ‘brain circulation’.

Although linked to (neoclassical) economic theory, the meaning denoted by the ‘brain drain’ metaphor has never been very precise and has got mixed up with political and ethical considerations. The term was apparently first used in

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3 The following is a dramatically simplified account of the human capital theory, largely taken from one of the author’s earlier publications [1]. For a more profound version, cf. the works of the ‘Chicago School’, especially Human Capital (1964) by the Nobel laureate Gary S. Becker. The theory of human capital is considerably older than Becker’s work in this field. His foremost achievement is to have formulated and formalized the micro-economic foundations of the theory. In doing so, he developed the human-capital approach into a general theory for determining the distribution of labour income.

4 The EU’s Lisbon Strategy, and particularly its education agenda, Education & Training 2010, is a perfect emanation of this view of things.

5 Sometimes, an attempt is made to quantify what is here called “sizeable numbers”. Based on empirical observations, Böhning concludes that, in- and out-flows of 2% or more of the highly qualified population of a country can be regarded as brain drain (or gain), since this is the threshold for impact [2].
the discussion about the emigration of British scientists to the USA in the early 1960s, which was sparked off by documentation from the British Royal Society. In the late 1970s and early 1980s, it became better and more widely known in a development-policy context. This debate was about whether or not it was defendable on moral and other grounds to accept that the rich industrialized countries benefited from investments in human resources that poor Third-World nations had made, thus drastically harming the latter’s chances of economic and social development. An important question in the discussion was if it was justified to talk of ‘brain drain’ at all, or if it was more adequate to talk of ‘brain overflow’ [3]. While one school of thought, grounded in the economics of education, advocated regulatory strategies to limit and channel migration between the developing and the industrialized countries, another, rooted in neoclassical theory, warned against any interventionist measures. It is apparent that this debate, about the loss and gain caused by the migration of the highly skilled, continues to this very day. A third wave of the ‘brain drain’ debate has set in, concerning the feared exodus of scientists and researchers from the countries of Central and Eastern Europe and the former Soviet Union to the West. More recently, the ‘brain drain’ debate has (also) returned to its origins in dealing with the issue of an (alleged) emigration of a sizeable number of young, highly qualified European scientists, especially in the natural sciences, engineering and technology, to the USA. In parallel, measures to (re-)attract high scientific potential into individual European countries were put in place. This organized attempt at a ‘reverse ‘brain drain’’ led to a version of the term ‘brain gain’ that has positive connotations. While the ‘brain drain’ metaphor stresses the loss of the weak, the ‘brain gain’ image, which concerns the very same phenomenon, highlights the gain of the strong. The emergence of the ‘brain gain’ metaphor also indicates a change in the paradigm. While in earlier days a bad conscience prevailed, more recently the pride about being more attractive than others has won the upper hand.

The ‘brain drain’ concept in its basic form appears to be straightforward, but its application in the real world is not.

1. The first problem is that of multiple mobility. As long as a person makes a single, one-directional cross-border move, it is easy to compute the human capital loss of the country of origin and the human capital gain of the country of immigration. For example, if a PhD holder migrates from Spain to the USA, and remains there working as a scientist for the rest of his or her life, the USA is the human capital gainer. But if this same researcher later moves back to Spain or to a third country, the record is more difficult to establish. In addition, there are practically no systems to track the migration paths of migrants (see next section), therefore even if the human capital balance could be established in principle, in practical cases this is rarely possible.

2. Secondly, migration in general, and migration of the highly skilled in particular does not, in each and every case, lead to ‘brain gain’ on the part of the destination country. ‘Brain gain’ can be considered the result if, for example, a migrant nuclear physicist finds employment as a nuclear physicist (or a neighbouring profession adequately using his knowledge and skills) in the destination country, but it is not the case if he or she finds work below their education level, e.g. as a taxi driver or a bar tender. In the situation where a mismatch between the skills offered by the individual and those demanded...
by the labour market occurs (supply and demand mismatch), experts speak of a ‘brain waste’, where there are only losers (the physicist and the country of origin) and no winners. The migration literature indicates that such cases are not at all rare.

3. Thirdly, even in those cases where migrants remain in their host country and there is thus no return migration, it has not remained uncontested that the flow of benefits is in a one-way direction only. By keeping ties with their country of origin, migrants can act as ‘bridges’ that contribute to a transfer of technology and knowledge back to their country of origin. On these grounds it has, for example, been argued that Indian expatriate engineers working in Silicon Valley have played a central role in starting India’s emerging software industry. While India’s software production is still a low-service industry employing cheap labour, the price and salary gap to the USA has decreased considerably over a 10-year span, and is likely to narrow further still [4]. In the same vein, it has been argued that the simple inflow–outflow balance of human capital does not correctly identify the full economic picture, because it does not include the effects of ‘remittance payments’ (capital transferred by emigrants to their country of origin).

**Statistical data on researcher mobility**

Every article that relies on statistical data of a minimum level of sophistication to make its point is bound to complain that the available statistics leave much to be desired. The present one is no exception to this rule.

**Official migration statistics**

Official migration statistics have a number of shortcomings. The following is a list of the more important ones. It is very far from being exhaustive.

First, migration statistics are rarely differentiated enough. The demarcation lines between the different groups of migrants are fuzzy. In a previously-quoted study [1] devoted to the migration of the highly skilled, the author of this article found that even this very large group of migrants was often not separately statistically measured. It is, with the exception of a few countries where there are, for example, separate visa categories for researchers (among them the USA), even more difficult to obtain data on the particular group of migrant scientists, let alone sub-categories of the latter.

Secondly, where there are statistics on migrating researchers available, different definitions and categorizations and different levels of coverage create problems of international comparability. Coverage problems concern, for example, the question of whether statistical analysis only includes researchers in higher education institutions or if it also includes those in extra-university research institutes and in private companies. Definition problems concern demarcation lines to neighbouring professions. A further problem in this respect is the classification of the entirety of researchers into sub-groups. Thus, the term ‘post doc’, which originated from the research system in the USA, is now used almost everywhere...
around the world, but the exact conditions under which ‘post docs’ operate in the USA is most markedly different from those in other countries.

Thirdly, and still in terms of the international comparability of migration data (for all types of migrants, inclusive of researchers), there is no commonly shared definition of ‘migration’. Jahr et al. [5] identified four different criteria underlying statistics on international migration; these are, nationality, country of birth (or country of origin), country of prior residence and country of prior education (for example, for researchers, this can include the country where their PhD was obtained). It is obvious that the application of different criteria leads to different numbers of migrants. The nationality criterion, for example, is not able to capture return immigrants, whereas the principle of country of prior residence is; however, even if the criteria are taken alone they do not all lend themselves to straightforward comparison. The application of the nationality principle, for example, contains distortions in international comparisons because the conditions for naturalization (and thus status change) are more restrictive in some countries than in others.

Fourthly, migration statistics in general and, if available, on researchers, either measure the ‘stock’ of migrants in a particular country or the ‘flows’ of migrants, i.e. those who entered or left the country in a particular year. Stock data are derived from population registers, residence permits, censuses and surveys and, in the case of labour migrants (the category to which researchers very predominantly belong), work permits and labour force surveys. The precision with which these instruments can measure immigration and emigration is to a greater extent dependent on the researchers’ co-operation. Emigration registers are notoriously unreliable, since many people see no point in ‘deregistering’. The willingness to register on arrival also varies: in some countries access to certain benefits is conditional on registration, in others not.

Fifthly, and probably most importantly, official migration statistics do not provide, as a rule, the means to trace the movements of individuals over time. They therefore give no evidence on whether or not immigrants stay for a short period of time (and would not commonly be regarded as part of a ‘brain drain’), an extended period or even for good. Moreover, they do not reveal the destination of immigrants who subsequently leave the immigration country, i.e. whether they return to their country of origin or move to a third country. In other words, they cannot answer the much-debated question of whether the predominant mode of migration is one of a balanced ‘brain circulation’, or of a lop-sided ‘brain drain’.

Individual studies and surveys
The fact that official statistics are of limited use to answer the question of whether or not, and where, there is, ‘brain drain’, does not mean that there is no relevant information. In fact, the literature on migration in general, and on researcher migration in particular, is considerable. It consists of a bulk of individual studies and surveys.

However, these various sources do not permit the drawing of a comprehensive and internationally comparable picture of researcher mobility either. The reason is that the foci of these studies are not the same. They differ in, for example, the country or regions on which they focus; the types of researchers they address (postgraduate/doctoral students, post docs, senior researchers, etc.) and the
modes by which they entered the immigration country (scholarship programmes, free mobility, inter-institutional exchanges, etc), and the particular issues they investigate (for example, the motivations for migration and the reasons to stay), to name only a few categories.

It is impossible to establish a complete and reliable empirical picture of researcher mobility flows based on these studies. They are like a jigsaw puzzle with too many pieces missing. However, it is possible to make some very general observations.

1. The literature shows a considerable concentration on the study of researcher migration (and possible ‘brain drain’) to the USA, and thus responds to the popular fear that institutions in the USA are emptying Europe’s (and other continents’/countries’) universities.

2. The literature does give strong indications that the research system in the USA is indeed a magnet of attraction for (young) researchers from outside of the USA (see next section).

3. The literature suggests that international mobility is — empirically speaking — a phenomenon that mainly affects young researchers in their ‘formative years’. It is interesting that researchers do not differ in this respect from other groups of migrants, who are much more mobile up to the age of 40 than after.

4. There appears to be a higher likelihood among researcher migrants, rather than other internationally mobile groups, that they will not stay for good and will return to their country of origin. It appears that a stay in a competitive research system abroad (mostly in the USA) is by now an almost necessary precondition for a researcher career in many national systems (the ‘must-have-been-to-the-USA’ requirement). After the ‘formative years’, many researchers re-migrate into senior positions. This, however, happens only if the research system ‘back home’ is not much less attractive in terms of research funds, infrastructure, pay and conditions when compared to the country to which the young researcher initially migrated.

The Promised Land: foreign post docs in the USA

As stated above, the conventional wisdom is that the Promised Land for researchers, and especially for young ones, is the USA. To what extent does the literature on the migration of young researchers substantiate this picture?

In the USA, in 2003 and 2004, the Scientific Research Society, Sigma Xi, conducted a survey [6] of post docs in universities and extra-university research institutes and laboratories which yielded illuminating facts concerning the attractiveness of the USA to young researchers. The survey addressed a representative sample of 22 000 (40%) of the approximately 55 000 postdoctoral fellows in the USA at the time. Of those, 7600 (34%) participated in the survey, giving it a solid empirical base. The following are some key results.

1. Only two out of five post docs in the USA are citizens of the USA, therefore 60% have a non-US nationality [which can be broken down further into two sub-categories, temporary visa holders (54%) and permanent residents (6%)]. This single finding not only sheds light on the ability of the USA to attract
young researchers from abroad, it is also telling in respect of the dependence of the research system in the USA on foreign talent.

2. The dominance of non-Americans is even stronger in the subject areas of physical sciences and engineering, where 68% of all post docs are foreigners. The figure is, however, much lower in the social sciences, with only 26% of post doc positions being filled by non-US citizens.

3. The largest nationality group after the Americans is the Chinese (14% of all foreigners), followed by Indians (6%), Germans (4%) and Japanese, French and South Koreans (3% each).

4. Almost two-thirds of foreign post docs are male, compared with a slightly greater proportion of female post docs that are citizens of the USA (or have permanent residence).

5. The vast majority of foreign post docs — over 75% — earned their PhDs at universities outside of the USA, predominantly in their country of nationality. This seems to repudiate the frequently-voiced belief that the USA benefits from the large number of foreign students at higher education institutions within the USA when recruiting post docs. It suggests that most foreign post docs take up their position in the USA after obtaining their PhD elsewhere.

The attractiveness of the post doc system in the USA is a surprise in the light of a number of sobering facts.

1. Most post docs aspire to a tenure track position at a research university in the USA at a later stage of their career; however, according to earlier research by the NSF (National Science Foundation), most of them never achieve this goal, and very many do not even stay in academia.

2. In the USA, the median salary for post docs is, at $38 000, very modest. Foreign post docs even earn less (approximately $36 000 per year). This is considerably less than the average for PhD holders in the USA ($71 000), and still less than the average of Masters ($56 000) and even Bachelor graduates ($45 000). This, coupled with the fact that they work more hours per week (51) than the population average, and thus earn an hourly wage of under $15, and that almost half of them live in the 15 most expensive cities in the USA, makes the average postdoctoral scholar appear as a slightly masochistic creature.

The above data tempt conjecture regarding the dominance of foreign nationals among post docs, suggesting that it is not only a result of the attractiveness of the system for foreign nationals, but also, and perhaps more so, of its relative unattractiveness for citizens of the USA. The history of the postdoctoral system might underpin this suspicion. Although there were post doc positions as early as the 1950s, these numbers expanded rapidly in the 1980s and 1990s, when the number of PhD graduates increased at a greater rate than the number of available faculty positions. The creation (or at least the expansion) of the post doc system was seen in many ways as an emergency measure.
Mobility into and out of the UK

The UK appears to be one of the countries with better-than-average data on the mobility of researchers. The data and findings presented in this section draw heavily on recent research by Bahram Bekhradnia and Thomas Sastry of the Higher Education Policy Institute (HEPI)\(^6\) [7]. Their study attempted to identify the volumes and patterns of academic mobility between the UK and other countries, and to identify the driving forces behind the movements, in order to assess their impact on higher education and research in the UK. It drew on four data sources:

1. higher education staff movement data (1994/95–2002/03) of the UK Higher Education Statistics Agency (HESA);
2. the publication records of highly cited staff, which were used to identify the spatial movements of this group over time;
3. the publication records of a wider group of academic staff (for the years 1994, 1999 and 2004), which were to shed light on the general mobility of staff, and;
4. The *Who's Who*, which was used to trace the international careers and movements of outstanding researchers, i.e. the members of various UK academies.

Based on HESA data, which covers all staff in UK higher education institutions, the UK was, in the reference period of 1994/95–2002/03, a net importer of academic staff. For every academic who left the UK, 1.4 arrived\(^7\). Migration was concentrated on junior staff in their ‘formative years’, which made up roughly two-thirds of all inwardly and outwardly mobile staff. The number of migrating academics in more senior positions (the UK categories of lecturers, senior lecturers and professors) was low. The analysis of the movements of staff with publications and citations — and in particular of the highly cited category — confirms and differentiates the HESA data. In the case of publishing academics, the UK loses researchers in the early stages of their careers, but for later-stage academics, it attracts more than it loses, that is, those who have built up a reputation as serious researchers are attracted to the UK. The data suggest that almost all highly-cited researchers, inclusive of the most eminent academicians, who at some stage in their careers left the UK, later returned.

Interestingly, mobility over life is highest among the ‘best brains’ (measured by publications/citations and membership in academies). Of all academics in the UK, only 16% had been abroad at some stage of the surveyed periods, which, according to the authors, is ‘modest’ and less than in other European countries; however, 45% of highly cited academics had moved abroad and this value was even higher (58–85%) in the case of members of various academies. One conclusion of the study is, therefore, that it is the high achievers who leave the country in early (postdoctoral) stages of their development, and later return to the UK academic system. In line with this, the authors of the HEPI report suggest that postdoctoral outbound mobility should be regarded, not as a form of ‘brain drain’

\(^6\)This publication is the summary report of two studies on the issue of migration of academic staff and researchers into and out of the UK, by William Solesbury Associates (WSA) and Evidence Limited, as well as an analysis of data from the UK Higher Education Statistics Agency (HESA).

\(^7\)The HESA data include all staff movements into and out of the UK — irrespective of whether the migrating staff are British or foreign nationals.
and as a loss of human capital, but as a necessary and desirable career-development step for the highly talented, who later return into the system and thus strengthen UK research. At the risk of stating the obvious, it should be stressed that this UK experience cannot necessarily be generalized for other countries. The study also revealed that mobility into the UK — and especially return mobility of the ‘best brains’ — is motivated by the perceived strength of the UK university and science system, and its open and meritocratic culture. Needless to say, not every research system in Europe (and elsewhere in the world) shares these traits.

A first look at the distribution of migration, covering different destinations and source countries, suggests that the USA does not play as important a role as it is usually granted in the public debate. When looking at all staff movements (HESA data), the distribution is as follows. Among immigrants, 44% originate from countries within the EU (EU-15, referring to the fifteen countries that formed the EU until the end of April 2004), 19% from the USA and 37% from elsewhere in the world. Therefore, Europe plays a very important role in the number of people migrating to the UK. Among emigrants, the EU-15 is also the chief region of outbound mobility (41%), 23% leave for the USA and 36% for other parts of the world. However, the importance of the USA increases very palpably when focussing on the subgroups of publishing academics and particularly of academicians. Among these, the USA is the most important destination, ahead of the EU and the rest of the world. Amongst those academicians who had been mobile one or more times in their careers, the USA position is even more overwhelming: for example, 85% of all members of the Royal Society had been to the USA at least (often additionally to other destinations)\(^8\).

Interestingly, there are indications that mobility into the UK displays some parallels with mobility into the USA. Immigration is concentrated on research-intensive UK universities, with the four quantitatively leading UK institutions employing 31% of all immigrants, and 50% found within the top 12. Immigration (and also emigration) shows a concentration in the physical, biological and mathematical sciences. There is one more similarity, although the authors cautiously treat it as a hypothesis only, that some of the UK data could be interpreted as evidence that the position of the UK in Europe, as an immigration country, is beginning to parallel that of the USA on a global scale, that is, it is a strong magnet for young scientists, who build their reputation in the UK, and later return ‘home’ or move elsewhere\(^9\).

Overall, the study does not find that UK higher education and research is suffering from a ‘brain drain’, that is, there are no dramatic discrepancies between the number of people flowing into, and out of, the country. Mobility is highest amongst the most talented of the young researchers in their ‘formative years’, flowing mainly to the USA, but these people’s mobility is predominantly

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\(^8\)Whether or not the mobility patterns of academicians can be used to demonstrate the level of present-day attractions in the research system of the USA, is, however, debatable. Academicians are usually advanced in years, and their formative-year experiences in the USA therefore took place at least a decade ago.

\(^9\)There are data on intra-European researcher mobility that can support this hypothesis. A recent analysis of the flow data of doctoral students in the EU Marie Curie Fellowship Programme, in the period 1999–2002, reveals that it is by far the top destination of Marie Curie Fellows [8].

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a career-enhancing measure, and they return to the UK at later stages, thus strengthening the UK system rather than weakening it.

**Mobility of Germans into the USA**

Two recent studies explored aspects of the international mobility of German researchers (and partly the mobility of foreign researchers into Germany) [9,10]. This section reports on the results of these two studies.

*Brain Drain — Brain Gain. Eine Untersuchung über Internationale Berufskarrieren* [9] is an investigation into the factors that play a role in the decision of German academics to migrate to another country, and into the relative attractiveness of the German university and research system for foreign researchers and other highly skilled persons. It is, first of all, an investigation into people’s motivations and perceptions, and less an investigation of international movements. The study was based on a survey of 1690 ‘academically-qualified’ Germans abroad [the majority of whom (61%) were employed as researchers or worked in academia], and of 2197 foreign academics and researchers in German universities and extra-university research centres. All of the Germans abroad had, at an earlier stage, been abroad as fellows of various German scholarship organizations. While the study does not focus exclusively on post docs, the majority of the sample were, at the time of the survey, in their ‘formative years’, with 56% of Germans under 35 years of age and 85% under 40; the foreign researchers in Germany were even younger. The majority of Germans abroad were concentrated in three countries, the USA (30.2%), the UK (17.2%) and Switzerland (13.3%), with European (mostly EU-15) countries making up the rest of the numbers. In contrast, the distribution of source countries among foreign researchers in Germany was much wider, with the Russian Federation, countries in Central and Eastern Europe, and China providing the largest numbers of immigrants.

According to the findings of this study, the motivations for the decision to become internationally mobile are complex but they do not appear to differ markedly between the Germans who went abroad and the foreigners who moved to Germany. This could indicate that the criteria that researchers apply when taking location decisions seem to be fairly similar globally, that is, the same push and pull factors appear to be at play.

The single most important criterion for Germans abroad, as for foreigners in Germany, is the scientific reputation of the university or institute in the destination country. For 80% of Germans abroad, and for 70% of foreigners in Germany, this was the most frequently cited reason for relocation. It is, however, telling, that it plays an even stronger role for those moving to the USA (87%) and the UK (85%), and that US and UK scientists in Germany rate it as relatively less important than other immigrant groups, at 58% and 51% respectively. This indicates that the attractiveness of the USA and the UK, as viewed through the eyes of migrating researchers, is outstanding.

The second most important criterion, again for both groups, is the possibility to be able to follow a specific research pursuit in one’s area of specialization. This reason was given by 74% of all Germans abroad (with this reason cited more highly by Germans in the USA). Foreign scientists in Germany accord this
criterion almost identical importance (73%), although it was, again, less important for US (60%) and UK (55%) nationals. For Germans abroad, ‘push factors’ in the form of perceived deficiencies of the German research system follow, such as, the lack of adequate career prospects at home and the presence of these abroad. While the average number of researchers giving this reason across all destinations is 56%, it is again highest for German emigrants in the USA (68%) and the UK (67%). Better career prospects play a much smaller role for foreign researchers in Germany (44%), with US nationals (19%) and UK citizens (25%) mentioning these reasons very rarely. It is also noteworthy that 71% of US citizens very often mention ‘private reasons’ for their stay in Germany, with 47% of UK citizens giving the same reason, whereas on average these reasons play no large role for most other nationalities. If the results are to be believed, better salaries are very rarely a reason for migration, irrespective of source and destination country.

The study also enquired into the perceived quality of science in the host country, in comparison with the home country. On average, foreign scientists in Germany do not rate this quality as lower than Germans abroad. This would be good news for the country’s often-criticized science system, were there not two important caveats.

First, the reputation of German research rests largely on the high appreciation of the extra-university research institutes, whereas German universities are less favourably assessed. In addition to this, the already known pattern evolves: the USA and the UK are much more favourably viewed by Germans compared with other foreign destinations, and are therefore more highly regarded by Germans than the German research system is by the average of all foreigners.

A second finding, which the authors of the study did not highlight, that was quite obvious from the research results, was that the researchers who gave relatively good marks for Germany were from source countries with comparatively weaker research systems (predominantly in Central and Eastern Europe). If one worked on the assumption that the satisfaction of an immigrating researcher with the quality of a research system was dependent on how this quality compared with that of the country they left, and if one further takes into consideration that Germans moved mainly to high-quality systems (USA, UK and Switzerland), whereas foreigners who moved into Germany mainly came from lower-performing systems, the fact that both groups are almost equally satisfied with the research quality in the immigration country does not necessarily mean that this quality is the same. The points of reference are different for the two groups. It is therefore possibly inaccurate to conclude that, since the average rating for the attractiveness of German research does not differ markedly from the attractiveness accorded to foreign research systems by German scientists, there should be no grounds for ‘brain drain’ out of Germany. The comparison of attractiveness assessment would suggest that Germany has the potential to gain ‘brains’ from less developed systems, but that it risks to lose ‘brains’ to higher performing ones.

The above seems to be underpinned by the evaluation of a number of important framework conditions for research in Germany. Foreign respondents in Germany stated the number of adequate researcher positions was too low, with rigid (bureaucratic) access conditions, inflexible career paths and underdeveloped co-operation across disciplinary boundaries. Most of all, they noted a lack of available research funding.
These judgements are consistent with the findings of the publication *Deutsche Nachwuchswissenschaftler in den USA* [11]. In part 4 of this report, Christoph Buechtemann detailed the comparative assessment of the strengths and weaknesses of the research systems in Germany and the USA, based on interviews with present and former German post docs in the natural and life sciences, who have worked in the USA. Some legal and technical aspects apart (visa regulations, recognition of qualifications), the interviewees saw the following advantages in the USA and disadvantages in Germany.

1. The research system in the USA was seen as decidedly better funded and resourced than the German one.
2. The overall availability of positions for researchers was perceived to be much better in the USA than in Germany.
3. The German ‘post-post doc’ career structure was seen as inferior to that in the USA. The USA was seen as offering flexible step-by-step career pathways for researchers — from assistant, to associate- and full-professorships — with a considerable degree of independence (own research projects and own researcher teams). In comparison, the German system offered no independence (in substantive and budgetary terms) except for full professors (the ‘C-4’ category at the time), and set requirements in the form of the ‘Habilitation’ (a form of advanced doctorate), viewed as ludicrous by many, which wasted the researchers’ best years.
4. German research was seen as less international (for example, in terms of the composition of researcher teams), and as taking place inside closed ‘in-bred clubs’.
5. German research was much more compartmentalised, with less cutting edge ‘new’ research in interdisciplinary fields (biophysics, bioengineering, neurosciences, epidemiology, etc.), for which the post docs had moved to the USA in the first place.
6. German universities were seen as bureaucratic, not providing necessary means, either quickly or sufficiently, which hindered research progress in many ways.

The same study also tried to assess the extent of the exodus of young German talent to the USA, and thus address the ‘brain drain’ issue. It concluded that, in quantitative terms, the migration of young Germans to the USA was not overly worrying. In the natural sciences and engineering, 9–10% of all new PhD graduates per year from German universities move to the USA to undertake a post doc. This can be compared with the share of German ‘foreign scholars’ in the USA (taken from the total number of young researchers educated to PhD level in the German research system), where the figure is slightly higher at 14%. The study, which does not provide data on young American scientists in the German research system, concludes that these shares are modest and not likely to harm Germany’s research capacity if a sizeable number of the post docs return. No reliable data exist on the return migration of the latter. The study estimates a medium-term non-return rate of between one-quarter and one-third.

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10This again raises the question, which quantities are needed to legitimately speak of ‘brain drain’? As stated earlier, Böhning (speaking of the highly qualified in general) set the threshold as low as 2%.
The study, however, identifies a qualitative problem. It claims that German post docs in the USA are amongst the best ‘brains’ in Germany, and that the loss of each one of them therefore deals a blow to German research capacity. The study bases this assessment on the findings of earlier research, which indicated that (all) foreign-born scientists contributed disproportionately to the output of the research system in the USA. Further, it assumed that this must be so, since there is very fierce competition for post doc positions in the USA, while a considerable share of German post docs are financed by prestigious German scholarships for which selection is also competitive.

The study contains another highly interesting finding: German post docs and other ‘formative-years researchers’ are concentrated in very highly-reputed, ‘world-class’ universities, of the likes of Berkeley, Harvard, Stanford and the MIT (Massachusetts Institute of Technology) who have the highest number of German post docs, in this order. If this finding is representative of the distribution of foreign post docs over institutions (and research institutes) in the USA, it casts a doubt over the conventional practice to associate ‘brain drain’ and ‘brain gain’ with countries as a whole. Even though it is of course no coincidence that the top-ranked universities in the world concentrate in some countries and that there are none in others, it is very doubtful if researchers take their migration decisions based on countries rather than actual institutions. The British findings, discussed in the previous section, according to which 31% of all young foreign researchers are concentrated in the four leading UK research universities, would also seem to indicate that it is the institution that matters.

Conclusions

From all of the above, it should be obvious that it is difficult to make general, but valid, statements about the international migration of researchers and, in particular, about the presence or absence of an international ‘brain drain’ of young researchers; however, the following conclusions can be drawn cautiously.

First, ‘brain drain’ is a metaphor rather than a fully-fledged theory. It is rather imprecise in a number of important respects. Above all, there appears to be no consensus on the minimum migration quantities (and flow imbalances) necessary to speak of ‘brain drain’.

Secondly, we do not avail, in most countries of the world, of the statistical data necessary to reliably assess the in- and out-flows of young (or any other) researchers. Of the manifold problems in this regard, the most serious one is that we cannot trace the international movements of individuals over time. We therefore cannot decide if mobility of researchers is predominantly a temporary or a lasting measure, and we are not able to determine if the prevailing migration pattern is one of ‘brain circulation’ or ‘brain drain’.

Thirdly, there are strong indications that the popular perception of the very strong attractiveness of the university and research system in the USA upon young foreign researchers is not misguided. Institutions in the USA are, indeed, a strong magnet for young ‘formative-years’ researchers, at least in the natural sciences and technology. The majority of postdoctoral scholars in the USA are foreigners (who also earned their PhD outside of the USA). However, there are
reasons to believe that the quantitative dominance of foreign postdoctoral scholars in the USA could partly be the result of a lack of attractiveness of the home post doc system to nationals of the USA.

Fourthly, studies on the migrations of young UK and German post doctoral scholars to the USA seems to suggest the following.

1. A postdoctoral stay at a prestigious institution in the USA is becoming an almost necessary career development step for the best of young scientists elsewhere in the world.
2. Such mobility is, as far as the intentions of the young researchers go, temporary. For most of them it is, indeed, just an intermediary step, and this is usually the case where the research systems in the country from which the young post doc originates are able to offer a sufficient number of high-quality researcher positions and a well-resourced and un-bureaucratic environment which makes returning an attractive option. This appears to be more clearly the case in the UK than in Germany.
3. Overall outflow numbers of young researchers were not judged by the authors of the studies and surveys used in this article as particularly high (even though what is seen as ‘high’ or ‘low’ varies considerably between authors; see above). What may be concerning is that those who move from one country to another are rated very highly in their country of origin (a quality selection).

Finally, there are strong indications that young and experienced researchers do not base their migration decisions on their destination countries, but on the actual institutions they will attend. Foreign, young (or any) researchers in the UK and in the USA are heavily concentrated in a limited number of very highly reputed research universities and institutes. While such top-notch institutions are, of course, unevenly distributed between countries, it is nevertheless dangerous to make generalized claims of the sort that it is ‘the USA’ or ‘the UK’ that are attractive and not the institutions within those countries.

References
