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

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CHAPTER 5: THE CHANGING CHARACTERISTICS OF LIFE SCIENTISTS AND THEIR CAREERS

"The main point is that the demand for qualified SET (science, engineering and technology) personnel will no longer be concentrated in a few distinct sectors – 'academia', 'government', 'industry' – each with its characteristic research portfolios and conditions of employment. In effect, new entrants to this market place will be faced with a panorama of institutions, each with possible openings for their particular talents and ambitions. What they may not find, however, is the traditional array of conventional 'career slots' for which they might have thought they had been studying, and competing with their peers, for many long years." (European Commission, 2004, p. 86)

Life science career paths have changed in the course of the expansion of the knowledge economy. While earlier research linking skilled migration and the knowledge economy typically relied on a perspective of a job boom and high demand for skills in these areas, which was characteristic of discussion of the knowledge economy of the 1990s, later developments brought about much restructuring and retrenchment in knowledge-based sectors and related services, such as IT or biotechnology.

The first part of this study argued that both the nature of skilled work and patterns of international mobility are changing. These structural changes feed into the idea of a global competition for talent. To reiterate, the global competition for talent has evolved from changes linked to both the knowledge economy and its role in fostering competitiveness and increasing, or at least new patterns or destinations, of skilled human mobility. Taken together, this means that there is a demand both for new, specialized skills, and that the potential workforce is becoming more international in many places.

As argued in Chapter 1, there is a need to further merge understanding of mobility as it relates to competitiveness, and this analysis requires a more narrow focus on specific industries and employment. The rest of this study will examine how these aspects are manifested when viewed from the lens of one career area – careers in life sciences. As part of knowledge economy growth, attention is being drawn not only to R&D generally but to biotechnology specifically. As more regions and countries aim to build a biotechnology sector, competition for qualified employees increases globally. In the early and mid-2000s, industry articles indicated that there were crucial shortages of skilled workers in the biotech sector both on a global level and within Europe specifically (EPOHITE 2003, p.39-40; Sevier and Dahms 2002; Gwynne 2004; Hodgson 2006). These concerns were compounded by rapid growth and competition - 55% of European biotech companies were less than five years old in 2004 (Critical I 2006, p. 9). As more regions and countries were aiming to build a biotechnology sector, competition for qualified employees was viewed as increasing globally. At the same time, the nature of the biotech industry is fast-changing, with various products rising and in some cases later failing, due to either an inability to secure funding for R&D and/or lack of various government approvals, which can stifle growth of a specific research stream. Furthermore, the knowledge required for open life science positions can be highly specialized, as specific as having done research on a single protein, or requiring a combination of soft-skills, such as communication or management, with in-depth scientific knowledge. In addition, as explained in part I, understandings of the life science workforce are also limited due to lack of internationally comparative statistical data for the scientific workforce and their mobility.

This chapter helps to address the following research question: **What are the features of the labor market within which life scientists work?** It answers this question by looking at patterns and research related to recent changes in life science *career options and some important demographic changes in the life science workforce*. It argues that the main issue in the global competition as it applies to the life sciences is not necessarily one involving a need to train more individuals, but rather one of needing better matching of training, jobs and potential employees, as both the characteristics of scientists and their skills are different than in the past. This chapter first highlights various literatures on careers in life sciences, with a goal of describing how and why understandings of life science career paths are still limited, despite a fairly large supporting body of policy documents and academic literature. It discusses the main career options pursued by life scientists, particularly the difference between working in academia versus industry. Second, statistical data is used to look at the characteristics of the global scientific workforce that will have a bearing on the scientific workforce, and hence the global competition for talent in the life sciences. Three key changes are identified as particularly important to the life sciences: increasing numbers of female life scientists, the growing importance of scientists from developing countries, and relatively high numbers of international graduate students (when compared to other fields of study). Third, the chapters then presents the CiLS data related to desired career paths to better frame the aspirations of life scientists, and to understand their preferences for employment. Taken together, the analysis looks at recent developments, patterns and statistical evidence to better understand the changing context framing life science careers globally.

INCREASING COMPLEXITY OF LIFE SCIENCE CAREER OPTIONS

In recent years, there has been an increasing ‘blurring’ between once distinguishable life science research areas and career paths. The primary career path for life scientists has long been viewed as a “pipeline,” where life science careers were seen as progressing from doctoral studies to end as positions as tenured faculty positions (Fuhrman, Halme, O’Sullivan, & Lindstaedt, 2011; Human Frontier Science Program & European Science Foundation, 2002). To this day, life science careers are often categorized first and foremost as looking at the paths of research careers in particular. For example, a report from a meeting on the future of careers in the natural sciences stated:

> For a student entering the traditional scientific pipeline, there has been only one honored endpoint: the replication of the student’s academic mentor, the research professor heading a laboratory in a well-defined scientific discipline. Those who chose other exit points from the pipeline failed to achieve this outcome and thus did not achieve occupational success. This traditional model reflects the rigid disciplinary divisions that have existed

> historically within research universities as well as a rigid definition of success. (Human Frontier Science Program & European Science Foundation, 2002, p. 6).

Yet, with the growth of the knowledge economy, many new options have arisen for life science careers, given increasing commercialization of scientific discoveries and new fields of both products and research. This expansion has led to new possibilities for life science careers, and at a broad range of education levels (Human Frontier Science Program & European Science Foundation, 2002; New Economic Systems & The Leonard Resource Group, 2004). The body of literature on life science and biotechnology careers is rapidly growing, broad and diffuse. Recent research is published in a range of journals on a number of topics, including but not limited to those focused on: research policy; the geography of innovation and/or knowledge; economics; career articles in journals for specific scientific fields; and the human resources literature. Much of the literature on the biotechnology industry in the knowledge economy relates to the topic of "knowledge production," rather than the workforce or careers as hard data on patents and publications are easier to come by than workforce data, as discussed previously. Furthermore, each published study is set within a very specific institutional and policy context. While the full body of literature is not reviewed here, a few key issues and patterns are identified to better frame life science and biotechnology career context internationally.

Life science jobs: Academia versus industry

A few main distinctions are typically made in discussing the career options for life scientists. A first important distinction is the difference between working in academia versus industry, or in other words, companies. Research jobs occur in academia, where research may be done without any specific product application in mind, and industry, where a combination of academic or industry research is developed further for a specific product. Occasionally a third option is made to include those working in government research institutes, but often this is grouped with academia, as it entails intensive research and publication of results. Academia and industry are considered to be influenced by very different career motivations and skill sets, and there are often discussions of how to better bridge or even cross the academia-industry divide (Klee, 2001; Sauermann & Stephan, 2010). Traditionally, academia, or jobs in universities or research institutes, is seen as the preferred path for top researchers, given the possibility of working on a topic of personal interest and importance, rather than focusing on what can be applied to a particular problem or marketed.

Life science research is increasing involving more complex collaborations, between the academic centers conducting research, small biotech start-up firms, and larger companies, such as pharmaceutical firms (PwC, 2013). The collaborations also form a need for finding employees who have more than just strong scientific skills, but also skills in areas such as management, marketing, or knowledge of regulations. The changes in the life science industry involve more than just an evolving business model, they envelop wider global changes that include the workforce, as individuals navigate what skills they need to have to be attractive candidates and where to best apply the skills they have gained. In other words, business skills of various types are becoming more important in addition to scientific skills. This is true not only of work in companies, there has been increasing pressure in many countries for scientists to be able to secure their own funding at universities or to commercialize their research (see e.g. Lam, 2011; Morris & Rip, 2006; Powell & Jason, 1998).

It is also important to point out that, the science curriculum at most universities has long been geared towards grooming students for academic careers (Borrell-Damian, 2009; Fuhrman et al., 2011; National Research Council (US) Committee on Dimensions, 1998). That is to say, life science PhD students are usually trained in skills linked to conducting research in academic settings and to publishing their results. Academic jobs also can offer security, through the possibility of top researchers receiving tenure, which affords job stability. However, tenured positions are hard to come by, and the number of temporary contracts and length of having lower paid post-doctoral positions has been increasing in both the US and Europe. Life science programs that facilitate work with industry, through internships or seminars for instance, are becoming more common, but are not yet the norm[27].

Sauermann and Stephan (2010) present a good overview of key features of scientific careers. They conducted a survey of 5,000 scientists, trained in either the life sciences or physical sciences. They state that there are four dimensions that distinguish the two career paths in academia versus industry: "(1) the nature of research (e.g., basic versus applied); (2) organizational characteristics (e.g., degree of independence, pay); (3) researchers' preferences (e.g., taste for independence); and (4) the use of alternative disclosure mechanisms (e.g., patenting and publishing)." Life science research has long been distinguished as being either 'basic,' or to expand the knowledgebase, or 'applied,' which aims to solve practical problems, and includes research that is used for inventing new products or changing processes[28]. Scientists pursuing basic research generally have been associated with academic settings, whereas applied research is done in companies, often called 'industry' by life scientists and practitioners working on issues linked to scientific employment. This difference is then linked to the second point, scientists that pursue careers in academia are generally assumed to be driven by knowledge-discovery and more research autonomy, whereas those pursuing jobs in industry are assumed to benefit from higher salaries. A final distinction has been found in the importance of publishing results for academia, versus patenting in industry. Sauermann and Stephan (ibid., p.3), argue that while delineations are made in various factors defining scientific careers, the extent that these actually influence scientific career choices and job satisfaction has not been well understood:

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[27] One of Young European Biotech Network's core projects was related to the industry focused PhD programs. In the discussions I heard, most of the students in YEBN from diverse EU countries had not been exposed to this form of education. This is anecdotal evidence that these programs are still in their infancy in many European universities.

[28] The CiLS survey draft contained questions on whether the individual conducts basic or applied research, but in testing, I was told that it is difficult to classify research in these categories, and this question was removed. A similar theme emerged in an interview at the Academy of Sciences in Vilnius, Lithuania, where I was told often the same research proposals are submitted in calls, whether for 'basic' or 'applied' research, with just minor changes. These anecdotes may be indication of the blurring between these two concepts in the current research environment.

> Our results paint a complex picture of academic and industrial science. On the one hand, we find significant differences between the two sectors with respect to the nature of research, the use of various disclosure mechanisms, organizational characteristics, and scientists' preferences. Despite significant differences, however, we also find remarkable similarities. To wit, while industrial scientists appear to enjoy less independence than academic scientists, over 50% of industrial scientists indicate that they are "very satisfied" with their level of independence. Similarly, scientists in both sectors publish extensively, with 60% of scientists in industry having published in a 5-year span. Over the same period, 16% of academics have applied for a patent. Many of the differences between sectors are smaller in the life sciences than in the physical sciences, suggesting that scholars should remain cautious about generalizing insights based on data from the life sciences to other fields. Moreover, our analyses also point to important differences within each of the two sectors, indicating that the broad industry versus academia distinction may obscure important nuances.

Vallas and Kleinman (2008) also argue that the long-held distinction between life science jobs in academia versus industry no longer fully apply, based on qualitative analysis from interviews in Massachusetts and the San Francisco Bay areas in the US. They found that feelings of research autonomy in university science departments have decreased as institutions must justify their research budgets and choose priority topics to focus on, rather than allowing staff to pursue any topic just because of personal curiosity (p. 291-294). In contrast, they spoke to scientists at companies who found their employer to be supportive of them finding a 'hot' topic of interest for them and the company and personally pursuing exploratory research on it (p. 295). While full autonomy was not possible in companies, they concluded many managers "had made a determined effort to accommodate academic traditions, in keeping with the expectations of their scientists" (p. 295). They also found this carried over to publications – given either the academic tradition of their scientists wanting to publish or because of the need of small research companies to build credibility, publication was encouraged in many life science firms (p300-301). However, it is not clear if industry behaves similarly in other countries and markets. There are great variations in institutional contexts and their influence on scientific careers and few internationally comparative studies addressing institutional differences across various countries (some exceptions are Bartholomew, 1997 who studies biotechnology innovation systems in the United States, United Kingdom, Japan, and Germany; Youtie, Rogers, Heinze, Shapira, & Tang, 2013).

Industry also offers diverse job roles. One distinction that is often made is between those who work in R&D versus other functions in life science-based companies, such as sales or project management. The life science career pipeline was aimed at preparing individuals for research careers in particular. In 2001, science funding representatives from a range of places, including in North America, Europe, and Japan, met at the European Science Foundation and proposed a model of a career tree, rather than a pipeline, which is a break from the idea of a single career path (Human Frontier Science Program & European Science Foundation, 2002). This model shows the branches linked to various levels of education, ranging from Bachelor's to post-doctorate positions. It shows, for example, that a position as a laboratory technician is possible with a Bachelor's degree, while more research-intensive jobs typically require at least a PhD. The branches also incorporated a full range of employers, including those where some scientific knowledge is needed, but the job itself is outside the realm of traditional scientific careers, such as writing articles about science for mainstream readers or teaching science below the university level.

Another problem with conducting comparative research on biotechnology is the diversity of companies involved, including across different industries (healthcare, equipment, chemicals, etc.) and frequently in companies that are not working solely in biotechnology. "Dedicated biotechnology" firms in Europe are often small and with many relatively new companies, and only some are active in R&D. Although small companies are viewed as fostering innovation, they are also often in a vulnerable position, largely due to the need to secure funding and necessity of gaining governmental approvals for the products. As with other types of small and medium-sized enterprises, the rate of failure is high. Furthermore, there is also reason to question how important is to look at "dedicated" biotechnology companies alone when assessing the sector's international competitiveness. For instance, biotechnology is often one essential part of pharmaceutical companies' business. It is reported that "Currently, 50% of all medicines in the global pipeline are derived from biotechnology. It is important to note that more than 70% of these companies in the EU employ fewer than 50 people." (Ernst & Young, 2012). Since pharmaceutical companies are among the largest investors in R&D in the world, when looking at all sectors, the location of large, multinational pharmaceutical corporations often has an influence on biotech development in the region, and particularly in Europe.

Job satisfaction will also range substantially. The study, *Talent 2020: Surveying the talent paradox from the employee perspective -- The view from the Life Sciences sector* (Deloitte., 2013) which surveyed companies around the world finds high levels of *dissatisfaction* among life scientists, as compared to other four industries studied (Consumer/Industrial Products, Technology/Media/Telecommunications, Financial Services, and Energy/Utilities). They conclude:

> Compared to other sectors, the Life Sciences sector is noteworthy for the relatively high level of dissatisfaction among surveyed employees, particularly among longer-term employees (more than five years at the company). There are a number of reasons that may contribute to this key finding:
>
> • Employees desire meaningful and innovative work that is aligned to their skills and interests
>
> • Ineffective communication of long term strategic vision within organizations
>
> • Lack of trust in leadership due to high turnover at the top level (p.3)

It is generally thought that scientists are highly motivated by altruistic motives and curiosity – they want to be the ones to solve top world problems, to find new cures and other ways of improving life. Life scientists, therefore, may be dissatisfied with their careers when their job functions do not match with these motivations.

Furthermore, the structure of life science opportunities, meaning the number, form, and quality of life science opportunities in academia versus industry will also vary substantially across regions or countries. Some places can have strong government research labs, for instance, and few companies. Others may have had government support for funding small firms, but with many of these failing in the first year or two. Each is highly tied to a number of institutional and work culture elements, including but not limited to, the security of job contracts, typical number of working hours, the degree of pressure put on individuals for finding funding and/or publishing, the independence of research afforded in different places (or job roles or grants/funding), and the openness of hiring systems and promotion. Furthermore, much of the academic research on biotechnology industry careers has been set in just one context, often the United States, and it is not fully clear what differences exist in other locations. This is a complex issue and cannot be addressed in full, but some defining elements of the situations in different countries will be discussed in later chapters.

Further complicating understandings of life science careers are differences related to specialization. Biotechnology is not really one industry, but rather is comprised of a complex mix of goals related to healthcare, agriculture, environment, energy, and industrial processes. For example, a partial list of specializations linked with biotechnology research, careers, or training includes: genetics, microbiology, biochemistry, chemistry, marine biology, food science, mechanical engineering, and biochemical engineering. There is also the possibility for specializations to be as complex as in-depth knowledge of a single protein, for example. As also suggested by the cluster literature and studies on biotechnology, specific scientific specializations often emerge in given regions (Boschma, Heimeriks, & Balland, 2013; Heimeriks & Boschma, 2012). This means that a given location might have outstanding opportunities for scientists in one research field, while offering few opportunities for research about another life science topic. The degree of interest in various research specializations also changes over time. For example, a chart on the changing numbers of publications in biotech, based on PubMed data from the National Center for Biotechnology Information, showed five fields of research, each field produced fewer than 500 publications in 2000, but since have had rapid growth by 2010: Proteomics (approx.. 5,000 publications), RNA interference (also around 5,00 publications), Epigenetics (around 3,500 publications), and microRNA (also around 3,500) (Peng, 2010). In other words, fields such as proteomics[29] and RNA interference had changed from marginal fields, to those with the highest numbers of publications in the field of biotechnology in a ten year period.

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[29] Proteomics is the study of a cell's proteins. The field is considered the next step and more complicated than genetics, as proteins change across time. Proteomics is of interest in developing customized drugs for patients. According to BCC Research, the global market for proteomics was estimated at USD 7.9 billion in 2009, with expected growth to USD 19.4 billion by 2014. The actual value did not meet this expectation, and was at USD 5.1 billion in 2014, with expectations to reach USD 11.6 billion by 2019.

Are recent life science graduates aware of the various routes available? And, are scientists, whether young or in a more advanced career stage, prepared to meet these challenges of changing employer needs? A study on life science workforce and career paths, conducted in the US found life science students to be ill-informed on specific skills needed for biotechnology careers, particularly for those who want to work in industry as well as those who do not want to pursue an advanced life science degree (New Economy Systems & The Leonard Resource Group Inc., 2004, pp. 24-26). A similar conclusion, that education programs are inadequately addressing the needs for many types of scientific positions, was made about the situation in Europe. For instance, a report by the European Commission (2004) argues:

> The education, professional training and putative prospects of researchers are still being patterned as if in preparation for careers in 'academic' science, even though this is now only a small part of the whole system where, in fact, they will mostly work. This is not to deny the continuing vital role of academic science in scientific and technical progress. It is just to say that it is very ill-adapted institutionally, at least in its modern European form, to the type of extensive and intensive research and development now undertaken on a large scale in the public and private sectors of our economies – even in the great research universities where it once ruled supreme. (p. 88)

Youtie et al. (2013) argue that research recognition is important in science, and that the criteria for this recognition are different in the US compared to Europe. They find:

> Our key results are these. In the early-career model, for the United States, we find that scientific recognition is associated with broad academic education, fast completion of PhD, and a record of independent postdoctoral research, while in Europe these factors are less prominent. The mid-career model suggests that both in the United States and Europe fast job promotion within academia is a strong predictor for future recognition. However, there is a clear divide across the Atlantic regarding other mid-career factors: work experience inside and outside academia, research leadership, external grant income, and prizes from professional associations are connected to high scientific recognition in the United States, but are less influential in Europe. (p.1342)

This is further evidence that the academic career path is still the main guide for life science career training in Europe.

Internationalization of life science research

Life science research has long been a collaboration-intensive field. What is changing is that with the growth of the knowledge economy as well as the ease of international travel and communication, scientific research has involved larger teams and often working in various countries. One piece of evidence is in the growing number of scientific publications co-authored by authors in two or more countries, increasing from around 25% in 1996 to around 35% now globally, and for publications including American scientists from 16% in 2006 to 30% in 2008. The countries involved are also changing. China, notably, publish 6 times more scientific articles in 2008 as compared to in 1996 (Sexton, 2012). In biotechnology specifically, China produced the second highest number of publications in 2009-2010, after the European Union, and China had an average annual increase of 13.6% for biotech publications between 2006-2010 (Peng, 2010). The increase in countries involved in research is, coupled with the ease of communication and shared concerns for solving scientific issues, such as related to improving public health or understanding climate change. Cross-border partnerships are only one form of internationalization of the sciences. It also involves increasing international mobility of scientists, which is the topic of the next chapter.

CHANGING DEMOGRAPHIC PROFILE OF LIFE SCIENCE STUDENTS AND RESEARCHERS

The demographic profile of life scientists is also changing. To better frame the data from the global CiLS study, which is reported in the remaining chapters, a few main patterns are identified: a changing gender balance, higher interest in scientific careers in developing as compared to developed countries, increasing numbers of post-doctorate positions in life science careers, and the increasing internationalization of scientific research.

Why are these trends important to note in this study? As discussed in earlier chapters, the development of scientific innovation is shifting. Previously 'uncompetitive' places are building their knowledge base, an aspect tied closely to the education of their researchers, whether educated domestically or abroad. It is important to understand how the face of scientific talent has changed, so to speak. Also, assuming that all fields follow the same trends is problematic as the demographic characteristics, career paths, and competitive locations can vary across fields of study and specific research topics. Or in other words, the characteristics and career concerns of engineers, for instance, is likely very different from that of life scientists (Mahroum, 2000a). Even in the 'hard sciences' differences are likely, for example between characteristics of employees and their careers in physics versus the life sciences. This means that strategies for tackling the global competition for talent, and particularly those done through government policies, will only be effective if they can address the true deficiencies in workforce characteristics as well as skills, rather being based on assumptions from past decades.

Increasing and high numbers of female life scientists

The number of female life scientists is increasing and high; typically more than 50% of life science graduates are female. Yet, this contradicts what is often expected. There has been a large amount of policy attention about the gender inequality in many scientific fields, and hence the need to increase numbers of female scientists (European Commission, 2013; UNESCO Institute for Statistics, 2012). Yet this analysis often built on fragmented data[30]. Although females are often reported as being underrepresented in science and engineering, analyzing broad categories

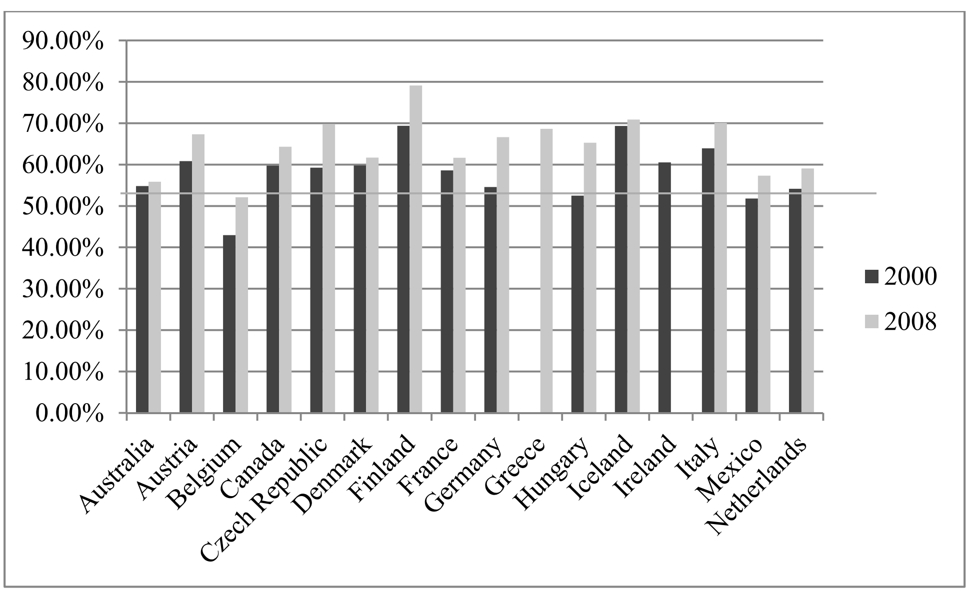
[30] For example, the UNESCO Institute for Statistics issues a brief fact sheet about women in R&D positions globally, but in looking at the actual database in more detail, it becomes clear no data is provided for a large number of countries. Furthermore, where it is provided in this report, it is separated by employer: government, higher education, business enterprise, or non-profit, but not on the function or field of research.

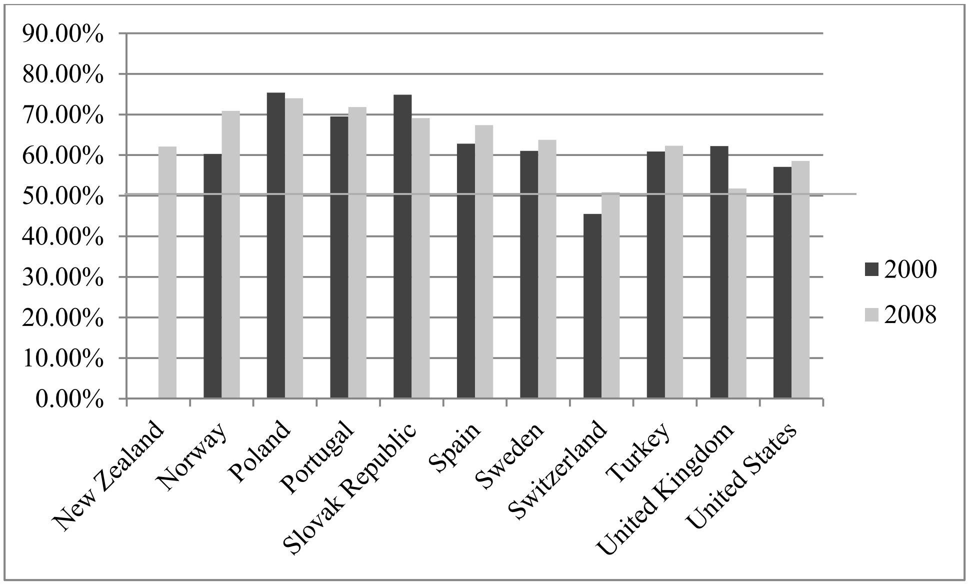
masks differences in various countries or in different fields of research. There is a range of evidence.

One source of evidence is that employment trends vary across countries with some countries having more females employed in science and technology than men, particularly in Hungary, Poland and the Slovak Republic (OECD, 2009b, p. 17). The trend of a high number of women with science and technology careers in Central and Eastern Europe is important particularly for the EU, where free mobility is allowed from these markets to the Northern and Western European countries that are seen as global leaders in the studied scientific or technical fields.

A second piece of evidence is the OECD *Careers of Doctorate Holders* international study (Auriol, 2010, p. 9), which reported that the life sciences are the only one of the scientific and engineering disciplines where the number of female doctorate holders is equal to or higher than the males. Figure 8, uses OECD data to show the percentage of female life science graduates in various countries in 2000 and 2008. In 2008, females made up *more than half* of the life science graduates in most countries, with especially high numbers (around 70%) of females in diverse regions of Europe, including Northern Europe/Scandinavia (particularly Finland, Norway, and Iceland), Central and Eastern Europe (Poland, Czech Republic, Slovak Republic, and Southern Europe (Italy, Portugal, and Spain). Furthermore, the percentage of female life science graduates increased between 2000 and 2008 in most countries reported. Only the UK had a drop in the percentage of females studying the life sciences in 2008, but that drop still made the number of women graduates on parity with males. In global comparison, Switzerland typically has more men with advanced degrees in life sciences than women, but it too reached a 50-50 ratio by 2008. The lower percentage of Swiss females studying the life sciences was also reflected in the CiLS survey data.

FIGURE 8 PERCENTAGE OF FEMALES AMONG LIFE SCIENCE GRADUATES (ISC 42), TERTIARY TYPE A AND ADVANCED RESEARCH PROGRAMS, 2000 AND 2008





Source: Data extracted from OECD iLibrary (OECD, 2013)

Finally, similar trends in the high numbers recent of female life science students are seen when looking at data from university departments. Table 9, reflects the percentage of females for doctoral enrollments and faculty positions in various biology faculties across Europe. This table shows that females make up half or more of the doctoral students in the vast majority of the select institutions within Europe. However, the percentage of female faculty is much lower in all institutions.

The impact of the gender shift on life science careers and employment patterns is not readily understood, and limited research exists generally on gender and life science careers. Some research suggests that among employed life scientists, the balance is still skewed towards males, as in part because the higher female graduate school enrollments reflect a more recent trend in many OECD countries (Auriol, 2010, p. 9; National Science Board, 2012, pp. 3.5, 3.40-41). Other research has looked at the aspect of gender in terms of concerns about managing family versus work life among life scientists (Ackers, 2003; Eaton & Bailyn, 1999). It has been reported that female life scientists often do not have children, or delay having them, due to the demands of their jobs. It is important to point out that the academic research on female life scientists or women in biotechnology is often based on a specific location. Eaton and Bailyn (1999) examined how gender issues affect work in small and medium enterprises in the biotechnology industry in the US by interviewing 15 men and 15 women. One of their key findings is that biotech work in SMEs is also knowledge-based, which means productivity does not depend fully on work hours. They recommend more flexible arrangements for employees, so that they can meet both work and family demands. McQuaid, Smith-Doerr, and Monti (2010) conducted unique research, which looked at female biotechnology entrepreneurs in the New England region of the US, and reported that only 21% of firms had a woman as one of the founders of the company. A few studies exist that look at international mobility of female life scientists or biotechnologists using samples of a single nationality (see e.g.Beoku-Betts, 2008; Jonkers, 2011), but little to no international research exists on this topic. More information on gender and scientific careers, including for life scientists in particular, is needed in various contexts, including in European countries.

TABLE 9 PROFILE OF EUROPEAN GRADUATE EDUCATION IN BIOLOGY—INTERNATIONALIZATION AND GENDER

		Enrollments		**International Students and Staff**			**Gender**	
Country	School and Institute	Total Students in University	# of Biology Doctoral Students	% Int'l Staff	% Int'l Doctorate Students	% Int'l Masters Students	Facult y % Female	Doctoral students % Female
BELGIUM	U Gent Faculteit Wetenschappen*	29,344	296	23.3	35.5	44.4	41	53
	KU Leuven Faculteit Wetenschappen	29,257	148	16.1	22.3	13.7	39	47
DENMARK	Aarhus Universitet	30,141	67	36.2	34.3	7.3	30	58
FRANCE	U Strasbourg (Faculté de Sciences de la Vie)*	38,845	522	11.7	33.7	17.4	34	50
	U Paris 6 (Unité de Formation et de Recherche (U.F.R.) Sciences de la Vie)	25,945	1100	na	27.2	18.9	na	57
GERMANY	FU Berlin	28,537	460	8.2	20.0	9.8	34	65
	HU Berlin	24,010	783	13.6	21.7	6.5	27	56
	U Münster	31,267	392	16.3	29.1	1.7	43	54
	U Tübingen	24,273	560	na	66.1	na	26	59
	U Freiburg	21,622	429	17.6	47.6	na	32	52
	LMU München*	40,431	28	na	21.4	54.3	30	68
	U Heidelberg*	24,584	888	31.1	34.2	N/A	33	58
	TU München	23,891	580	15	17.4	20.4	25	60
ITALY	U Padova (Facoltà di Scienze Matematiche, Fisiche, e Naturali)	57,837	131	0	4.6	1.3	40	61
NETHER-LANDS	U Groningen (Faculteit der Wiskunde en Natuurwetenschap)	26,342	193	30	59.6	21.2	24	50
	U Amsterdam (Faculteit der Natuurwetenschap, Wiskunde en Informatica)	30,825	125	17.4	49.6	28.4	17	53
	U Utrecht*	29,122		NA	NA	NA	NA	NA

	U Nijmegen (Faculteit der Natuurwetenschap, Wiskunde en Informatica)	18,624	49	26	26.5	13.0	27	63
SWEDEN	U Uppsala (Faculty of Science and Technology)*	28,907	186	na	41.9	89.0	34	62
	U Lund (Faculty of Science)	46,000	96	na	28.1	29.2	29	60
	Karolinska Institutet - Stockholm (Biology)*	5,776	1538	na	31.6	na	48	61
SWITZER-LAND	U Lausanne*	9,895	366	66.2	53.0	9.1	35	57
	ETH Zurich*	11,133	358	69.1	71.2	31.0	29	49
	U Basel	11,593	210	68.9	61.6	29.3	32	49
	U Bern	11,371	99	62.9	56.6	12.6	36	53
UK								
ENGLAND	IC London, Faculty of Natural Sciences*	11,394	249	49	28.5	20.2	30	54
	U York, Dept. of Biology	12,787	119	37.5	15.1	14.6	27	46
	U Manchester*	33,791	370	30.8	35.7	38.6	42	
	U Birmingham, College of Life and Environmental Sciences	26,073	140	20	17.9	na	40	50
SCOTLAND	U Edinburgh*	25,744	290	24.2	26.9	59.6	31	59
	U Aberdeen	12,827	223	n/a	21.1	47.5	na	na
IRELAND	NUI Dublin, UCD College of Life Sciences	17,091	195	55.6	54.4	36.4	38	65

Source: Compiled by author from CHE University Excellence Ratings 2010 based on schools where international student and gender balance is available for Life Science departments in this database.

* Indicates the institute has been noted as one of the 50 most competitive life science departments globally, according to at least one of the following rankings: Times Higher Education Rankings from 2010 or 2012; QS Rankings 2010, or ScImago Institutions SIR rankings 2010.

Note: No data available for Biology departments in Poland, Portugal, or Spain, even though these countries are included in the CHE study

Post-doctoral positions as part of life science career ladder

"I have seen a comparison of a postdoc with a piece of equipment that is replaced whenever there is a new model on the market—and nobody buys a second-hand Polymerase Chain Reaction machine. Despite what I feel are excellent skills, I feel like a used piece of equipment." (Doronina, 2013)

Another change affecting for the life science workforce is the increasing prominence of post-graduate positions in the life sciences in particular. For instance, The National Science Foundation in the US reports that in 2006, "More than two-thirds of academic postdoctoral appointments were in biological and medical/other life sciences."[31] They also report growth in the number of post-docs across time, from 46% of individuals in the US with a life science doctoral degree also having a postdoc position in 1972, to 61% among life science doctoral graduates from 2002-2005 (p.3.39). Completing a postdoc has become part of the career path for life scientists in the US. This increase also relates to the rising number of post-doctorate life science researchers who are foreign-born. Other research found that the EU had more post-doctorates numerically in the life sciences in 2003 than the US did; however, only 25% were non-nationals in Europe compared to 57% in the US (see Table 10). The statistics may have changed with further encouragement for international mobility through the EU's goal of creating a European Research Area, but this data is not readily available.

TABLE 10 NUMBER OF POSTDOCTORATES IN LIFE SCIENCES IN EU-25 AND US, ACCORDING TO NATIONALITY, 2003

	EU-25		US	
	Numbers	%	Numbers	%
Nationals	14, 600	75	7,800	43
Non-nationals	4,800	25	10,100	57
Total	19,400	100	17,900	100

Source: IPTS. Estimations from data from Eurostat, NSF, and NetReAct survey from Intra-European mobility of researchers publication (European Commission Directorate General Joint Research Centre, 2007, p. 12)

In other words, in the United States, the life sciences have more post-doctorates than other fields and the majority of doctoral students in the US go on to pursue a postdoc position. While the data on Europe is less detailed, it is clear that post-doctorate positions are a crucial, structural element influencing life science careers.

Although the number of post-doctoral students in the life sciences is high compared to other fields of study, their utility has been debated, particularly in the United States (see discussion in Youtie et al., 2013, p. 1343). While it could be argued that the growth shows the demand and highly developed and specialized research skills needed for life science careers, there is also some concern that the postdoc positions may not be of adequate quality, due to lack of monitoring mechanisms (Human Frontier Science Program & European Science Foundation,

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[31] http://www.nsf.gov/statistics/seind10/c2/c2h.htm#s3, Accessed 4 March 2015

2002, p. 10). Moreover, the National Research Council (US) Committee on Dimensions, Causes, and Implications of Recent Trends in the Careers of Life Scientists (1998) has reported concerns related to postdocs employability:

> By the 1980s, however, there were signs of trouble ahead as the postdoctoral pool began to swell in size. The dramatic jump in number of graduates from PhD programs that began in 1987, driven by the influx of foreign-born PhD candidates together with the increase in foreign-trained PhDs who have sought postdoctoral training in the US, has greatly exacerbated what was already the growing imbalance between the rate of training versus the rate of growth in research-career opportunities.

Taken together, these quotes bring up several concerns. The first point is that although the US is typically considered the leading country for life science research and competitiveness, there have often not been enough open positions for the trained scientists. This situation means that life science careers have both an aspect of being highly competitive and potentially only offering insecure, short-term contracts, mainly in the form of postdoc positions. This is often a prerequisite before getting a tenured position, yet doing this stream of postdocs offers no guarantee that tenure will be reached, as there are few positions available. Furthermore, when a high amount of foreign (noncitizen) post-docs are involved, there is more chance of workforce inequality, of post-docs being used as cheap labor, so to speak, with few long-term job prospects. This may be beneficial for these individuals, if the skills they gain are valued and useful upon return to their home countries or elsewhere, but it brings about questions of whether attracting 'global talent' is a long or short-term policy mechanism and if rights are adequately addressed. Finally, it should be noted that life scientists are often older when they finish their education. Those with post-doctorates may be highly-educated but it is not clear that they necessarily hold the main skills employers want, particularly for jobs in industry. As the biotech industry develops, places with many jobs in industry report that positions may require anything from only a high school degree to advanced research (New Economic Systems & The Leonard Resource Group, 2004, pp. 30-31). The academic faculty positions that post-doctorates are best trained for are often few and far between.

Interest in studying science: Developing versus developed countries

The US has become known for attracting the 'best and brightest' scientists from around the world, including high percentages from developing countries. Recent programs in Australia have also aimed to attract more international students, particularly from Asia. As discussed in Chapter 4, Europe is also trying to expand its openness to researchers from across the world through the ERA programs. The role of students from developing countries in science programs in graduate schools in Europe has not been well-documented.

Other research shows that more people from developing countries aspire to be scientists than in developed countries. This trend is reflected both in numbers of enrollments and in survey data. Likewise, the largest rates of growth in scientific researchers also are occurring in developing countries and the US National Science Foundation, using OECD data, reported "moderate average growth from 1995 to 2007 for established scientific nations and regions, in contrast to rapid growth in selected developing regions."[32] The Relevance of Science Education project (Sjoberg & Schreiner, 2010), a survey conducted among students up to the age of 15 in 40 countries, similarly found more interest in science careers among developing countries:

> Children in most countries agree strongly that 'Science and technology are important for society' (p.6). […] However, within Europe very few young people agree with the statement 'I would like to become a scientist'. In particular, there are extremely few girls who want to become scientists, and even for the boys the percentage is very low. We also observe that the more developed the country is, the lower is the wish to become scientists.

If these trends continue, a larger proportion of the world's scientists may come from developing countries.

INTEREST IN VARIOUS LIFE SCIENCE CAREER OPTIONS IN THE CILS STUDY

Before turning to the survey results from the CiLS study, a caveat has to be made about how the various trends named above can be analyzed. One of the greatest challenges of social science research is the need to understand various demographic, contextual, institutional and cultural differences of the research question at hand. In order to address this, gender, age, field of study, country of origin, and current country of residence are each provided after quotes from individuals in the CiLS study, but each topic cannot be addressed in full in one study.

Educational attainment and career goals

The sample of the CiLS survey (n=594) reflects the views of a global and highly-educated group. As mentioned in the methodology section, the study was open to anyone who had a higher education or experience in a life science job. The CiLS respondents, reside in 69 different countries. The majority (68%) has a graduate-level education: 43% have a Master's degree, 14% a PhD, and 12% a postdoc. 59% of the sample (350 individuals) were studying at the time they took the CiLS survey. Among the total sample, 11% are currently working on a Bachelor's, 14% a Master's, 27% a PhD, 2% a postdoc, and the remaining 5% in apprentice, technical, or other programs. The total CiLS sample contains a nearly even split between males (49 per cent) and females (51 per cent). This is nearly in line with the EU average whereby *Eurostat* reports that 51 per cent of those employed in science and technology occupations in the EU are female (Meri 2008). The mean age of the sample is 28, with a range from 17-64. 63% are single compared to 20% who are married, 13% who live with their partner, and the remaining 4% who classify themselves in another category, such as widowed or divorced. The majority of respondents do not have children (89%). The sample of those with work experience (419 people, remainder are students), report a mean of 5.92 years of full-time work experience in life sciences, including time working in internships. Although science career options asked in the survey range from

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[32] http://www.nsf.gov/statistics/seind10/c3/c3h.htm, Accessed 4 march 2015

sales to production to media to teaching, the majority of those currently employed are working in research (75%). In other words, the group in the survey sample is in line with the group discussed as ‘attractive’ in the global competition for talent: young, highly-educated, and pursuing research careers linked to the knowledge economy.

As shown in Tables 11 and 12, the survey asked the respondents, “What is the highest degree or qualification you plan to achieve (by the end of your academic career)?” First, almost all respondents seek a higher education in the life sciences. Females also were more likely to say that they do not know yet, and were less likely than men to say they are aiming for the title of professor. Second, it, it is important to note that the development level of the country of origin seems to have an impact on the top qualification desired, with those from developing countries more likely to aim primarily to attain postdoc or professor positions. In contrast, individuals from various European countries are more likely to say the “don’t know”. In contrast, individuals in developing countries are more likely to see high education as a necessity for personal career success. These differences can be interpreted as showing that females and people in developed countries frequently have an attitude of wanting to keep their options open and adjust depending on the course of their careers and family lives.

TABLE 11 HIGHEST ACADEMIC QUALIFICATION DESIRED - GENDER CROSSTABULATION AND BY COUNTRY OF CITIZENSHIP

Highest academic qualification desired		Gender - Counts		Total
		Male	Female	
	Other	12	6	18
	Secondary school/high school	1	0	1
	Apprentice, technician or higher training in life sciences (outside of university)	1	2	3
	Bachelor’s or equivalent	7	4	11
	Master’s or equivalent	25	23	48
	PhD	79	80	159
	Postdoc	50	64	114
	Professor	78	57	135
	Don’t know yet	39	66	105
Total		292	302	594

		Highest Qualification Desired						
Country of citizenship		Bachelors or less	Masters or equivalent	PhD	Post-doc	Professor	Dont' know yet	Total
World Bank Developing, not in EU	Count	4	6	24	26	38	9	107
	%	3.74%	5.61%	22.43%	24.30%	35.51%	8.41%	100.00%
India	Count	5	9	31	27	26	4	102
	%	4.90%	8.82%	30.39%	26.47%	25.49%	3.92%	100.00%
China	Count	0	0	4	2	2	4	12
	%	0.00%	0.00%	33.33%	16.67%	16.67%	33.33%	100.00%
EU-10	Count	0	0	2	4	9	6	21
	%	0.00%	0.00%	9.52%	19.05%	42.86%	28.57%	100.00%
Poland	Count	0	0	7	5	7	8	27
	%	0.00%	0.00%	25.93%	18.52%	25.93%	29.63%	100.00%
France	Count	0	4	5	2	3	2	16
	%	0.00%	25.00%	31.25%	12.50%	18.75%	12.50%	100.00%
Germany	Count	4	1	27	15	10	19	76
	%	5.26%	1.32%	35.53%	19.74%	13.16%	25.00%	100.00%
Italy	Count	6	4	13	8	5	13	49
	%	12.24%	8.16%	26.53%	16.33%	10.20%	26.53%	100.00%
Spain	Count	5	10	14	12	12	14	67
	%	7.46%	14.93%	20.90%	17.91%	17.91%	20.90%	100.00%
Switzerland	Count	3	3	12	6	5	13	42
	%	7.14%	7.14%	28.57%	14.29%	11.90%	30.95%	100.00%
United Kingdom	Count	1	2	2	0	2	4	11
	%	9.09%	18.18%	18.18%	0.00%	18.18%	36.36%	100.00%
United States	Count	1	1	1	2	4	1	10
	%	10.00%	10.00%	10.00%	20.00%	40.00%	10.00%	100.00%
All Others	Count	4	8	17	5	12	8	54
	%	7.41%	14.81%	31.48%	9.26%	22.22%	14.81%	100.00%

Post-doctorate positions

In the CiLS study, 65 individuals (11% of total sample) have completed at least one post-doctorate (Table 12). Among these, 39 have had one postdoc position, 18 have had two positions, 5 percent have had three positions, 2 have had four, and 1 had five or more.

In addition, 11 individuals said they were currently working in a post-doctorate position. Most of these are working on their first post-doctorate, as only 2 had indicated they had held a postdoc position before. The duration of the postdoc positions varies substantially (Table 13).

TABLE 12 NUMBER OF POSTDOCS ALREADY COMPLETED

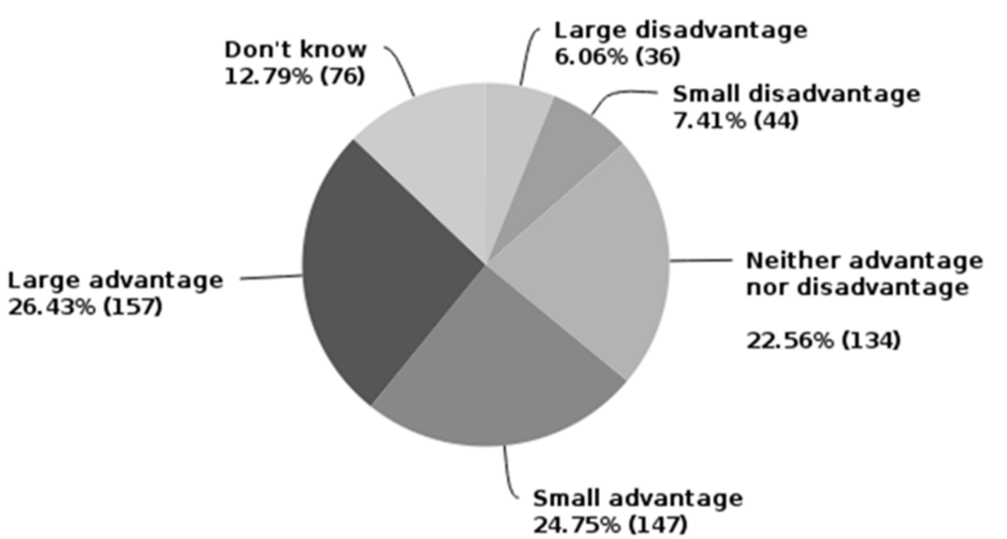
Answer options	**Percent**	**Response count**
One	53.4%	39
Two	24.7%	18
Three	6.8%	5
Four	2.7%	2
Five or more	1.4%	1
Have not completed a postdoc position yet	11.0%	8
answered question		**73**

TABLE 13 EXPECTED TIME IN POSTDOC POSITION

Answer Options	**Percent**	**Count**
Less than 1 year	12.30%	9
1-2 years	23.30%	17
More than 2 years but less than 3 years	17.80%	13
More than 3 years but less than 4 years	15.10%	11
More than 4 years but less than 5 years	15.10%	11
More than 5 years	16.40%	12

Figure 9 shows that more than half of CiLS respondents expect having a postdoc will be a benefit for employment in industry and slightly less than half feel it is not needed or are not sure. Although postdoc positions are often needed to gain tenure in academia, the additional time in an academic setting may not be of value for industry. Furthermore, higher education often means the employer needs to pay a higher salary.

FIGURE 9 IMPORTANCE OF POSTDOC FOR CAREER IN INDUSTRY

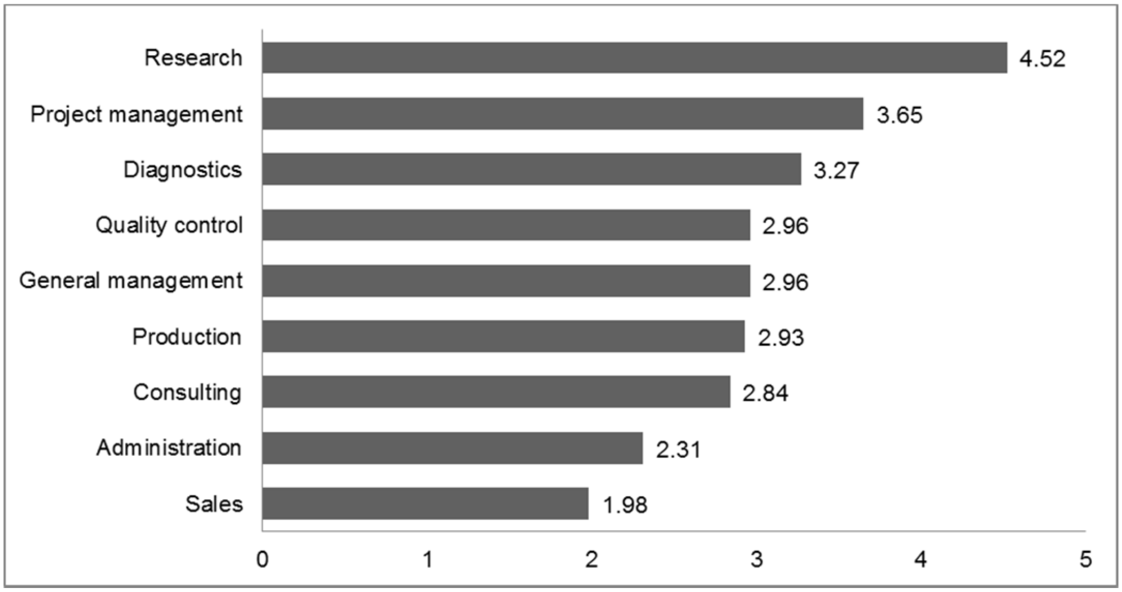


Desired type of employer and job role

The CiLS survey also asks a number of questions to assess life scientists' interest in various employment types and forms of biotechnology. All of the questions shown in this section use the following 5-point rating scale: 0 is for don't know; 1 is for not interested at all; 2 is for not very interested; 3 is for interested, I would consider it; 4 is for quite interested; 5 is for extremely interested.

Despite the broad definition to account for the full spectrum of life science careers, the CiLS respondents indicate that they are aiming for jobs as life science *researchers* (see Figure 10). Research received a mean score of 4.52 on a scale with 5 as the highest. Furthermore, the mean score remained the highest rated option, with a mean 4 or higher when looking across each level of education (ranging from those who have only finished high school to those with post-docs). The next highest score was for project management, but with a steep jump downward, having a mean score of 3.65. Sales and administration positions within the life sciences were the least desired positions. This is in line with the research and reports discussed earlier, which show that the life science graduates have a narrow focus on the type of career desired. It is also worth mentioning that the result was personally surprising to me, as I expected that with the large range of job functions available there would be more individuals aiming for other career paths, particularly among life scientists with undergraduate level training or less.

FIGURE 10 INTEREST IN VARIOUS JOB POSTIONS IN THE LIFE SCIENCES IN THE NEXT 5 YEARS, MEAN SCORES



Life scientists' answers on the *types* of employers they are interested in show combined interest in academic, government, and industry for future employment. Six employers have a mean score of around 4: Biotechnology company, research outside of university, local or national government research institutes, academic career/university, international organizations and agencies (e.g. WHO, UN, EC etc.), and pharmaceutical companies. In fact, within the CiLS sample, there is higher interest in jobs outside of academia (see Figure 11), particularly within biotechnology companies, in all of the country groups except for those from developing countries (outside of the EU and not including India). The high interest in biotechnology companies may be partially a reflection of the sample, and may be due in part to the intro of the survey saying that the study is being conducted by the YEBN. However, it is also an important indication that life scientists see their career options as extending past the traditional academic route and that any range of employers are considered in order to pursue the goal of having a *research* career. Interest in working in large (mean 4.07) or medium-sized (mean 4.05) companies is higher than for small (mean 3.75) and micro-companies (mean 3.17). There are some differences by education (see Figure 12) – life scientists who have only completed their Bachelor's degree find large companies particularly attractive, likely due to the large range of career options, prestige, and resources available. Individuals who have already finished their postdoc are more favorable about options available in companies with fewer than ten employees than those with less education, but the overall rating is still lower than for larger companies. In comparing mean scores by gender, the biggest difference is seen in interest to work in large companies, where males average 4.16 and females 3.94.

FIGURE 11 INTEREST IN WORKING FOR VARIOUS EMPLOYERS IN NEXT 5 YEARS (OR WITHIN 5 YEARS OF FINISHING STUDIES) , MEAN SOCRES

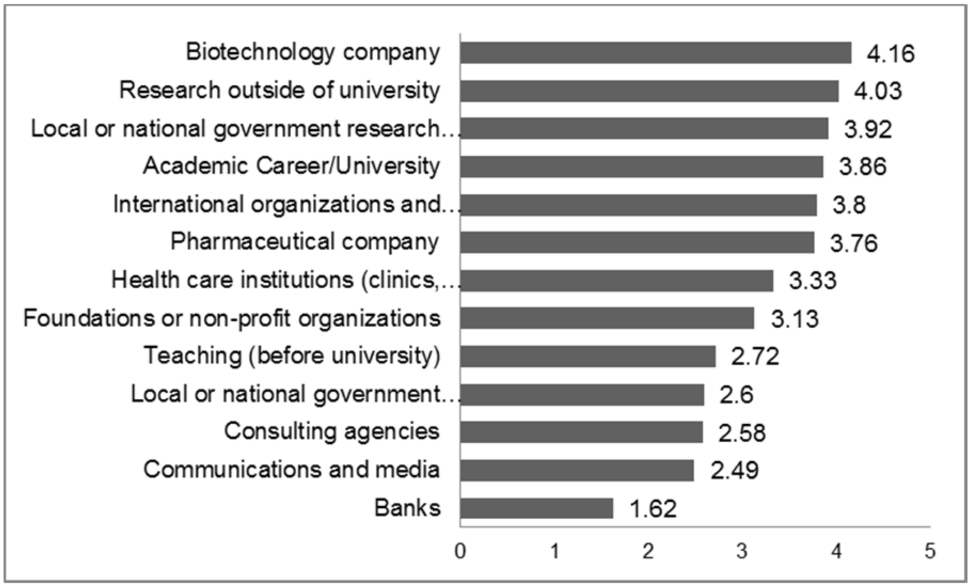
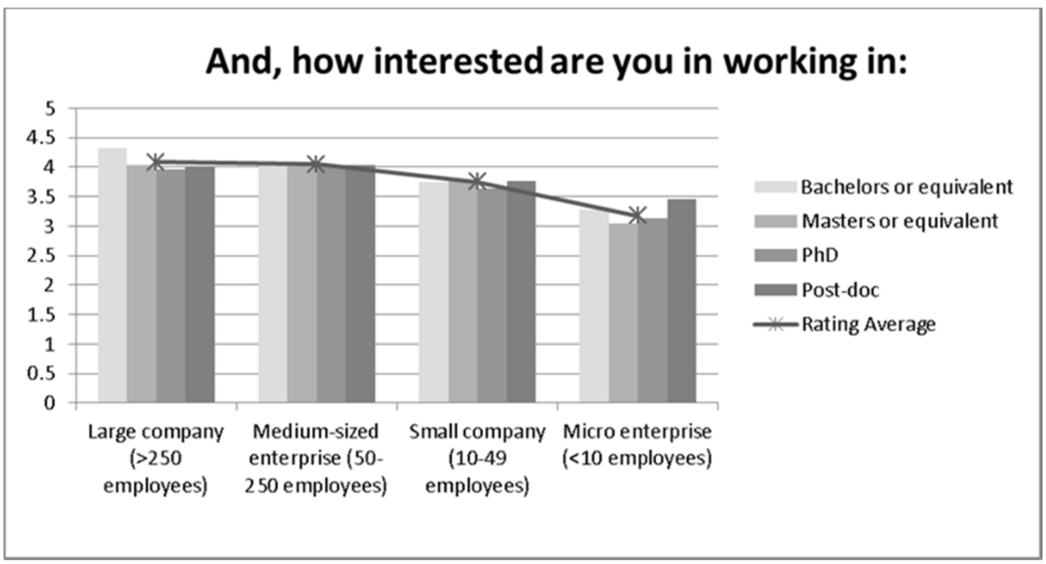


FIGURE 12 INTEREST IN COMPANIES, BY SIZE OF COMPANY AND EDUCATION LEVELS



DISCUSSION AND CONCLUSIONS: NEW CHALLENGES FOR LIFE SCIENCE CAREERS

This chapter has used academic literature and statistical data to show some of the industry and career particularities among life scientists. The analysis helps to address the research question, "Which patterns have influenced the development of the global competition for talent as observed in the life sciences/biotechnology in particular?" A review of the literature and statistical data shows that large-scale changes are occurring both in the career trajectories and demographic characteristics of life scientists.

What are these career particularities that have an impact on life scientists globally? Desk research has shown that the career options for life scientists have changed in recent decades, led primarily by the rising importance of biotechnology research and its application in industry, or for use towards various products. While life scientists traditionally have been seen as grooming themselves for an academic career, secure academic positions have since become more coveted and a series of insecure, postdoc positions is common among advanced researchers. At the same time, with the rising need for research within industry, the options for conducting scientific research outside of the academic setting are also expanding, yet the educational system may not be preparing students sufficiently for the skills needed in these jobs. There has also been a long-held prestige among life scientists for conducting independent research, and life science careers often spawn from altruistic motives and an interest in solving global problems in fields such as healthcare or the environment. Whether or not this expectation is met by the actual career path will vary, not just between academia versus industry, but also by individual job roles.

In addition, the composition of scientists has changed in several pronounced ways in the past decades. First, women have a prominent place in life science graduate programs, outnumbering men in most countries. This statistic is important, as it is still common to see studies about the need for more females to pursue scientific careers, although this assumption rarely applies now to the life science sector. This means that the life sciences can serve as an especially fruitful example for looking at the integration of women into the scientific workforce in future research. Second, both statistics and attitude surveys show that scientists from developing countries will likely be a crucial part of the global scientific workforce. This is in line with the discussion presented on what structures the global competition for talent in general. On one hand, there are increasing higher education levels in general across many countries and is coupled with the strengthening of scientific spends in these countries. These increases are found not only in China, India and Brazil but also across the diverse countries in the EU, as will be discussed in more detail in later chapters. On the other hand, it is also due to the higher regard many individuals from developing countries have for scientific careers, compared to attitudes among individuals from OECD economies, an aspect that is important for scientific careers in particular. At the same time, there is also increasing opportunities for international mobility, and scientists from developing countries now have more international options, particularly for destinations for study, including more choices in Europe. Since internationally comparative statistics are often not available for the scientific workforce in general or even by field of study the extent of these changes may not be fully understood. In combination with the increasing global mobility, international partnerships are increasing, as evident through looking at published journal articles.

These partnerships are a further indication of increasing international networks among institutions, networks that may lead to future exchange of students and faculty. Third, numbers of post-doctoral positions have been rising in the life sciences. The life sciences have the highest percentage of postdoc positions as compared to other departments in academia in the US. However, the utility of post-docs is criticized, both in terms of their skills as well as in terms of whether insecure post-doctorate positions are replacing longer term, more secure academic positions.

The global competition for talent is a topic of interest to businesses and governments precisely because of the complexity of these changes. It is not a simple linear situation where increasing interest in life science research within the knowledge economy means an identifiable demand that individuals can train for and a clear chance for a fulfilling career. It rather reflects the difficulty for individuals to choose from an increasing myriad of career possibilities, and for organizations to reach and select the best matches for their needs. Research positions are the most coveted, as evident in various research and through the CiLS study, but the demand for these will vary greatly across place, time, as well as by specific field of research. The characteristics of the workforce too are changing, and demographic changes present both policy and organizational challenges, as the workforce diversity undergoes new patterns. Women, who are now forming the majority of life science graduate students in many countries, may have different needs from their employers then men, for instance.

This chapter also looked at the desired educational attainment and career paths of the individuals in the CiLS sample. This information helps to frame the discussion in the following chapters. The majority of the CiLS sample either already has or wishes to attain an advanced degree. One of the main findings is that the sample is interested in pursuing careers in research, a career path which often requires high levels of education, but will consider a range of employers, including both academia and industry. However, further investigation shows that scientists prefer medium or larger-sized companies, when working in industry, which is assumed to be due to the greater resources available in these companies and greater degrees of stability (although job security is rarely certain). Interest in obtaining the higher levels of education was related to a growing interest in research careers, over other job types, but was not fully linked to a strong interest in having an academic career. The exceptions were those desiring to be a professor, which by the designation alone, shows intent to pursue a mainly academic career. However, those desiring their final qualification to be a PhD or postdoc showed more interest in both pharmaceutical and biotechnology companies as future employers. Nonetheless, the life scientists had very mixed impressions as to the degree to which very high research experience, in the form of a post-doctorate, would help in finding jobs in industry. This was echoed in the various discussions I had with members of the Young European Biotech Association. Many scientists told me that asking the importance of the postdoc for jobs in industry was interesting, precisely because they did not know how it affected their employability. Higher education often means companies have to pay a higher salary, and the skills obtained may not match the employers' needs.

The characteristics that structure the global competition for talent as well as a lack of research of various contextual differences that guide scientific careers add fuel to better understand the quote in the opening paragraph of this chapter, which states that scientists may not be able to find jobs that match their training or personal expectations. The characteristics of scientists and their careers are changing; the institutions involved in scientific research are changing; the topics, methods, and types of scientific knowledge produced are changing. With so many changes, there are also multiple configurations for competitiveness, whether it is viewed in terms of personal career strategies or in terms of institutional structures that influence differences and competitiveness across places. Collett and Zuleeg (2009) have referred to the global competition of talent as being related to the need to better assess and access “scarce, soft, and super skills.” All of these variations in skills sets are relative to life science careers. These changes mean that the core concern may not always be to train more scientists, but rather in matching the right individual for the right position, in the right place. These changes also need to also be considered alongside the broader structural changes discussed in the first part of this book – more options and patterns for international mobility, particularly among students and scientists, and the growth of the knowledge economy and related changes in employment patterns albeit with differences across places. Although much more can be said about the changes in careers of life scientists, for instance on skills needed for scientific careers, the primary goal of Part II of the study is to focus first on competitiveness and then on international mobility, and how life sciences can show dynamics of the global competition for talent.