The global competition for talent: Life science and biotech careers, international mobility, and competitiveness

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Publication date
2015

Document Version
Final published version

"Being a scientist almost always means that you have to pack up and move at least once – if not several times – during your career."

This quote (Gannon, 2007, p. 14) opens a commentary in *European Molecular Biology Organizations' Report* called "The downsides of mobility". It adds further fuel on the importance of understanding the global competition for talent as it applies to scientists, as it purports that mobility, in terms of changing geographic location, is generally not the *exception* in scientific careers, but instead the *expectation*. In contrast, skilled migration theory typically assumes that international migration occurs only among a select few and reports also show low intra-EU mobility among European citizens (EUROFOUND, 2007). Following the article on the mobility imperative, another commentary titled "Mobility is not the only way forward" added to the argument stating,

> This perplexing automatic promotion of mobility has left some researchers feeling as if the system were designed to minimize the opportunity for stable family and social ties, to the point where the best choice left to scientists is to devote themselves exclusively to their research (Garvalov, 2007, p. 422).

International mobility is not only about careers, but rather a life choice that has to fit within a full range of other considerations, which includes first whether to move or not, and only then where to move. This chapter addresses the following questions: **How important/prominent is international mobility in life science careers?** This discussion is critical for understanding the global competition for talent, as observed through life science careers.

International movement of scientists and its effect on the availability of researchers in the countries they left is not a new topic. Many of the earliest debates surrounding brain drain stemmed from the loss of scientists to the US following World War II. US scientific *advantage* has often been attributed in part to its ability to attract talented foreigners (see Gordon, 2004; Peri, 2005), while 'brain drain' has long been considered as a barrier not only to developing countries, but also to European scientific advancement, as the original debates on brain drain stemmed from a loss of European scientists. However, the demographic characteristics of scientists and their destination choices, fields in demand, and educational trajectories have been changing. Additionally, given the increasing importance of the knowledge economy, there is also more attention to *attracting* international science and engineering students and scientists.

This chapter discusses individual interest and patterns related to scientific mobility, which can be linked to the aspect of 'people' in the analytic framework presented in Chapter 3. More specifically, it addresses the following research questions: **How important/prominent is international mobility in life science careers?** This chapter will utilize descriptive data from both open and closed-ended questions in the CiLS scientist survey. The focus of this chapter is on life scientists, as one *career* group, with more analysis among life scientists from or living in different countries added to the discussion in later chapters.

Although scientific mobility has been said to be a norm in life science careers, there are still gaps in understanding the extent to which it really occurs and the reasons why. It would be expected that it varies to some extent by country of origin and the opportunities available there, in line with the 'push-pull' models of international migration, but these models cannot offer a complete explanation. In *The Age of Migration* (Castles, de Haas, & Miller, 2013), a thorough list of critiques to the push-pull models are presented. In summary, push-pull models place too much emphasis on rational decision-making. It overlooks the selective nature of migration, the fact that migrants do not have full and perfect knowledge when making their decision. Furthermore, markets do not achieve perfect equilibrium. There are cases both of people being excluded, due to policy or social factors such as discrimination, as well as of individuals creating their own, new opportunities. In addition, these models have tended to expect individuals to be reacting primarily to wage differences rather than what is truly driving them, their personal aspirations (de Haas, 2011). In addition, there would also likely be differences in destination choice across countries and demographic groups, which may occur even when the economic context is similar (see also Radu & Straubhaar, 2012). Therefore, further contextual information is needed to understand international mobility decisions.

This chapter focuses on CiLs survey questions to better understand (1.) the extent of life scientists' international mobility and interest in future scientific mobility (2.) a brief exploration of possible differences based on demographic factors and life stage (3.) assessment of the importance of international mobility for life science careers (4.) a look at the various forms of mobility reported in the CiLS survey. The main CiLS survey questions used are listed in the order they are analyzed in this chapter:

- **Interest in future mobility:** Q95 Interest in moving abroad for scientific careers: After selecting which country would be their first choice to move to and explaining why, respondents were asked "On a scale of 1-5 (1 as the lowest and 5 as the highest), how interested are you in moving to another country, other than where you live now, to work in the life sciences? The ratings for this question are also analyzed in terms of other key variables that were thought to potentially influence the level of interest, including gender, age, marital status, partner's career type, and having children
- **Self-reported moves abroad:** Q111. Thinking of stays of 2 months or longer (not including vacations/holidays), have you ever lived abroad (in a country other than where you were born)?
- **Relative importance of international mobility:** Q85. Now we would like to ask about a few specific skills and how important they are, compared to each other, in the life sciences job market. Please use a scale of 1-5, where a 1 means "not important at all" and a 5 means "extremely important". – which includes a statement on the importance of international mobility
- **Importance of living abroad for careers; importance to academia vs. industry careers:** Q85 Rating of statement "importance of work experience abroad" and Q 96: It

is necessary to live abroad in order to have a successful scientific career in academia vs. outside of academia

- **Profile of moves abroad**: Q.114. Starting with your most recent move, please let us know which country you lived in, how long you were there, and the main (most important to you) reason for this move. If you lived in a place for several different reasons -- for example, if you studied in Switzerland and then later got a job there, please list Switzerland twice. Example: 1. Study, 2-6 months, Switzerland, 2005 2. Work (related to life sciences), 12-17 months, Switzerland, 2006

DATA ON SCIENTIFIC MOBILITY ON A GLOBAL SCALE

In this section, data are examined to gauge the relative importance of international mobility among scientists in various countries. As noted earlier, national statistics on this topic are patchy, at best, in most countries, with one exception being the SESTAT data in the US. However, some recent research has been conducted that help fill in some the gaps and will be shown in this section.

Given both the importance of the US for global science and as a migration destination, a brief overview of some of the recent trends in the US is provided. The growing rate of international mobility is reflected in the US statistics on the science and engineering workforce as well in science education. Notably not only do foreign-born individuals make up a substantial part of the science and engineering workforce in the US, the relative percentage has grown substantially since the 1990s, particularly among those with graduate-level degrees. Foreign-born individuals comprising nearly 40% of the US S&E doctorate holders in 2005, compared to less than 25% in 1990. These statistics are important as they indicate not only the importance, but the growing reliance of the US on foreign-born workforce for science and engineering[33].

These trends are supported in part by foreign graduate students staying in the US after their studies. The National Science Foundation reports, "More than 90% of 2004–07 U.S. S&E (science & engineering) doctorate recipients from China and 89% of those from India reported plans to stay in the United States, and 59% and 62%, respectively, reported accepting firm offers of employment or postdoctoral research in the United States[34]." However, to put these numbers into perspective it is important to note that similar stay rates are seen for European graduates in the US. The report, *Europe in the Global Research Landscape* (European Commission, 2007b, p. 22) , reported "In the period 2000-2003, 74.3 per cent of European S&E doctorate recipients in

[33] However, it is important to mention that many of these foreign-born individuals are citizens or permanent residents, as data on graduate enrollment shows a smaller percentage of temporary visa holders, for instance 23% of graduate students in biological and agricultural sciences in fall 2010 (Bell, 2011, p. 14)

[34] http://www.nsf.gov/statistics/seind10/c2/c2h.htm#s2, Accessed 4 March 2015

the US planned to stay, and 55.0 per cent had firm plans to stay (i.e. had accepted an offer of employment or postdoctoral work)." In other words, the US data shows:

- Foreign-born candidates make up a substantial proportion of US graduate students in scientific fields
- More than half of graduate students in the US plan to stay after graduation, including both individuals from developing countries and from Europe.

Interestingly, it seems that while the mobility of foreign graduate students into life science programs has been increasing in the US, the number of US post-graduates going abroad has been declining. Using data from the National Science Foundation, Gladfelter (2002) reports that in the 1970s, having international experience was valuable for tenure. However, rates of international mobility among life science post-docs who are US citizens had declined steadily from 6% in 1965 to 2% in 2000. This is in contrast to what would be expected in an increasingly globalized world. Other career and structural dynamics must be influencing the change.

Are similar trends of the importance of the foreign-born for the scientific workforce seen elsewhere? This has been to determine in the past given the lack of an internationally comparable database on the scientific workforce (see Appendix D) and little data collection on whether international graduate students later become employed in the country where they studied. Limited data shows that the foreign-born make a strong contribution to science in other advanced economies. Hawthorne (2009, p. 368) calculated that based on census data from 2001, 37% of science professionals in Australia were foreign-born and 36% in Canada.

Data from the GlobSci survey conducted in 2011 also aimed to better understand scientific mobility on a global scale, looking at the percentage of foreign scientists, the mobility of native scientists, and the percentage with international experience in each country (see Table 14). The study surveyed published scientists in the fields of biology, chemistry, materials and earth and environmental sciences during 2009 and working in the 16 countries with the highest numbers of published scientific papers (Franzoni, Scellato, & Stephan, 2012). Approximately 16,500 surveys were analyzed. All of the top countries producing highly rated scientific journal articles are represented, except China, where there was a low response rate. According to their study the highest percentage of foreign scientists is found in Switzerland (57%), followed by Canada (47%), Australia (45%), the US and Sweden (both at 38%), and the UK (33%). In contrast, some countries have low numbers of foreigners in their scientific workforce, with less than 10%. In Europe, this is particularly true of Spain and Italy. This trend also occurs in developing countries, such as India and Brazil. Japan, long seen as being a closed society, has similarly low levels. In these results, scientific mobility ranges from being widespread to occurring only in very limited numbers. Looking at the countries of origin for destinations across the globe shows high intra-European mobility. The GlobSci survey (Van Noorden, 2012, p. 327) found that the largest groups foreign scientists employed in various European countries are typically from other European countries, with German scientists as the largest foreign group in Switzerland, Sweden, UK, Netherlands, Denmark, and Belgium. There are also moves between Italy and France. The study also shows large inflows of Chinese scientists to Canada, Australia, and the US, again

suggesting that these countries have more scientists from developing countries. The percentage of scientists from developing countries employed is likely lower in European countries than in the US (Cervantes & Goldstein, 2008, p. 315; Anne Marie Gaillard & Gaillard, 1998). Within Europe, only Spain had a developing country as its top source of foreign scientists, in this case, Argentina. At this time, I am not aware of any research that has looked at changes in the number of scientists from developing countries in Europe in recent years. Given the increases seen in international student mobility, more legislation allowing foreign students to seek employment after graduation, and the advance of the ERA, including the Researchers Directive from the European Union to facilitate international mobility of scientists into the EU, at least a slight increase in the number of scientists from developing countries working in Europe is plausible.

The GlobSci study shows a few 'top' destinations for scientists. The US was found to be among the top two destinations for scientists from every country studied, and their results support the long-held image of the US's strength in attracting scientists globally. The UK and Germany are both important destination countries within Europe.

The GlobSci study also offers insight into the international mobility of scientists (Table 14, column 6) during their careers. They look at rates of mobility among natives, defined as scientists living in that country at age 18. The rates of mobility are high for most countries, over 50% for the majority of countries, with the highest rates found in Switzerland (78.4%) and India (75.1%). The only countries with rates of mobility lower than 50% are the US (19.2%, the lowest rate of international mobility of natives), Japan (39.5%), and Italy (40%).

The authors report that their survey is the "most comprehensive" (Franzoni et al., 2012, p. 1252) study of scientific mobility across the 16 countries reported in their study. The GlobSci study is one of the most important for understanding international mobility of life scientists and serves as an important benchmark for the CiLS results. However, the types of respondents are not the same and there are a few limitations to their data. One of the limitations of their approach is that country of origin determined by country of residence at age 18 versus when published, so some individuals with mobility early in their careers or studies would not be included. Also, as it is based on published scientists, fewer early career scientists are included, and given the recent changes in more widespread international student mobility, the trends for this group may show different patterns (see Van Noorden, 2012). Additionally, there may varying mobility rates for specific scientific fields, which means patterns and rates may change when looking at life scientists as a single group.

TABLE 14 RESULTS OF THE GLOBSCI SURVEY ON EMPLOYMENT OF PUBLISHED SCIENTISTS

	Immigration into country:		Scientific mobility of natives:		
	% in Foreign country at age 18	Main countries scientists are from:	% of natives outside of the country in 2011	Main destinations countries for native scientists:	% reporting international experience
Canada	47	UK 14%, US 14%, China 11%	24	US 70%	67
US	38	China 17%, India 12%	5	Canada 32%, UK 16%, Australia 10%, Germany 10%	19
UK	33	Germany 15%, Italy 10%	25	US 47%, Canada 17%, Australia 17%	56
Denmark	22	Germany 24%	13	UK 38%, US 36%	54
Sweden	38	Germany 12%, Russia 10%	14	US 24%, UK 14%, Germany 12%	54
Belgium	18	Germany 15%, France 15%, Italy 13%	22	France 30%, US 20%, UK 10%	53
Netherlands	28	Germany 15%, Italy 13%	26	US 23%, UK 20%, Germany 19%	53
France	17	Italy 14%	13	US 23%, UK 15%, Canada 14%	59
Germany	23	No country with more than 10%	23	US 30%, Switzerland 19%, UK 18%	58
Spain	7	Argentina 13%, France 10%, Italy 10%	8	US 31%, Germany 16%, UK 16%, France 14%	63

Italy	3	France 13%, Germany 11%, Spain 11%	16	US 25%, UK 20%, France 16%, Germany 11%	40
Switzerland	43	Germany 37%	33	US 34%, Germany 30%	78
Brazil	7	Argentina 16%, France 14%, Columbia 12%, Peru 12%	8	US 34%, Canada 16%, Germany 16%	51
India	1	Figures too small	40	US 75%	75
Japan	5	China 34%, S. Korea 12%	3	US 51%	40
Australia	44	UK 21%, China 13%	18	US 46%, US 25%	63

Source: Franzoni et al. (2012, p. 1251)

INTERNATIONAL MOBILITY IN THE CILS SURVEY

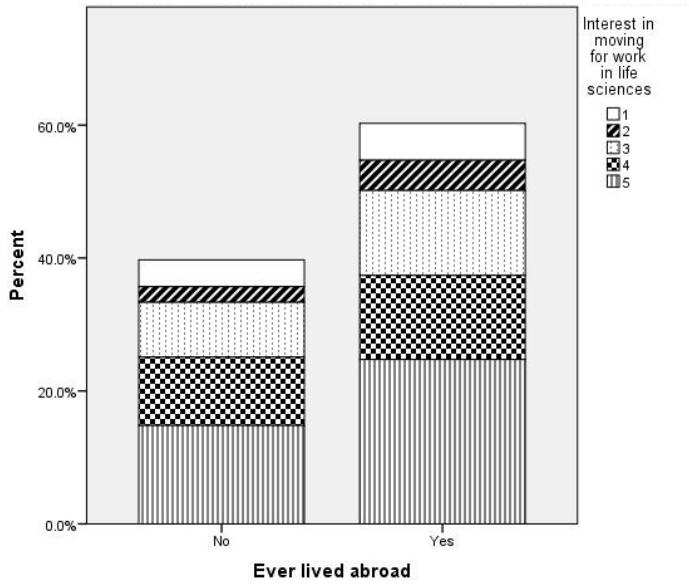
How important/prominent is international mobility in life science careers? In this section, the analysis from the CiLS scientist survey aims to add particularly to this research question. The review of the literature highlights some trends related to international mobility, but most of it is not specific for life scientists, who may have different mobility rates or patterns than other types of scientists.

Rates of international mobility and future interest in international mobility in the CiLS survey

The CiLS survey results show widespread interest in working abroad in the future, with a median interest of 4 and a mode of 5 (on a 5-point scale with 5 as the highest interest). This is further evidence that scientific mobility is evident on an international scale. The individuals with the lowest interest to move are generally older (average age 32, median 30 among those saying 1 for international mobility). Interestingly, low current interest in moving abroad does not equate to general immobility, as shown in Figure 13, but rather there is a tendency even among those who have not moved yet, to have medium to high interest in future international mobility. The rating of 1, the lowest rating, was the least common response. Among those expressing the lowest possible interest (measured as 1 on a scale of 1-5) in "moving to another country, other than you live now, to work in the life sciences" more than half (58%, 33 of 57 individuals) had lived in another country, for at least two months or more, in the past, and the primary reason for the move was career related (academic degree, postdoc position, short-term project, employment) for

all but two individuals, who had moved in the past for relationship or personal reasons. Furthermore, in the group with the highest interest, 37.4% (88 people) had said they had never moved abroad before. These results are interpreted as showing that there is a high interest among life scientists to move abroad in their career and the high levels of mobility are further supported by research such as the GlobSci study (Franzoni et al., 2012). The reasons reported for wanting to move internationally will be discussed in the next few chapters.

FIGURE 13 INTEREST IN WORKING ABROAD IN FUTURE, BASED ON PAST INTERNATIONAL MOBILITY



Demographic factors

Past international mobility also features in the majority of life scientists' careers in the CiLS survey. Table 15 shows the rate of past mobility and mean interest in future international mobility for work among life scientist. Among the total respondents, 60% self-reported that they had lived abroad for a period of two months or longer, not taking into consideration holidays or vacations. In looking at these percentages by sub-group, it becomes clear that life scientists who were in a later career stage were more likely to have been abroad. Although the percentage was at least 57% for those who had already completed a Bachelor's degree or higher, it rises with more experience – 78% of scientists with more than 7 years of work experience and 85% of individuals with a postdoc report that they have lived abroad for a period of 2 months or longer. At the same time, the mean scores for interest in working abroad decrease with more work experience. The exception is for those with less than a year experience, who also have lower interests in moving abroad, possibly because their main focus is on gaining experience in their current job.

TABLE 15 PERCENTAGE WHO MOVED ABROAD IN THE PAST AND MEAN INTEREST IN MOVING INTERNATIONALLY FOR LIFE SCIENCE WORK IN THE FUTURE

	% self-reporting moves abroad	Interest to move from current country of residence - Mean	N
Total	60.4%	3.76	594
Male	59.6%	3.78	292
Female	60.9%	3.74	302
Highest education completed			
Other	63.2%	3.16	19
Secondary school/high school	34.5%	3.78	58
Apprentice, technician, or higher training in life science (outside of university)	37.5%	4.5	8
Bachelor's or equivalent	57.6%	3.95	99
Master's or equivalent	57.8%	3.84	256
PhD	69.1%	3.6	81
Postdoc	84.9%	3.47	73
Graduate with honors (after high school)			
Yes	65.2%	3.9	290
No	57.5%	3.52	200
Not applicable	52.4%	3.85	103
Work Experience			418
12 months or less	57.7%	3.59	123
1-2 years	59.1%	4.24	66
2-3 years	66.1%	3.89	62
4-5 years	64.3%	3.83	70
6-7 years	69.7%	3.48	33
More than 7 years	78.1%	3.36	64
Marital status			
Single - not in a serious relationship	54.1%	3.94	244
Single - in a serious relationship	61.4%	3.9	132
Living with partner	68.0%	3.25	75
Married	67.8%	3.49	121
Other (widowed, separated, no answer)	54.5%	4.14	22
Long-distance relationship			328
No	58.4%	3.54	231

Yes, but we live in the same country	69.4%	3.53	49
Yes, we live in different countries	93.8%	3.98	48
Does your partner have same nationality (citizenship before marriage) as you?			328
Yes	58.3%	3.54	214
No	86.4%	3.78	114
Have children			328
Yes	69.2%	3.42	65
No	59.2%	3.8	529
Partner's career			328
Yes, it is also related to the life sciences	60.2%	3.78	108
Yes, but it is not related to life sciences	71.6%	3.43	148
No career	63.3%	3.68	60
Not applicable	41.7%	3.67	12

Various questions were asked in the demographic section to better understand family and life stage factors that may have an impact on scientific mobility:

- Gender: Gender did not have a strong influence the rates of past mobility (approximately 60% among both males and females) or the interest in future mobility (mean of 3.78 for males; 3.74 for females). Rather than gender, the family/relationship dynamics appear to be more influential.
    - Marital status: Those who are single have the highest interest in moving abroad in the future (mean 3.9). Customized choices were asked in regards to marital status, in order to capture differences in between singles that are in a serious relationship versus those who are not, as it is assumed those who are may be more reluctant to move; however both groups of singles had similar interest in moving abroad (mean around 3.9). The group with the lowest interest was those who were living with their partner (mean of 3.25). This may be due to fewer visa options being available for unmarried, long-term relationships as compared to married couples (mean interest 3.49), in many countries.
    - Long-distance relationships: Not surprisingly, those who are in a long-distance relationship with someone in another country were also more likely to desire future international mobility (mean 3.94) than those who did not (mean 3.5).
    - Households with children: Only a small percentage of the CiLS sample has children (10.9%), and among these families, future interest in moving abroad is lower (mean 3.42) as compared to those without children (mean 3.8).
    - Dual career families: There are a substantial number of dual life science- career households, with one-third of respondents who are either living with their partner or are married reporting that their partner *also* has a career related to the life scientists. Respondents in this dual science-career category show more interest in moving abroad (mean 3.78), than individuals whose partner has a career outside

of the life science field (mean 3.43), or those whose partner is not currently career-focused (mean 3.68). This difference could be a reflection of the expectation to move to places that are competitive in the life sciences field and the 'norm' of mobility in life science careers. Opportunities in other career fields may be more limited, whether due to lack of credential recognition (particularly in fields like law or medicine) and/or language barriers in the workplace. Furthermore, the majority of respondents whose partners have careers in fields other than the life sciences, had already moved abroad already earlier in their career (71.6%), and this percentage was higher than among dual-life science career households (60.2%).

The importance of international mobility in life science careers

International mobility was found to have high importance rating among a list of skills and experiences needed for the life science job market (see Table 16). Among the total CiLS, sample, "work experience abroad" has a mean score of 3.9. It was one of the top rated items, topped only by "having previous work experience in the field" (mean=4.21), "experience with interdisciplinary projects" (mean=3.97) and "the research area of the post-graduate degree" (mean=3.94).

TABLE 16 RELATIVE IMPORTANCE OF INTERNATIONAL MOBILITY COMPARED TO OTHER SKILLS AND EXPERIENCES NEEDED IN THE LIFE SCIENCE JOB MARKET (Q85)

Having previous work experience in the field	4.21
Experience with interdisciplinary projects	3.97
The research area of the post-graduate degree	3.94
Work experience abroad	**3.9**
The research area of the graduate degree	3.68
Record of obtaining grants/funding in the past	3.59
Grades/Marks on graduate degree	3.28
Having previous experience in management	3.22
Knowledge of government regulations	3.07
Grades/Marks on Bachelor's degree	2.98

Comparing rates and attitudes toward international mobility in various countries

Table 17 provides data for various countries, where there were more than 20 citizens answering the survey, with the exception of the US and UK, which were included given their high ratings for life science competitiveness and expectations as top skilled migration destinations. It shows that the overall percentage of people who have moved abroad in the CiLS survey is weighed down by data from a few countries where there is a relatively larger sample size within the CiLS dataset, but low mobility in the survey, namely India and Spain. Scientists from Spain have one of the lowest self-reported rates of having moved abroad, which is in line with academic literature that shows lower international mobility among Spanish citizens. In the CiLS study, Indians in the sample also have low rates of having moved abroad. The low mobility among Indians is surprising, but it is important to note that the GlobSci study, which found high

mobility, focuses on published scientists. These are likely among the most elite Indian scientists, whereas the CiLS survey reached a broader group. The interest in moving abroad was high in India (mean of 4.04) and for Spain (mean 3.60) was similar to or higher than many of the other European countries.

As would be expected, there are differences in the ratings of importance of working abroad in different countries. It was found that citizens of the US and UK rated international mobility as having relatively low importance (mean of 2.1 and 2.5 respectively). There are two possible interpretations. The first is that in these countries, the inward mobility of foreign scientists is more important than the outward mobility of its citizens. The second possibility is that international mobility of nationals is less integrated in funding schemes, compared to that in most countries of the EU. The highest ratings of the importance of international mobility in the life science job market were from citizens of European countries, where every country had a mean score higher than 4.

As discussed in Chapter 5, there are differences in careers paths among those pursuing life science careers in academia versus in industry. Little is known about how scientific mobility differs in academia versus industry among life scientists. The CiLS study asked respondents to rate the following two statements to assess if there is a difference: It is necessary to live abroad for a while in order to advance an academic career; It is necessary to live abroad for a while in order to have a successful scientific career outside of academia. An interesting finding was that agreement was much higher for academic careers and was seen more neutrally for careers outside of academia.

Scientists answering the CiLS survey express that international mobility is a part of the life science career path, including in many European countries where the life sciences are well-developed both in industry and academia. In other words, scientific mobility does not only occur in places where opportunities are few. For instance one German respondent stated:

> *"It is a basic requirement for all scientists that they spend time abroad if they intend to advance their career regardless if this is really necessary or not."* (Male, 31, German citizen living in Germany, Molecular Biology)

Another respondent expressed:

> *We had a talk with people from industry (organised by the university). People who had worked abroad some time got a better job in the country they come from and got more opportunities in their career. They all gave a positive feedback on their experience abroad and encouraged us to move abroad.* (Female, 28, French citizen studying for Master's in Switzerland, Biotechnology)

Another scientist from Switzerland observed that *"Everyone with a good position went abroad"* (Male, 24, Swiss citizen living in Switzerland, Biotechnology). Taken together, these quotes indicate that within Europe, moving abroad is often seen as career *credential*, which is believed to be highly valued by employers.

TABLE 17 EXPERIENCE WITH AND ATTITUDES TOWARD INTERNATIONAL MOBILITY IN THE LIFE SCIENCES, BY COUNTRY OF CITIZENSHIP (OR RESIDENCE)

By country/ country group	% self-reporting moves abroad- Citizens	n=	Interest to move from current country of residence for work in the life sciences– Mean among those living in that country	n=
World Bank Developing, not in EU	67.2%	119	4.35	69
India	32.0%	103	4.08	78
EU-10	79.2%	48	3.56	27
France	90.5%	21	4.00	11
Germany	70.5%	78	3.37	91
Italy	66.7%	51	3.92	36
Spain	42.0%	69	3.60	65
Switzerland	61.0%	41	3.52	105
UK	61.5%	13	3.67	18
US	82.4%	17	3.80	25

By citizenship	Importance of "work experience abroad" - mean	Importance int'l mobility for academic career	Importance int'l mobility for non-academic career	n=
World Bank Developing, not in EU	3.82	4.33	3.66	117
India	3.71	4.38	3.69	103
EU-10	4.08	4.23	3.49	48
France	4.48	4.14	3.67	21
Germany	3.99	3.88	3.07	76
Italy	4.20	4.02	3.80	51
Spain	4.07	4.19	3.62	68
Switzerland	4.13	3.78	3.62	40
UK	2.55	2.75	2.38	13
US	2.88	2.94	2.56	17

In contrast, and as would be expected based on push-pull models, individual in less competitive life science countries, scientists are driven to move by the hope of accessing better opportunities. For instance a Bulgarian scientist explains:

> *"In my country of origin currently there is no such thing as life sciences anymore, at least not when compared to other European countries and US. Moving abroad is the only way for working in an industrial life sciences setting or good academic place. Working in academia in my home country is simply put teaching students what is written in the textbooks without proper facilities for achieving modern practical hands-on experience. In the same time home academic ladder is currently very subjective, no objective criteria exists. Gaining scientific or managerial experience abroad gives advantage only in industry (currently only sales is developed), but not in academia."* (Male, 36 living in Bulgaria after returning from US, Cancer Research and Proteomics)

Outside of the EU, a similar sentiment was expressed, comparing the growing opportunities available in Russia as still paling in comparison to that which is found in the EU or US:

> *"Today the situation in life science in Russia is not so bad like 10 years ago, but still not so good like in European countries. If you want to have interesting work and to get some money for it, you should move..."* (Female, 26, from Russian and currently living in Russia, Biochemistry)

What can be said about the reasons for low perceived value of international mobility for citizens of the US and UK? One respondent in the US indicates that attitudes toward international mobility may be led in part by funding schemes, but in this case, it is seen as a detriment to receiving academic funding:

> *"(Moving abroad) makes it more difficult to find an academic position; (and has a) neutral effect in industry: There is a perception in some circles that work done outside the US is of lesser caliber than that done here. Someone postdocing outside the US is at a detriment when looking for an academic position. Part of this is the lost opportunity to network within the circle of those that judge your grants. In the current funding environment this is particularly important. If you don't have an advocate in the room, you won't get funded. Great science is not enough when the NIH (National Institutes of Health) budget has lost buying power by remaining flat so long. Work abroad shatters your ability to make these vital connections. The only opportunity would be if one did another postdoc or two back in the US. In industry, at least at my company, we don't really consider it particularly. I certainly deal with many people from other countries, but it is neither an asset nor a detriment in this setting."* (Male, 34, US citizen living in US, Cancer Research and Cell Biology)

This respondent also expresses that international experience is not necessarily an advantage in hiring in industry either, but rather companies are looking for the best candidate available, without strongly considering whether they have an international background.

No respondents from the UK mentioned funding schemes as a reason to prevent mobility. Instead, they generally expressed that good opportunities in science were available in the UK and/or that they were not willing to move away from friends and family (a common concern among individuals from any country who do not want to move).

These quotes are provided only as an introduction to some of the themes found in the CiLS study on the importance of international mobility. They highlight both that international mobility has become part of life science careers, in many but not all cases, and also that the reasons show an interaction between what is expected in the career path, whether or not there are local opportunities, and personal preferences. More details on differences between countries are provided in Chapter 9.

Forms of international mobility

The CiLS study also asked respondents for a profile of the past five moves to better understand scientific mobility (See Table 18).

Calculations were made to see how many countries were featured in the past five moves. Among the CiLS sample, 39.7% have not moved, 35.2% moved to one country, 16.2% lived in two countries, 6.6% in three countries, 1.9% in four and 0.5% in five. The mean age of the CiLS sample is 28 and the individuals reporting multiple moves were only slightly older, with individuals saying they had moved twice averaging age 29, and those with three or more moves being on average age 31.

TABLE 18 MAIN REASON FOR MOST RECENT AND LAST FIVE MOVES

	Most recent move	Total/sum across past 5 moves
Study as part of degree program	119	166
Short-term study abroad or exchange program	67	100
Postdoc	39	61
Internship	34	58
Work (Professional/office/research, related to life sciences)	32	61
Moved to be with family	15	26
Research (Not part of degree and not listed above)	14	22
Language courses	8	23
Work (other)	6	15
Work (Professional/office/research, not related to life sciences)	4	11
Moved to be with boyfriend/girlfriend	6	9
To leave a bad situation in the country I come from	5	6
Other	9	15
Total number of individuals/ moves*	358	573
*For most recent move, total number of moves is the same as the number of respondents. For the total moves, one person has multiple answers if they have moved more than once		

This question also offers a look at whether the moves were for study, work, or personal factors, with the respondent asked to list the reason that was personally most important to them. This is unique in that it acknowledges that a person may move for reasons other than their career, even if they also have a job opportunity in the place they move to. The most recent move was generally as a student, either for a degree program (33% of respondents who have moved) or study abroad/exchange program (18.7% of respondents who have moved). Moving abroad for a postdoc is also common, mentioned as 39 of the most recent moves and 58 of the total moves, and when taking account that only 74 CiLS respondents had worked on a postdoc by the time they answered the survey. Only 8.9% of CiLS respondents reported work in the life sciences as the main reason for their most recent move, and it was a reason among 10.6% of total moves. Internships consisted of 9.6% of the total reasons for moving.

The results show the importance of student migration and moves as an early career researcher within greater patterns of international mobility. International student mobility is currently the key route for moving, which is in line with the statistics shown in Chapter 2. Options for student mobility have increased globally, and this form of the global competition for talent is taking place on a greater scale than that which happens from employment.

CONCLUSION

Scientists have been said to face an expectation of mobility (Ackers, 2008; Gannon, 2007; Schiermeier, 2011). Little data has been available in the past to look at patterns and rates of mobility among scientists as there are few comparable statistical sources. In the US, the number of international advanced degree candidates has risen substantially since the 1990s. The GlobSci study, one of the most comprehensive looks at scientific mobility, found the mobility rates vary across countries. A few basic patterns emerged, with Europe showing mostly intra-European mobility, while the main sources for the US are China and India. Rates of international experience among natives, as it is called in their study, varies from a low of 19% in the US to a high of 78% in Switzerland.

How important/prominent is international mobility among life scientists? The data found that is considered to be a core feature of life science careers. At the same time, it should be noted, in line with the critique of push-pull models, that there are variations in terms of the extent it occurs and reasons why. The CiLS data illuminates some interesting patterns for life scientists in particular, keeping in mind that there are variations across countries or demographic factors:

First, mobility is indeed seen as part of the career path for the majority of life scientists answering the survey. It is reflected across a range of questions, including past mobility, interest in future international mobility, and the importance of international mobility in life science careers. Part of the high interest in international mobility may be linked to most respondents planning to have an academic career, as shown in the last chapter. Respondents from all countries found international mobility to be more important to academic careers than other life

science career types. Particularly in Europe, with the exception of the UK[35], international mobility is seen not just as a personal experience, but as a qualification that is viewed as being either helpful or even essential in the life science job market. It has been argued that the EU academic system has a strong focus on international mobility due to its policies and funding frameworks, whereby scientists are more likely to receive advanced graduate positions or funding if they move to another country (Schiermeier, 2011). Interestingly, scientists from developing countries also place value on international mobility, although when taken as a group, they rate it less important than the individuals in Europe do. In the US, there is strong inward mobility of advanced life science researchers, but little perceived benefit of the out-migration of nationals for life science careers.

Second, around 60% of the CiLS sample has already moved internationally. There may be a succession of international moves. 25% of life scientists in the CiLS study have moved twice or more, despite the average age of respondents being only 28 years old. This shows that international mobility is often not just a simplistic move between one country of destination and one home country. It also likely reflects the higher rates of international mobility among younger generations. While the changing complexity of international migration has been frequently noted, it is not yet fully understood.

Third, there is a strong interest in future mobility, with the mode being the highest rating of 5. Among those who had not moved yet, there was generally still high interest in working abroad in the future. This finding is substantial, given that the CiLS survey did not require that respondents express any interest in moving abroad, but rather was framed as looking at skills needed for life science careers.

Fourth, the high interest in mobility does not hold for all individuals, and career stage and family life clearly play core roles. The first move abroad typically occurs as a student and other anecdotal evidence suggest that there is high value placed on doing graduate or post-graduate studies abroad. The prevalence of international mobility increased by each degree level, with 85% of respondents with post-docs reported they had moved abroad in the past. Student mobility in particular has become important within scientific mobility as well as what is being called the broader global competition for talent. Next, with the high importance and high rates of international mobility, there are also changes in the family structure, with a sizeable number of international couples. The number of couples in which both are life scientists is also sizeable. Other research has also shown that female scientists often delay having children (Dean & Fleckenstein, 2007, p. 33), and in the CiLS survey, the number of couples with children was low. Further research is needed on how high rates of mobility in the life sciences have impact on families.

[35] It is important to note that the UK does not follow the EU Researcher's Directive and other policies for promoting scientific mobility in the EU.

As proposed in the introduction, the dynamics of international migration can be much more complex than what is proposed by most push-pull models. As Part I of this study has shown, dynamics of international mobility have changed in recent decades, creating new patterns of international mobility between and among countries globally. Although life scientists have long been an internationally mobile group, the forms and patterns of mobility are likely changing, and these cannot be explained by the typical push-pull factors alone. Crucially, differences in mobility rates across countries may be attributed to structural aspects (such as funding systems or relative value of international mobility for employment), an individual's personal and career aspirations, and life stage. The next chapter further explores reasons for moving abroad and destination choice.